



Economic Commission for Africa

State of the Environment in Africa



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State of the Environment in Africa

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EXECUTIVE SUMMARY

The main objective of the State of Environment in Africa report is to identify and highlight the major environmental issues of concern on the continent and to make recommendations for action.

The information presented confirms that the state of the environment in Africa has been (and continues to be) influenced principally by rapid population growth, increasing and chronic poverty and inappropriate development practices, especially agriculture production methods. These factors have led to what has become popularly known as the population-agriculture-environment nexus. Other factors include unfavourable terms of international trade, the debt burden, the impact of drought and other natural disasters, and ineffective development policies.

The cumulative impact of the above-mentioned factors on the environment is extensive degradation of land and other natural resources. The issues of concern are many and include: widespread land degradation and desertification; loss of arable and grazing land; declining soil productivity; loss of biodiversity; pollution and depletion of freshwater resources; and deteriorating air quality (especially in urban areas). These have wider implications on food security, sustainable natural resources management, human health and efforts towards poverty eradication. Details of the identified factors and major environmental issues of concern are discussed below.

Africa's large population (estimated at 778.4 million in 1999) and its high rate of growth are exerting pressure on the continent's natural resources. Per capita arable land has dropped from 0.6 ha/person in 1961 to 0.27 ha/person by 1993. The majority of the people are poor and they depend on natural resources for their livelihoods (i.e. to meet their food, energy, water and other basic needs). Because of their poverty, many farmers are incapable of undertaking intensive agriculture that requires significant inputs or to undertake other soil improvement investments. The only alternative left for them is to use the soil until it is completely degraded.

Land degradation is widespread and a major problem throughout Africa. Nearly 500 million hectares are moderately to severely degraded. This is linked to population pressure, as well as inappropriate land uses, poor agricultural production technologies, poor land management and drought. The degradation has given rise to increased desertification, decreasing land productivity and loss of arable land. Approximately 50 per cent of land degradation in Africa is from overgrazing, 24 per cent from activities related to crop production, 14 per cent from vegetation removal and another 13 per cent from over exploitation of the land. A degraded environment produces less food, makes biomass fuel scarcer, reduces ecosystem resilience, and renders people malnourished and more susceptible to diseases.

Africa has a large and diverse heritage of biodiversity, including more than 50,000 plant species, 1,000 mammal species and 1,500 bird species. Unfortunately, a significant proportion of these rich biodiversity resources is either endangered or under threat of extinction. Africa holds five of the 25-biodiversity hotspots of the world, including the Guinean hotspot, which is home to half of Africa's mammalian species. There

are a number of critically endangered species in all African countries, with the highest numbers being, perhaps, in Tanzania (43 mammal, 33 bird and 236 plant species) and Madagascar (50 mammal, 27 bird and 162 plant species). The Democratic Republic of Congo and Côte d'Ivoire are other countries where biodiversity is endangered and/or are vulnerable. Most of Africa's indigenous tropical forests are also threatened. One estimate puts the rate of decline at nearly one per cent per annum.

The major threats to Africa's biodiversity resources come from climatic variations and human activities. Logging, over-hunting, introduction of alien species, and expansion of agricultural land are some of the most serious threats to biodiversity. Logging accounts for 79 per cent of forest loss in Africa, while agriculture and energy and other infrastructure development account for 17 and 12 per cent of biodiversity loss, respectively.

Though the continent is endowed with abundant water resources, most of them are not developed and, therefore, are not available to the large and growing population. About 65 per cent of the rural population are without access to clean and adequate water supply and 73 per cent of the people in rural areas do not have access to adequate sanitation facilities. The situation is no better in the urban areas where an estimated 25 and 43 per cent of the population do not have access to clean water and sanitation facilities, respectively. Projections show that by 2025 some 690 million people will be living in either water-scarce (230 million) or water-stressed (460 million) countries due to inadequate development in the water sector to meet demand.

Pollution of water bodies from poor sanitation and poor management of solid waste, and by effluents from agricultural and industrial activities is aggravating the problem of water scarcity. Wetlands in many countries (including Nigeria, Cameroon and Botswana) are also at risk from conversion to agricultural production and other developments such as construction of dams on rivers that feed into the wetlands. Development of wetlands has considerable ecological and socio-economic costs on the continent.

In addition to the depletion of fresh water resources, marine and coastal area resources are also under threat. The African coastal and marine environment has a broad range of habitat types that harbour rich biodiversity of great ecological and economic significance. Over the years, however, these resources have been exploited to meet development needs. Humanity's increasing demands on the coastal and marine environment have been very exploitative in nature, resulting in the degradation of its resources both quantitatively and qualitatively.

Compared to the industrialized countries of Europe and North America, Africa's contribution to global climate change is not significant. Fossil fuel CO₂ emissions are low in both absolute and per capita terms. Only five countries are largely responsible for Africa's regional emissions from fossil fuel and cement. South Africa is by far the greatest emitter, responsible for 39 per cent of the continental total. Another 42 per cent of CO₂ come from Algeria, Egypt, Libya and Nigeria combined. Only Libya (with 1.98 metric tons) and South Africa (1.88 metric tons) have per capita emissions higher than the global average of 1.13 metric tons of carbon per year.

Despite this, the continent is considered more susceptible to the effects of climate change, because limited resources restrict Africa's ability to undertake preventive measures to mitigate the effects of weather and climate extremes. Climate-related disasters and diseases are on the increase. The impact of drought, cyclones, floods and bushfires has brought misery (e.g. starvation, homelessness and death) to millions of people, especially in the Horn of Africa and throughout Southern Africa. Malaria, cholera and lower respiratory tract infections are also on the increase. These are a result of climate change, deteriorating water and air quality, and poor disposal of solid waste in urban areas, among other factors. Malaria, for instance, is increasing in territories where the parasite was hitherto non-existent. Similarly, diseases once thought to be under control, such as drug resistant tuberculosis, have reappeared and increased tremendously, causing over three million deaths annually.

The inability of urban authorities to provide basic amenities such as water and sewage facilities and their inability to properly manage solid and other wastes from domestic and industrial sources is a major concern. The quality of life in many African cities deteriorated during the 1990s, especially in spontaneous, unplanned informal settlements. Air pollution and foul odours are common in such cases.

In conclusion, the environment in Africa is undergoing various types of deterioration. In order to correct the continuing disastrous trend, African countries must address the root causes of the deterioration. In this regard, action must be taking in four major areas. These are:

- Transforming the agricultural sector to make it more productive;
- Safeguarding and sustainably utilizing the natural resource base;
- Pursuing accelerated socio-economic development to eradicate poverty; and
- Reducing the high rate of population growth.

SECTION ONE OVERVIEW

I. INTRODUCTION

1.1 Background

For the past 50 years, Africa has been the region with the highest population growth in the world. The continent is also the poorest region. The majority of the people, especially the rural dwellers, are poor. Recent estimates show that nearly 60 per cent of the rural population live below the acute poverty line of \$US 1 per person per day. Urban poverty is equally widespread, with approximately 43 per cent of the population living on less than \$US 2 per person per day. In total there are about 300 million people in sub-Saharan Africa that live below the poverty line.

The majority of the people depend on natural resources for their livelihoods. They are engaged in agriculture but because of the high rate of population growth, arable land is becoming scarce. In 1961, the average per capita arable land in Africa was 0.6 ha/person. By 1993, this amount has more than halved - dropping to 0.27 ha/person. Poverty has also rendered many farmers incapable of undertaking intensive agriculture that requires significant inputs and capital investments in land and farm-level improvements. Thus, African agriculture has largely remained traditional.

The implications of the acute poverty, poor agricultural production methods and high population growth rate include high illiteracy, increasing starvation, poor health and a degraded environment, among others. A poor and hungry people will often destroy the environment in their efforts to survive. Through traditional crop and livestock production systems, they cut down forests and/or overuse marginal lands in order to produce food; their livestock overgraze grasslands, and because of lack of access to more land as a result of increases in their numbers and obstacles from land tenure regimes, they migrate to congested cities in growing numbers in search of alternative employment. In the cities they establish shanty dwellings in slums where they do not have access to clean water and sanitation facilities.

The cumulative effect of this state of affairs is the creation of a vicious cycle in which the poverty and deprivation intensifies and the environmental degradation worsens. The transition from a healthy environment to the present conditions may be traced back several decades.

At independence, i.e. between 1950 and 1970, many African countries achieved fast economic growth and development through the exploitation of the rich natural resources. However, towards the end of the 1970s and in the early 1980s, there was severe deterioration in economic performance and a rapid environmental degradation. Many countries embarked on structural adjustment programmes with the hope of addressing widespread poverty and the debt burden, without much success. From similar experiences around the world, it became obvious that issues of economic development cannot be separated from environmental issues and that the two are not separate challenges but are intricately linked in a complex system of cause and effect.

This realization led, first, to the Stockholm Conference in 1972 and subsequently, to the United Nations Conference on Environment and Development (UNCED) in Rio

de Janeiro in 1992. Agenda 21, seen as the guideline to sustainable development, was adopted during UNCED or the Earth Summit. In Rio, there was a firm conviction that the nations of the world, in a spirit of multilateralism, would join hands in the implementation of Agenda 21 so as to create harmony between economic development and the environment, thereby achieving sustainable development. Africa participated fully in UNCED with great expectations from the new idea of global cooperation for sustainable development forged in Rio.

Ten years after Rio, and as the world prepares to review the progress of sustainable development during Earth Summit II in Johannesburg, many African countries still face enormous economic pressures and the quality of the environment continues to deteriorate. The need to raise much needed finance to service the increasing debt burden and to address issues of chronic poverty is as strong as ever. The overexploitation of the continent's rich natural resources continues while soil fertility is decreasing as land degradation and desertification are on the increase. Salinization, soil compaction, overgrazing, deforestation, and agrochemical and accumulated pesticide pollution are also on the increase. So are the depletion of freshwater resources and some of the world's richest biodiversity.

1.2 Goals and Objectives

The goals of the State of the Environment in Africa report are two fold: first, it is a requirement under the Work Programme of the Food Security and Sustainable Development Division (FSSDD) of the United Nations Economic Commission for Africa (UNECA) for the biennium 2000-2001. The intention is for the Commission to provide specific Africa regional input into the Global Environmental Outlook report produced by the United Nations Environment Programme (UNEP). Secondly, the report is intended as a resource material on the environment in Africa for the general public. The report seeks to achieve three objectives:

- To describe the continent's environmental status for the general public;
- To highlight the major environmental issues facing the continent; and
- To recommend strategic actions concerning these issues.

In this regard, the report may be a timely and useful contribution to the African regional preparations towards the 2002 World Summit on Sustainable Development. Because of the nexus dilemma of population, agriculture and environment that is plaguing the continent, this report also attempts to link the prevailing environmental issues to food security and poverty. Updates may be produced in the future. However, these will depend on the availability of resources and the demand for reporting on the state of the environment. Nonetheless, comments and suggestions are invited from users with the view of providing guidance and improvements upon possible future editions.

1.3 Organization of the Report

The report comprises three sections. The first section provides a general background to the current status of the environment. A historical perspective of post-independence development strategies and choices is provided to show the link between some of Africa's past development efforts and the present state of the environment, shown by highlighting the nexus of population, environment and development.

In section two, a synthesis of various current sectoral issues and facts are provided. Issues related to the atmosphere, climate and natural disasters, land resources, food production, freshwater resources, coastal and marine ecosystems, biodiversity, the urban environment, and environmental impact on human health are discussed. The final section contains suggestions for immediate action, including the setting of priorities with a focus on sustainable development.

II. ENVIRONMENT AND DEVELOPMENT

2.1 Physical Characteristics

Africa is the second largest of the world's seven continents with a land area of 30 million km² - about one-fifth of the world's total land area. Straddling the equator, it stretches 8,050 km from the northernmost point in Tunisia to its southernmost tip in South Africa. It is 7,560 km wide, measured from the western tip in Senegal to the eastern tip in Somalia. Mount Kilimanjaro in Tanzania, measuring 5,895 m above sea level, is the highest point while the lowest is Lake Assal (153m below sea level) in Djibouti.

Physiographic Regions: Made up of 54 countries, the continent comprises a vast rolling plateau. Much of the west, central and northern Africa is low-lying while the eastern and southern Africa regions are dominated by high altitudes. On the basis of elevation, the continent may be divided into three major regions:

- tainous regions along the desert fringes such as the Atlas Mountains, the Fouta Djallon and the Adamawa Massif.
- The Central and Southern Plateau, averaging 900 m in height encompasses west-central and southern Africa. It contains several major depressions, notably the Congo River Basin and the Kalahari Desert. South of this plateau are the folded chain of the Maluti-Drakensberg mountain range which runs some 1,000 km along the south-eastern coast of the continent.
- The Eastern Highlands, the highest part of the continent, lie near the eastern coast, extending from the Red Sea southwards to the Zambezi River along the fault of the Rift Valley. The average elevation in this region is more than 1,500 m above sea level and it includes a number of towering volcanic mountains such as Mount Kilimanjaro, Mount Kenya and Mount Elgon.

Soils: Although African soils vary widely, they have major similarities. Most have developed locally, primarily by weathering. A few areas have alluvial soils laid down by rivers or ocean currents. Being typically tropical soils, most are relatively infertile, lacking humus and subject to mineral leaching from heavy rainfall and high temperatures. About 90 per cent of the soils are deficient in phosphorus, a key nutrient for the production of biomass. The soils also have low water infiltration and retention capacity due to surface crusting. The most fertile soils include the black soils of eastern Africa and the alfisols in parts of western and southern Africa.

About half of Africa's cultivable land is arid and semiarid comprised mostly of desert soils (aridisols and entisols), which have the least organic matter content. Therefore, most of this land is degraded. About 65 per cent of cropland and 30 per cent of the pastureland in Africa are affected by degradation with consequent decline in crop yields and chronic food insecurity. It is also estimated that 14 per cent of degraded soil result from vegetation removal, 13 per cent from over-exploitation, 49 per cent from over-grazing and 24 per cent from agricultural activities (World Resources Institute - WRI, 1992).

Drainage System: Some of the world's greatest rivers are contained in Africa. In all, six major networks drain the continent. The River Nile drains northeastern Africa, and, at 6,650 km, is the longest river in the world. The River Congo, some 4,670 km long, drains much of central Africa while the Niger River (4,189 km long) is the third longest on the continent and, rising from the Fouta Djallon highlands, it drains most of West Africa before emptying into the Gulf of Guinea. The other major river-drainage systems are: the Zambezi (3,540 km), the Limpopo (2,100 km) and the Orange Rivers - all of which drain the southern Africa region. With the exception of the Lake Chad basin, which forms the largest inland drainage system, all the drainage networks have outlets to the sea. It is argued in Chapter 7 that in spite of abundant freshwater resources, a large proportion of the peoples of Africa are without access to clean water due to inadequate development in the sector.

Climate: Changes in climate has been experienced over a long period. From 150,000 years ago to about 8,000 years ago different cyclic climatic conditions occurred, ranging from cold and arid, to warm and moist with associated poor and luxuriant vegetation (Adams, 1997). The weather has also varied between wet and dry decades with intermittent drought and floods. However, extreme weather conditions seem to be increasing in frequency in recent years (World Bank, 1995). Proportionately, Africa has a larger area in arid (or desert) climate zones than any other continent except Australia. Each of these areas - the Sahara in the north, the Horn of Africa in the east, and the Kalahari and Namib deserts in the southwest - has less than 200 mm of rainfall annually.

Precipitation varies from almost zero over the Horn of Africa and the Namib Desert to over 4,000 millimetres a year in the western equatorial region (United Nations Environment Programme - UNEP, 2000d). A large proportion of the continent, however, is semiarid with rainfall ranging from 200 to 800 millimetres a year. A study of the rainfall pattern between 1900 and the 1980s shows a decline in amounts since 1968 (UNEP, 1985).

Vegetation: Most of the vegetation can be classified according to rainfall and climatic zones on basis of which seven broad vegetation zones are identified. The tropical rainforest zone with numerous species of tropical hardwood trees and dense surface cover is found where rainfall is more than 1,270 mm per year. In the mountain forest zone, the annual rainfall is slightly less than in the tropical forest. This is found in the mountains of Cameroon, Angola, eastern Africa and parts of Ethiopia. The savannah woodland zone experiences annual rainfall of between 890 to 1,400 mm. It covers vast areas and is characterized by fire-resistant shrubs, deciduous and leguminous trees. The savannah grassland zone is found in areas with annual rainfalls of between 500 and 890 mm and is covered, predominantly, by low grasses and shrubs.

The remaining three zones occur where the annual rainfall is below 500 mm per annum. These are the thornbush zone (300 and 510 mm), characterized by sparse grass cover and a scattering of succulent or semi-succulent trees, the sub-desert scrub zone (130 to 300 mm), and the zone of desert vegetation (below 130 mm). These have sparse vegetation or none at all.

2.2 Population

Africa is the continent with the highest population growth rate of 2.7 per cent in 2000. At the turn of the 20th century, the region's population was only 118 million but by mid 1999, it had reached 778.4 million. Even though Africa's population growth rate has started to slow down, it is estimated that the total population will increase to 1,453 million by the year 2025. There will, however, be regional differences. The growth will be slightly faster in central Africa (2.2 per cent), eastern Africa (2.0 per cent), and western Africa (2.0 per cent) but slower in southern Africa (1.3 per cent).

Two main population density types characterise the continent's population: high variability and low on average. The average population density increased from 7 inhabitants per km² in 1950 to 24 in 1995 and is projected to increase to 46 in 2050. This is low compared to other tropical regions of the world: 152 in the Caribbean, 127 in southern Asia, 121 in eastern Asia, and 107 in Southeast Asia. Regional differences occur, however, in the continental distribution given rise to both very low and high densely populated areas. The highest population densities are found in the island states of eastern Africa where densities range from 160 in the Seychelles to 570 in Mauritius. While some of the lowest population densities are found in the Horn of Africa, for example, Somalia (14), Djibouti (27) and Eritrea (30).

Factors accounting for the growth and distribution of Africa's population are ecological and historical. Areas with ecological factors conducive to agriculture have dense populations while most dry tropics are sparse. Hills and mountainous areas are not obstacles to habitation while rivers scarcely influence settlement. Historical factors that contributed in reducing Africa's population include slave trade, devastated bloody conflicts and international migration. Colonization, on the other hand, only modified population distribution.

2.2.1 Future Population Trends

Population projections show a decline in fertility from 6.1 children per woman in 1995 to 2.9 by 2025. This will be accompanied by a slow and uneven decline in mortality. Life expectancy is expected to increase from 50.1 years between 1995 and 2000 to 62.1 in 2025. There are expected striking differences. In 2025, life expectancy at birth could reach 80 years in Reunion, 77 in Mauritius and 74 in South Africa. It will probably not rise much above 57 years in countries with poor health services or hard-hit by the HIV/AIDS epidemic. The HIV/AIDS epidemic has a definite slowing effect on the decline in mortality.

2.2.2 Urbanization

There is a fast urbanization process in Africa although most Africans live in rural areas. It is estimated that rural populations will continue to grow from 400 million in 1995 to 600 million in 2025 but will eventually fall after 2050; dropping from 69 per cent in 1995 to 51 per cent in 2025. Urban population, on the other hand, is projected to increase from 232 million in 2000 to 612 million in 2025, thus jumping from 34 per cent in 2000 to 49 per cent of the total population in 2025. From 1950 to 1990, the number of city dwellers multiplied by a factor of eight while the total population increase was only three folds. Sub-Saharan Africa, which had only 19 towns with more

than 100,000 people in 1950, had at least 188 towns in 1990 with more than 500,000 people. Factors contributing to urbanization include increased economic activity and the development of social infrastructure after the 1950s and 1960s. These factors have intensified migration from rural to urban areas in search of better prospects.

2.2.3 Human Health

Africa continues to suffer from preventable diseases partly due to poverty and the introduction of user fees for basic social services. Although access to potable water, sanitation and health facilities improved world-wide since 1972, more than half of Africa's population do not have access to potable water and about 66 per cent lack basic sanitary services. The result is that almost 50 per cent of Africans suffer from water-related diseases. For example, of the 46 countries world wide in which schistosomiasis is endemic, 40 are in Africa while 16 of the 19 countries where guinea worm disease is prevalent are also in Africa.

Malaria and HIV/AIDS have become major health hazards in Africa and pose serious threat to Africa's sustainable development. About 300-500 million cases of malaria are reported annually in sub-Saharan Africa. Malaria mortality ranges between 1.5 million and 2.7 million deaths annually, with 2,800 African children dying of malaria daily. The estimated direct and indirect cost of malaria in sub-Sahara Africa in 1995 was \$US1.8 billion (Centre for Study of Responsive Law 2000). In 1996, about 14 million people in sub-Sahara Africa were living with HIV/AIDS (UNEP, 2000). This figure increased to 25.3 million by December 2000. The rapid increase in HIV infection and HIV/AIDS related deaths are likely to erode the marginal gains made in increasing life expectancy. For example, it is projected that Zimbabwe's life expectancy will be cut to only 27 years in a decade (United Nations Programme on HIV/AIDS - UNAIDS / World Health Organization - WHO, 2000). Another worrisome trend associated with HIV/AIDS is the increasing number of orphans in sub-Sahara Africa - an estimated 12.1 million by the end of 1999 - a situation that has tremendous negative impact on African economies and development.

2.3 The Economy

Africa's pre-independent economy was designed to support the economies' of the colonial powers. The sectors of infrastructure, education, health and industry were purposely maintained small or just enough to support the colonial economy. Raw materials were exported and finished goods imported. The 1950s saw the beginning of the political emancipation of Africa. However, even after independence, most African countries maintained the same colonial economic structures.

Since the colonial system did not expand and modernise the economies, government expenditures were low and this ensured price stability and positive balance of payments. In contrast, governments of the newly independent African states came under pressure to expand and modernise their economies so as to assure higher standards of living for their citizens. People needed education, health, electricity, water and jobs. The strong ideological battle between the communist/socialist and the market/liberal economic blocks influenced the development models adopted by the newly indepen-

dent States. The socialist block achieved high economic growth within a short period of 40-50 years. This and the fact that the political leadership did not change influenced most independent African governments. With the exception of the Francophone countries and Kenya, all adopted that model of politics and development strategy.

Consequently, during the decade between 1960 and the end of 1970, the economies of most African countries were characterized by large government presence in all sectors including the productive ones. Due to several factors, including terms of trade deterioration, controlled price regimes including foreign exchange, inefficiencies, large governments, corruption and military coups, even countries whose economies performed well in the 1960s and early 1970s deteriorated. Between the late 1970s and mid-1980s, most countries had balance of payment deficits, high rates of inflation, over-valued currencies, deteriorated infrastructure and very low economic growth rates.

Table 1 shows that all the economic indicators (growth rate of GDP, agriculture, manufacturing output, savings, investment, exports and imports) fell from the 1965-1973 period. Despite the generally poor economic performance, the North African countries, in particular, experienced high economic growth rates with diversified economies due largely to industrial growth and oil revenue. North Africa accounted for 40 per cent of Africa's GDP in 1998 and 1999.

2.3.1 Structural Adjustment Programmes

As a result of poor economic performance, most African countries in the 1980s undertook structural adjustment programmes (SAPs) with the support of the World Bank and the International Monetary Fund (IMF). The aims of SAPs were to improve the balance of payments, encourage growth, reduce inflation, build infrastructure and enhance the standard of living of the people. The typical policies included decontrolling input and output prices, increasing user fees for social services such as education and health, liberalising trade and payments regime, divesting state enterprises and retrenchments in the state sector.

At the end of the 1990, slight economic improvements occurred in some countries. The indicators in table 1 show that there was a slight improvement in economic performance between 1986-1993 that seemed to have deteriorated between 1990 and 1998. On the whole, however, the economic performance was below that of the 1965-1979 period. There seems to be an upturn in most of the indicators in 1999 and this could be a sign of recovery. Although Africa's performance was generally not encouraging, some countries made slight progress. The North African countries continued to achieve high growth rates. Mauritius and Seychelles did well while reforming countries such as Botswana, South Africa, Namibia, Lesotho, Equatorial Guinea, Gabon, Ghana and Cape Verde achieved greater GDP growth and exports.

Despite the positive growth recorded in some countries, there was no transformation in the structure of the economies and development lagged behind expectation. Countries that achieved export growth did so through increased exploitation of natural resources. Table 1 shows that the average manufacturing output declined from a high of 7.3 per cent during the 1965-1973 period to a mere 1.3 per cent during the 1990-1994 period. The balance of payments situation and the terms of trade deteriorated further for most

Table 1
Economic performance in Africa: 1965-2000

INDICATOR	1965-73	1974-79	1980-85	1986-93	1990-98	1999
Population growth rate	2.7	2.9	3.0	2.9	2.7	2.7
Growth rate of GDP (avg.)	5.7	3.5	1.8	2.5	1.9	2.7
Growth rate of agricultural output (avg.)	2.7	3.0	1.5	2.7	2.9	1.1
Growth rate of manufacturing output (avg.)	7.3	6.7	5.2	2.5	0.3	3.5
Growth rate of investment (avg.)	9.6	6.9	-4.8	1.2	1.4	6.4
Savings-GDP (avg.)	16.2	20.9	16.3	15.6	15.3	15.6
Growth rate of exports (avg.)	8.2	2.6	0.4	3.0	0.6	2.1
Growth rate of imports (avg.)	7.4	6.2	-2.4	0.7	.04	1.5

Source: African Development Bank, 2001

African countries. Africa's share of world trade decreased to 1.2 per cent in the 1990s, from a high of 3.1 per cent in the 1950s, amounting to annual trade losses of \$US 65 billion. The introduction of user fees deprived majority of the people access to basic social services resulting in a reduction in the standard of living (Tutu, 1992). Poverty became widespread, especially among rural communities.

Globally, more people enjoy higher standards of living today than in 1973. However, in sub-Saharan Africa, about 40 per cent of the people live below the poverty line of \$US 2 per person per day with an estimated 240 million people living on less than \$US 1 per person a day. Because the majority of the people are poor, there is continuous overexploitation of natural resources, a situation that deepens the degradation of the environment.

2.3.2 Debt Burden

Africa's external debt also presents a major bottleneck to development and environmental management. The debt stock stood at \$US 313 billion in 1994. This was equivalent to 234 per cent of the export earnings and 83 per cent of GDP. In 1997, Africa's debt stood at \$223 billion. More than 60 per cent of African countries are on the list of the world's most heavily indebted countries, in relative terms. The pressure to service these debts leads to the exploitation of more natural resources, which is the quickest means of raising money to meet Africa's obligations in debt servicing and capital repayments. The consequence is more depletion of natural resources and further degradation of the environment.

2.4 The Environment Agenda

The need for African governments to improve the standard of living of its people through increased economic growth, together with the servicing of the growing debt and efforts towards poverty eradication, has led to significant environmental degradation - notably land degradation, deforestation, desertification, biodiversity loss and pollution of water and air quality. Environmental degradation is heightened by the lack of transformation in the economies from resource exploitation to manufacturing and service. Global and national efforts to address these issues started with the 1972

Stockholm Conference - leading to the ratification of global environmental conventions, establishment of national environmental agencies and ministries of environments and promotion of sustainable development agendas by world governments.

2.4.1 Global Efforts towards Sustainable Development

Dissatisfaction with traditional ideologies in Europe and North America, during the 1960s, led to severe protests from disenchanted youths and from academics. The environment featured strongly. Several individuals and groups, such as Prime Minister Indira Gandhi and the Club of Rome that published *The Limits of Growth*, played major roles in bringing the attention of world leaders to the state of the global environment. These efforts culminated into the United Nations Conference on Human Environment held in June 1972 in Stockholm (Sweden). That Conference marked the turning point on the issue of the environment and development. Among the achievements at Stockholm was the establishment of the United Nations Environment Programme (UNEP), whose mandate is to provide environment leadership, encourage partnership in caring for the environment and improve the quality of human life without compromising that of future generations.

Since 1972, some 18 Multilateral Environmental Agreements (MEAs) have been signed (box 1). The MEAs are meant to protect natural resources and biodiversity from over-exploitation and to safeguard the environment. Many African countries have ratified most of the conventions. The problems facing countries in the implementation of these conventions are threefold - reporting for each convention, integrating conventions into national development programmes and looking for synergies and linkages among the conventions. The reporting procedures need to be harmonized and African countries need support from their development partners in relating impacts of the implementation of MEAs to development and, in exploiting the synergies and linkages among the MEAs to improve upon their implementation.

2.4.2 The Brundtland Commission

The next major development in the area of the environment after Stockholm was the establishment of the Brundtland Commission by the United Nations General Assembly. In 1983, the World Commission on Environment and Development (WCED) or the Brundtland Commission, was formed to solicit views around the world on issues such as agriculture, forestry, water, energy, technology and how they impact on sustainable development in general. The Commission's report - *Our Common Future* - for the first time defined sustainable development as "development that meets the needs of the present generation without comprising the ability of future generations to meet their own needs" (WCED, 1987). The Brundtland Commission laid the foundation for the most important environmental gathering of the 20th Century - the Earth Summit in Rio de Janeiro in 1992.

Box 1. Some international MEAs adopted since 1972

- 1972 Convention Concerning the Protection of the World Cultural and Natural Heritage
- 1972 Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter (as amended)
- 1973 Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- 1973 International Convention for the Prevention of Pollution from Ships (as amended)
- 1976 Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques
- 1979 Convention on the Conservation of Migratory Species of Wild Animals
- 1982 United Nations Convention on the Law of the Sea
- 1985 Vienna Convention for the Protection of the Ozone Layer and the 1987 Montreal Protocol (The Montreal Protocol)
- 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their disposal
- 1990 International Convention on Oil Pollution Preparedness, Response and Cooperation
- 1992 United Nations Framework Convention on Climate Change and the 1997 Kyoto Protocol
- 1992 Convention on Biological Diversity and the 2000 Cartagena Protocol on Biosafety
- 1993 Convention on the Prohibition of the Development, Production, Stockpiling and use of Chemical Weapons and on their destruction
- 1994 UN Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa
- 1994 Convention on Nuclear Safety
- 1997 UN Convention on the Law of the Non-Navigational Uses of International Watercourses
- 1998 Convention on the Prior Informed Consent: Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
- 2000 Convention on Persistent Organic Pollutants

2.4.3 The Earth Summit

When towards the end of the 20th century, some 800 million people were both hungry and illiterate and more than 1.2 billion people lived on less than \$US 1 per person a day, it was evident that the concept of sustainable development was not getting far. This led the UN to convene the Conference on Environment and Development (UNCED) in Rio de Janeiro in June 1992. UNCED, or the Earth Summit, brought together the largest gathering in the area of the environment (box 2).

The Rio principles reaffirmed the issues that were articulated in Stockholm in 1972, placing human beings at the centre of development by stating that people are “entitled to a healthy and productive life in harmony with nature”. The so-called Agenda 21 is

the most significant non-binding instrument in the area of the environment. It serves as the guiding document for environmental management in most countries.

Agenda 21 is the channel to speed up sustainable development of countries. It is an action programme partially based on a series of specialised contributions from governments and international bodies (Box 2). In 1997, the international community convened a review summit, i.e. Rio + 5, in New York (USA) where concerns were expressed about the slow implementation of Agenda 21. A major review of Agenda 21 is scheduled to take place in Johannesburg (South Africa) in September 2002. For this summit, the regions of the world are preparing a review of Agenda 21 since Rio.

Box 2: Outline composition of Agenda 21

Some 172 States, 116 governments and Heads of State, some 10,000 delegates, 1,400 non-governmental organizations (NGOs) and about 9,000 journalists attended the Earth Summit. The Summit produced major outputs, namely:

- The Rio Declaration on Environment and Development, comprising 27 principles, Agenda 21- a 600 page guideline for environment and development into the 21st century,
- Two major international conventions, namely; the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD),
- Establishment of the Commission on Sustainable Development (UNCSD),
- Agreement to negotiate a world desertification convention (UNCCD), and
- The Statement of Principles for the Sustainable Management of Forests.

Agenda 21 considers the three main pillars of sustainable development, which are social, economic and environment issues. Agenda 21 has 40 chapters, and its actions are divided into four main areas:

- **Social and Economic Issues:** International cooperation is being sought to accelerate sustainable development by combating poverty, changing consumption and production and demographic patterns; and protecting and promoting human health.
- **Conservation and management of natural resources for development:** The issues include the protection of the atmosphere, combating deforestation, combating desertification and drought, protection of freshwater resources and the oceans and the sound management of toxic chemicals and hazardous wastes.
- **Strengthening the role of major groups:** This mainly concentrates on strengthening the role of civil society in supporting Agenda 21. The groups include women, children and youth, indigenous people and their communities, business and industry, the scientific and technological community and farmers.

Means of Implementation: This includes financial resources and mechanisms, transfer of environmentally-sound technology, promoting education, public awareness and training, international institutional arrangements, international legal instruments and mechanisms and information for decision-making.

Despite ten years since Rio and SAPs, African countries are far from achieving sustainable development. The increased land and environmental degradation, the continued existence of pre-independent economies and an increasing poverty and debt burden show that a re-thinking and commitment to development by governments must be actively pursued.

2.5 On-going Initiatives for Sustainable Development

The two main initiatives that are designed to propel Africa to achieve sustainable development in the 21st Century are the Poverty Reduction Strategies spearheaded by the World Bank and the IMF and the Partnership for African Development (NEPAD). NEPAD was brought onto the drawing board by African governments during the Organization of African Unity (OAU) Summit held in Lusaka (Zambia) in June 2001. NEPAD recognizes that a healthy and productive environment is a prerequisite for the sustainable development of Africa.

The review of implementation of Agenda 21 and the World Summit on Social Development (WSSD) in Johannesburg (South Africa) in 2002 will be a roundtable at which these initiatives may be scrutinized within the scope of Agenda 21. The concurrence of the review of these development initiatives at the world meeting offers hope for placing Africa on a sustainable development course.

The global initiatives have had positive impacts on Africa in terms of establishment of agencies and ministries of environment and environmental policy making. Also UNEP was established out of these initiatives. The various national institutions have enacted environmental action plans to address environmental degradation. Several Strategies and Plans have been formulated in countries including national environmental action plans, forestry management plans, biodiversity plans, coastal management plans and wetland conservation strategies. There are also attempts to address relevant multilateral environment agreements. Although these plans and actions have not achieved the desired results, efforts are being made to address the shortcomings. Some of the difficulties include lack of capacity, lack of financial resources and inability to exploit the linkages among MEAs. Finally, the inability of countries to mainstream environment into national policies has resulted in this limited success.

SECTION TWO: STATE OF THE ENVIRONMENT

III. ATMOSPHERE AND CLIMATE

3.1 Introduction

The atmosphere is the essential physical and chemical environment for land-based life, including a significant proportion of the biosphere on which human life depends. Changes, anthropogenic or otherwise, to the physical and chemical properties of the atmosphere have the potential of affecting directly or indirectly the quality of life and even the very existence of some forms of life (World Meteorological Organization - WMO, 2000). Indeed, the protection of the atmosphere and its importance in meeting sustainable development objectives has been adequately articulated in Chapter 9 of Agenda 21 (UNCED, 1992).

The climate of any area is defined as the statistical aggregation of local weather records, including information about extreme events (WMO, 2001). Climate shapes human cultures, location of many settlements and all landscapes; it largely determines food production and its variability can cause famine. Climate variability is caused by internal interactions between the oceans, the atmosphere and the land surface. External forces of climate variability include changed solar luminosity, earth orbital elements or human activity (WMO, 1997).

Adams (1997) traced changes in the climate of Africa from 150,000 to about 8,000 years ago. Over this period, almost all types of climatic conditions have been experienced in the continent and these changes have been almost cyclic (i.e. cold and arid, warm and moist, poor vegetation and lush vegetation cover). These changes were largely attributed to natural causes, however climate variability due to human activities has become increasingly significant in recent times.

The issue of climate change and global warming has been a subject for debate in the 1970s, 1980s, through to the 1990s and culminated in the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. Even though Africa's relative contributions to global climate change is not significant, the continent is considered most susceptible to the effects of climate change. In recent years, Africa has experienced various climate-related conditions and disasters, such as drought, floods, cyclones and bushfires that have been major setbacks in the road to socio-economic development.

Africa's vulnerability to climate change is due to the fact that it does not have the resources or technology to adapt to the conditions that would be imposed by climate change. Given this situation, Africa should tackle climate change issues within the context of poverty eradication. The development and transfer of environmentally sound technologies in Africa should be seen as key.

3.2 The Climate of Africa in the Twentieth Century

Like other regions of the world, the climate in Africa is influenced by global circulation and ocean interactions. The southern oscillation (SO) is the irregular fluctua-

tion of the sea level pressure (SLP) field between the western tropical Pacific/ eastern Indian Ocean region and the southeastern tropical Pacific. The SO gives rise to conditions characterised as El Nino/SO (ENSO), which influence the weather in the southern and eastern parts of Africa. Another name for ENSO is “Pacific Warm Episode”. El Nino has been associated with drought in Eastern Africa and severe storms and flooding in Southern Africa. The opposite conditions of ENSO are known as “Pacific Cold Episode” or “La Nina”. Due to these conditions, i.e. El Nino and La Nina, below-normal precipitation and wetter-than-normal episodes have been observed in southern Africa (WMO, 1998). Conversely, La Nina conditions contribute to below-normal precipitation over equatorial East Africa (WMO, 2001).

The North Atlantic oscillation (NAO) is a prominent mode of low-frequency atmospheric variability over the extra-tropical Atlantic. The NAO influences weather conditions and climate in northern parts of Africa. For example, depending on the circulation patterns of the NAO, climate conditions have varied from below normal wind speeds, above normal jet stream winds, drought and abnormally wet and warm conditions in Northern Africa (WMO, 1998).

3.2.1 Climate Variables

Temperature: According to the findings of the International Panel on Climate Change (IPCC), the global average surface temperature relative to 1990 is projected to increase by about 2°C by 2100 (<http://www.wmo.ch/climate/1996/wmo/statement>). Since comparable records began in 1861, the 1990s were globally the warmest decade. Recent scientific evidence also indicates that the 1990s were the warmest century during the last 1000 years. The ten warmest years have all occurred since 1983. The four warmest years were 1998 (+0.58°C above normal), 1997 (+0.44), 1995 (+0.38) and 1990 (+0.35) (<http://www.wmo.ch/climate/1999>). Like most other regions of the world, the temperature series in Africa show long-term warming. The warmth of the last century is near record level in southern Africa (WMO, 1998).

Temperature records generally correlates well with precipitation. In the northeast and northwestern regions of Africa, surface temperature anomalies were above average in 2000. This correlated well with below average precipitation observed in these regions and corresponded with observed drought conditions. In contrast, temperatures were cooler than the 1992 - 2000 averages across interior sections of South Africa. This compared well with the above average wetness observed at the surface and widespread flooding that devastated the region, especially in Mozambique (<http://www.ncdc.noaa.gov/o1/climate/research/2000>).

Precipitation and Drought: The continent has a long history of rainfall fluctuations of varying lengths and intensities. In some parts of Africa, droughts are rooted in the global ocean-atmospheric circulation variations, some of which occur dramatically in association with ENSO episodes. For example, the warm episode of ENSO has been shown to be associated with droughts in southern Africa. However, in Sahelian Africa, droughts are not well correlated with ENSO events (WMO, 1988).

The worst droughts were those around 1910, which affected East and West Africa alike. Increasing rainfall amounts generally followed those years, but negative trends

were observed again from 1950 onwards culminating in the West African drought in 1984 (Gommes and Petراس, 1996).

Even allowing for differences between countries in individual years, the period 1960-1993 saw widely different conditions from year to year. The years from 1960 to 1969 were among the wettest of the period, while lower rainfalls were recorded for the 1970s and 1980s. The downward trend from 1970s affected the whole continent, but resulted in negative impact on food production only in the low-rainfall areas.

The worse drought years were 1983, 1984 and 1992, while 1963 and to a lesser extent 1989, were remarkable years in that almost the whole continent experienced above average conditions. The year 1973 was interesting in that it constituted the first poor year after a run of good years. As such, it caught most countries unprepared. In contrast, the impact of the drought of 1984, which was more severe than that of 1973 in climatological terms, was relatively less serious as many countries (especially in the Sahel region) were better prepared to cope with such extreme situations.

In 1973 (and less so in 1984) almost all African countries suffered, North and South alike. In contrast, the 1992 southern African drought was relatively limited in space since the Sahel had one of its good “after 1988” years with average or above average rainfall conditions.

3.2.2 Regional Patterns

In discussing rainfall variability and drought in sub-Saharan Africa, Gommes and Petراس (1996), classified countries in the region into eight groups based on rainfall patterns since 1960.

Group I: the Sahel and the Sudan: the group comprise Burkina Faso, Cape Verde, Chad, Gambia, Guinea-Bissau, Mali, Mauritania, Niger, Senegal and Sudan. The group is characterized by a downward trend of rainfall until 1988, followed by series of above average years. Worst drought years correspond to 1983 and 1984, but severe droughts were also recorded in 1972, 1973 and 1977. In 1984, drought severely affected all countries from Mauritania to Ethiopia, including several bordering countries on the southern-end of the Sahel. Mali and Niger were affected more seriously than the other countries in 1983.

Group II: southern-central Africa region and Madagascar: the group comprises Madagascar, Malawi, Mozambique, Namibia, Zambia and Zimbabwe. The rainfall patterns in this group are not correlated with that in the Sahel region. Total amounts are slightly higher, and the inter-annual variability is somewhat less. There is also no marked negative trend in rainfall, although the years after 1974, and particularly after 1985, have been characterised by marked pseudo-periodic fluctuations, with peaks in 1985 and 1989, and lows in 1987 and 1992. Most of the area had not experienced serious drought since 1960, except in 1982, until it was hit by the 1991 - 1992 drought, which affected the 1991 - 1992 southern hemisphere summer-cropping season. The drought most seriously affected the centre of the group, while Namibia and Madagascar were relatively less affected.

Group III: the southern Africa region: this group comprises Botswana, Lesotho, South Africa and Swaziland. The Southern African group has a relatively low rainfall index and a variability that exceeds that of the Sahel. There are some common features between this group and the Southern-Central Africa group. For example, this group had dry years in 1973, 1982 and 1992. The two groups however have notable differences, for instance in 1985 and 1993. The countries in this group were severely affected by the 1991 - 1992 drought, which was the most severe after the 1981 - 1985 droughts, the latter years having been the worst since the 1920s.

Group IV: central Gulf of Guinea countries and Tanzania: this group comprises Benin, Côte d'Ivoire, Ghana, Tanzania and Togo. The behaviour of rainfall in this group is similar to what was observed in the Sahel, with a slight downward trend, and a tendency towards runs of dry years. The lowest rainfall index was recorded in 1977 (which also affected the Sahel), followed by 1992. The greatest differences, however, were observed during the 1960s when Group III experienced several well above normal rainfall years.

Group V: East and West Gulf of Guinea: the group comprises Cameroon, Central African Republic, Equatorial Guinea, Gabon, Guinea, Liberia, Nigeria, and Sierra Leone. This is the wettest (Rainfall index: 1938 mm) and one of the least variable groups of countries in the continent. The northern half of several of the countries has Sahelian features, in particular the downward trend or rainfall. However, in contrast to the Sahel, the East and West Gulf of Guinea countries underwent less irregular rainfall (albeit below normal) than the Sahel. The countries in this group do not suffer so seriously as the arid countries from a comparable reduction in precipitation. In this group, periods of good and bad years tend to be longer than in the Sahel.

Group VI: central-west Africa: the group is made up of Angola, Congo and Zaire. This is the second wettest group (rainfall index 1489 mm). The group has shown a very "smooth" behaviour between 1964 and 1984, with a slight positive 1960 - 1993 rainfall trend due to a run of wet and very variable years from 1985 to 1990.

Group VII: the Horn of Africa and Kenya: countries in this group are Djibouti, Ethiopia, Kenya, and Somalia. This area includes some of the driest places in the world. The time series that describes the group is almost uncorrelated with any of the above mentioned groups, but correlates slightly with neighbouring countries of the Great Lakes. Low rainfall and a high variability characterize the group. The time series displays a typical pseudo-periodic behaviour with a cycle of four to five years. The region as a whole experienced good rainfall in 1989, but the last run of good years goes back to 1981- 1983. Bad years tend to have less negative effect at the high elevations, which characterize central Ethiopia and parts of Kenya. The years 1973 and 1984 were poor ones in parts of the region. Some parts have more than one cropping season, and drought does typically affect one of them more seriously than the other. Since the late 1990s, drought conditions have continued to worsen with famine reported across portions of Kenya and Ethiopia (<http://www.ncdc.noaa.gov/01/climate/research/2000>).

Group VIII: the Great Lakes countries: These are Burundi, Rwanda and Uganda. In this group, rainfall indices are high and not very variable. The rainfall patterns have some similarity to those in the Horn of Africa with an almost-significant cycle of about

seven years. The region recorded some very wet years in the early 60s, and a run of low rainfall years starting in 1987.

3.3 Climate Change

The issue of global climate change gained prominence after scientists began observing, a few decades ago, that greenhouse gases, particularly carbon dioxide (CO₂), had been accumulating in the atmosphere as a result of human activities. It was also observed that the global mean temperature had, for some time, been steadily increasing and is now higher than the latter part of the last century when observations began. Global concern on the effects of climate change was translated to international actions that led to the adoption of the United Nations Framework Convention on Climate Change (UNFCCC) at UNCED (<http://www.wmo.ch/climate/sgstate/Agenda21>).

Methane is another principal greenhouse gas. Halocarbons such as chlorofluoro-carbons (CFCs) and nitrogen oxides also have global warming potential. Emissions of greenhouse gases and aerosols continue to alter the atmosphere in ways that are expected to affect the climate. The atmospheric concentration of CO₂ has increased by 31 per cent since 1750. About three quarters of the anthropogenic emissions of CO₂ to the atmosphere during the past 20 years is due to fossil fuel burning. The rest is predominantly due to land use change especially deforestation (WMO 2001).

Africa's fossil-fuel CO₂ emissions are low in both absolute and per capita terms. Total emissions for Africa have increased by a factor of eight since 1950 reaching 205 million metric tons of carbon in 1996 - still less than the emissions for some single industrial nations including China, Germany, India, Japan, Russia and the United States of America. Although per capita emissions of 0.28 metric tons of carbon in 1996 were 2.5 times those in 1950, they were still only 5.4 per cent of the comparable value for North America. Solid and liquid fuels contribute about equally, and gas fuels account for only 14.2 per cent of the emissions.

Only five nations are largely responsible for Africa's regional emissions from fossil fuels and cement. South Africa accounts for 39 per cent of the continental total, and another 42 per cent of the CO₂ come from Algeria, Egypt, Libya and Nigeria, combined. These are the only African countries with annual CO₂ emissions in excess of 10 million metric tons of carbon. Only Libya (1.98 metric tons) and South Africa (1.88 metric tons) have per capita CO₂ emissions higher than the global average of 1.13 metric tons of carbon per year. Based on 1996 per capita emission rates, 31 of the 53 African nations have per capita emissions below 0.1 metric ton of carbon per person per year (Marland, et. al. 2000).

National greenhouse gas (GHG) studies carried out in Ghana, Kenya, Mali, and Zimbabwe during the period 1990 to 1996 revealed that all of these countries are GHG sinks, and the results confirmed the low level of GHG emissions of African countries (ENDA, 1997). The forestry sector had an absorption capacity greatly superior to the emissions from all the other sectors - this was the case in all the countries studied. However, it was noted that the agriculture sector (in Ghana and Kenya) was a major

emitter, alongside the energy sector (in Mali and Zimbabwe). Methane was the second most common gas emitted in all the countries.

3.3.1 Clean Development Mechanism

It is recognized that the primary means of achieving the objectives of the UNFCCC and its Kyoto Protocol is through activities to reduce emissions in the energy sector. In principle, it is accepted that industrialized countries can enter into agreement with developing countries to implement projects on clean development mechanism (CDM). The modalities of the CDM are still being negotiated but African countries are generally of the view that the primary means for industrialized countries to achieve emission reduction commitments under the Kyoto Protocol should be through domestic action. It should, therefore, be ensured that projects pursued under the CDM must assist developing countries in achieving their sustainable development objectives. Poverty in Africa is a major hindrance to the continent's ability to mitigate the impacts of climate change and to be able to implement adaptation measures. Poverty reduction through development and the transfer and adaptation of environmentally sound technologies to Africa should therefore be seen as a key objective.

3.3.2 Stratospheric Ozone

The ozone layer present in the upper atmosphere protects man and the environment from the harmful effects of the sun's ultraviolet radiation. The human induced destruction of the protective ozone layer allows harmful ultra-violet radiation to reach the surface of the Earth, with serious effects on human health, including an increase in eye cataracts and non-melanoma skin cancers, damage to the genetic DNA and suppression of the immune system. These concerns led to international actions that culminated in the adoption of the Convention on the Protection of the Ozone Layer in Vienna (Austria) in 1985, its Montreal Protocol in 1987, and later amendments to the Protocol in London (UK) in 1990 and Copenhagen (Denmark) in 1992. Ozone depletion is closely linked to climate change; many of the same gases that cause ozone depletion also contribute to climate change. A major issue is that the stratosphere will most probably cool in response to actions related to climate change, therefore, preserving over a longer-time period the conditions that promote chlorine-caused ozone depletion in the lower stratosphere, particularly in polar regions (WMO, 2001).

The observation of highly elevated levels of tropospheric ozone (O₃) in some tropical regions, particularly over the southern tropical Atlantic Ocean between South America and Africa, led to the hypothesis that biomass burning, emissions and subsequent photochemical processes may play an important role in atmospheric chemistry over a large region of the Earth. This was supported by space-borne observations, which showed the observed ozone enrichment to coincide geographically with regions of elevated carbon monoxide (CO) concentrations such as South Africa where savannah fires are frequent (International Forest Fire News - IFFN, 1998).

3.4 Impacts, Vulnerability and Adaptation to Climate Change

3.4.1 Impacts and Vulnerability

The notion of climate change can be equated to changes in the frequency, location and intensity of weather-related disasters. Studies have shown that climate change is likely to decrease stream flow and groundwater recharge in many water-stressed countries in Southern Africa and around the Mediterranean Sea. Most studies suggest that increase of a few degrees centigrade would cause food prices to increase, lower the incomes of vulnerable populations, increase the number of people at risk of hunger and, possibly, worsen food security in Africa. Natural systems such as corals, mangroves, forests and natural grasslands are at risk from climate change.

Societies in Africa have been adversely affected by reduction in crop yields, decreased water availability, greater exposure to vector and water borne diseases and increased flooding. Adverse changes in seasonal river flows, floods and droughts, food security, fisheries, health effects and loss of biodiversity are among the major regional vulnerabilities and concerns of Africa (WMO, 2001). The ability to cope with the consequences will rely heavily on the ability to assess how and where weather and climate patterns are likely to change, to predict the continuous fluctuations in risk and vulnerability to communities, and to develop adaptive strategies that will increase community resilience (WMO, January, 2001).

All regions are likely to experience the adverse effects of climate change, but small island swathes and low-lying coastal areas are particularly vulnerable. Coastal settlements in for example, the Gulf of Guinea, Senegal and Egypt and along the East and Southern African coast would be adversely affected by sea-level rise through flooding and coastal erosion (PANA, 2001). It is believed that there may be significant extinction of plants and animals in Africa during the new century as a result of global warming which will increase poverty by impacting on rural livelihoods and tourism (PANA, 2001).

3.4.2 Examples of Innovations to Adapt to Climate Change

The establishment of improved early warning systems and the transfer of new and improved technologies could help Africa better adapt to the impacts of climate change. Solar, wind and biogas energy are being used in small-scale projects continent-wide, with promising results. For example, in rural Zimbabwe, biogas units using cattle dung are producing fuel for nearby communities.

Desertification has sparked a range of agricultural and forestry management changes: in Niger, farmers with access to credit are setting up low-cost technologies to combat wind erosion, including wind breakers, mulching and rock bonds. In Senegal and Burkina Faso, locals have improved their regional climates by using traditional pruning and fertilising techniques to double tree densities in semi-arid areas. These help in holding soils together and reversing desertification. Similar community initiated projects in Madagascar and Zimbabwe have been acclaimed successes.

Regional scale cooperation such as shared watercourses is important. Several agreements have been negotiated and some are already working. Other cooperative flood planning envisages using one country to store some of a river's floodwaters, reducing the flood peak and potential disasters in countries downstream (PANA, 2001).

IV. NATURAL DISASTERS

4.1 Introduction

The geographical location of some communities makes them more vulnerable to extreme weather and climate events. However, the extent to which an extreme event results in disastrous events depends on the community's ability to plan and take protective measures. Africa, being a poor continent is very vulnerable to climate and weather extremes that more often than not result in disastrous events.

4.2 Drought

Disasters caused by drought are exacerbated by diverse factors such as poor agricultural practices, increase in population density and a country's inability to provide alternative supplies of food, water and employment. However, the development of long-lead seasonal climate forecasts can improve early warning systems, so that the occurrence of drought will not be such a shock to communities. In Africa, where economies are mainly tied to agriculture, drought occurrences have resulted in mass starvation, famine and have severely affected economic activity (WMO, 1998).

Drought struck northwestern Africa and the Middle East during 1995. In the northwest of Africa, well-below-normal rainfall was recorded across the region during the periods from January to early February, and from late March to May, adding to long-term moisture deficits throughout much of Morocco, Algeria and Tunisia that had started in November 1994. By mid-February 1995, dams in Morocco held only 30 per cent of capacity. Less than 50 per cent of normal precipitation was measured from 1 November 1994 to 25 June 1995 across northern and western Morocco, central Tunisia and much of central and northeastern Algeria. Long-term shortages remained until surplus November and December precipitation fell over most of the region (WMO, 1998). Casablanca, Morocco, received 1168 mm compared to normal annual values of 583 mm and 523 mm, respectively. However, in 2000, drought in Morocco left the country's reservoirs at half their normal capacity.

Since the 1991-1992 drought that wreaked havoc with most economies of southern Africa, recovery has been rather slow. After a short respite during the 1992-1993 rainy season, there has been a virtual persistence of drought in sympathy with ENSO. For instance, there was a 17 per cent fall in the corn harvest in 1993-1994 compared to the 1992-1993 season yield, as most countries in the region suffered a climatically unfavourable growing season. The drought returned in earnest in the 1994-1994 rainy season. Several rainfall deficits over most of the sub-region resulted in extensive crop failures in Swaziland, southern Zambia and parts of Zimbabwe and South Africa. Consequently, national drought emergencies were declared in Lesotho, Botswana, Namibia, Swaziland, Zambia and Zimbabwe. The drought relented in the 1995-1996 season, except in parts of Namibia. Good rains started in northern and eastern South Africa, Swaziland, Lesotho, parts of Botswana and Zimbabwe in December 1995, progressing northwards to reach Ethiopia in March 1996. As a result, there was a tremendous recovery in grain output across most of southern Africa (WMO, 1998).

In the greater Horn of Africa, the year 2000 was the third consecutive year of below-normal rainfall. This aggravated existing drought conditions over much of the area, resulting in severe food shortages. Tens of millions of people were affected by this drought. Especially hard hit were Ethiopia, parts of Djibouti, Eritrea, Kenya, Somalia and Tanzania (WMO, 2001). The failure of the rains in the March- May 2000 period was associated with La Nina conditions and cyclone activity in the Indian Ocean. Parts of eastern Ethiopia, northern and southwestern Kenya, as well as the northwest of Tanzania experienced the driest conditions on record since 1961 during the usual peak rainfall month of April. Similarly, some parts of southern Ethiopia experienced the driest conditions on record since 1961 during the June-August 2000 period (WMO, 2001).

4.3 Drought Preparedness and Mitigation

In the past the response of governments and the international community to a drought has been to provide food aid and famine relief. However, it is now believed that the most effective way of managing drought is to strengthen the capacity of local communities to plan, develop, and manage their own drought response strategies by developing drought preparedness and mitigation programmes. It is essential to decentralize these programmes for a rapid response. Greater coordination and coherence is therefore required at local, district, national and regional levels (<http://www.undp.org/seed/unso/prog/>).

WMO and the Office to Combat Desertification and Drought - UNSO / UNDP have jointly sponsored training seminars on drought preparedness and management in West Africa and in the Maghreb region. National drought management programmes have been developed, for example, in Ethiopia, Kenya, Zimbabwe and Lesotho and initiated in Mozambique and Swaziland. At the sub-regional level, disaster mitigation strategy is being prepared for East Africa and South African Development Community (SADC) will also be developing a drought preparedness strategy for the region with support of UNSO.

The integration of drought preparedness and mitigation (DPM) programmes in national action plans for the implementation of the UNCCD is also being supported by UNSO/ UNDP and WMO (UNDP, 1999). At two separate meetings held in 1999 related to coping with drought in Africa, participants including farmer representatives and policy makers, agreed on the need to improve the quality, timeliness and relevance of climate information products for use by farmers. The need to base climate information on user needs was stressed, as well as the need to provide the information in forms and language understandable to end-users (UNDP, 1999)

Drought monitoring centres supported by WMO in Kenya and Zimbabwe provides timely warnings and guidance to decision-makers and farmers. The African Centre of Meteorological Applications for Development (AGHRYMET) in Niamey (Niger) monitors the drought situation in Africa and issues timely advice to assist governments in helping the affected populations (<http://www.wmo.ch/climate/wmodrought/desertification/press597>).

In order to mitigate the effects of droughts brought about by El Nino phenomena in 1997, governments in Southern Africa encouraged farmers to plant drought-resistant crops as early as possible and to adopt better water conservation methods. Other contingency plans included the distribution of seed packs and inputs and conservation of food stocks (Food and Agriculture Organization - FAO, 1997).

In Namibia, a drought management plan was prepared for the livestock sub-sector in order to mitigate the effects of El Nino. The plan included anticipatory management, drought crisis management and drought aftercare. With regards to anticipatory management, heeding early warning services was considered very important. Destocking grazing livestock is considered an efficient way of managing drought crisis (<http://www.geocities.com/agr726/drought>).

4.4 Storms and Flood Hazards

Storms of all scales absorb and convert huge amounts of energy and moisture, which can have significant consequences. These can be beneficial: for example, the delivery of rainfall to end a drought, or the removal of highly polluted air. However, they are more detrimental to society.

The southern portion of the Indian Ocean experienced not less than five tropical storms that caused devastating floods in the eastern parts of the southern Africa region in 1994 alone (Box 3). Of all natural disasters, floods produce some of the highest death tolls and material damage. Globally, during 1994-1995, floods comprised about 50 per cent of the major natural disasters, killing more than 8,500 people and causing nearly \$US 50,000 million worth of damage.

Floods are caused by a variety of factors, not all of which are meteorological. Topography and the hydrological capacity of the subsoil have considerable influence. In many cases, anthropogenic changes to the natural environment such as deforestation, building of dams and dikes or strengthening of rivers aggravates the effects. Sometimes flooding is induced by storm surges from the seas which, when entering low-lying coastal regions, are extremely destructive, especially where these regions are densely populated. Flooding is often associated with cyclones, hurricanes and typhoons or long periods of continuous, heavy monsoonal rain.

Many parts of South Africa, as well as Swaziland, Lesotho, Southern Botswana, Central Zimbabwe, Northern Mozambique and Southern Malawi received torrential rains (75 to 240 mm in one week) during December 1995. Locally severe floods plagued the region. Heavy rains over Kwazulu-Natal, especially in the three days preceding Christmas of 1995, contributed to the Umsunduze River bursting its banks in a flash flood on Christmas Eve. At least 130 people drowned when settlements in low-lying areas near Pietermaritzburg were swept away.

In 1999, heavy flooding was again reported in Kwazulu-Natal. The flooding resulted in some deaths and the disruption of harbour and airport operations and television reception (http://www.southafrica.co.za/daily_news/october1999).

Box 3: Examples of devastations from cyclones and storms

During early 1994, the southwestern portion of the Indian Ocean was a very active region of five tropical cyclones that brought untold hardships to Madagascar and several southern Africa states. Cyclones Daisy (mid-January) and Geralda (early February) traversed the southern and central portions of Madagascar. The latter cyclone reportedly left a half million homeless and caused the loss of more than 200 lives; 400 mm of rain fell and winds reached 300 km/h. Geralda was described as the “cyclone of the Century” because of the extreme devastation it exerted on the East coast. In March, Cyclone Nadia, with sustained winds of 185 km/h, claimed a dozen lives as it crossed the northern tip of the island. After crossing the Mozambique Channel, Nadia went into northern Mozambique, where more than 200 lives were lost and more than a million people were left homeless. The intense rains associated with the five tropical systems totalled 125 - 155 percent of normal for the January to March period throughout much of central and southern Madagascar.

During the same year, (November 1994), some Egyptian harbours were closed and convoys in the Suez Canal delayed due to a series of storms that moved across the Middle East.

In 2000, other devastating cyclones such as Eline, Gloria and Hudah again struck Madagascar, and this time, Mozambique and parts of southern Africa causing severe flooding and loss of life between February and April (WMO, 2001). In Zimbabwe, power and phone lines were cut and crops and village granaries washed away. The Limpopo River was at its highest level in 15 years (<http://www.mg.co.za/mg/news/2000feb2>).

In 2000, parts of the region from Madagascar into Mozambique and Zimbabwe southward into northeastern South Africa had heavy rainfall from several tropical systems. The storms brought heavy flooding to parts of the area (<http://www.ncdc.noaa.gov/01/climate/research/2000>). In Zimbabwe, at least 12 people were killed and 250,000 were left homeless (<http://www.mg.co.z/mg/news/2000feb2>). Loss of life, displacement of people and extensive damage to infrastructure and agriculture were also recorded for Mozambique, Botswana, Swaziland and South Africa (<http://www.fao.org/WAICENT/faoinfo/economic/giews>). In February 2001, heavy floods resulted in the displacement of at least 60,000 people in Malawi, and in Mozambique, some towns along the Zambezi River valley were cut off by the floodwater. All together, nearly a million people have had their lives disrupted by severe floods in the southern Africa region (FAO, 2001).

Between February to April 1996, rainfall totals were nearly double the normal in eastern Ethiopia, southern Kenya, southern Uganda and northern Tanzania. The worst floods in 40 years occurred in this region during the 1997 and 1998 El Nino period. In some parts of Kenya, rainfall totals 400 - 600 mm above normal were observed - for example, the swollen Tana River left thousands homeless, disrupted transportation and caused extensive property damage in eastern Kenya. Major flooding in southern Somalia along the Juba and Shabele Rivers claimed an estimated 2000 lives and forced hundreds of thousands of inhabitants from their homes (<http://www.wmo.ch/climate/>

wmo/statement98; <http://www.wmo.org/climate/ElNino>). After experiencing record drought conditions in the early part of 2000, from October to December, there was heavy rainfall in the west, and some parts of eastern Uganda and the southern part of Tanzania had the wettest conditions on record since 1961 for the months of October and December. This spilled over to January 2001, with parts of southern, central and western Kenya, as well as Uganda, experiencing flooding (WMO 2001).

Extreme rainfall also occurred in Niger, Benin and Ethiopia in August 1994, causing flash floods with high losses. Stormy weather and heavy rain hit many areas in Egypt, the Sinai Peninsula and Somalia in November 1994. For these arid areas, where the mean annual precipitation totals amount to 1 to 5 mm and most years are completely dry, this was an exceptional event. More than 500 people died when large areas were inundated. Flood surges menaced the ancient tombs in Luxor. Flash floods and devastating mudslides were reported from both Southern Ghana and southwestern Morocco after torrential rain in July and August 1995. Near Aflou, northern Algeria, 50 people died when a bridge collapsed on 10 October 1995 after heavy rains (WMO 1998).

In the Sahelian region as a whole, rainfall appeared to return to near normal after a long period of subnormal values. In West Africa, the 1994 wet season received the highest amount of rainfall in 30 years, with flooding in Niger leaving more than 100 000 homeless (WMO, 1998). This pattern continued to the end of the 1990s. During 1997 and 1998, El Nino-enhanced torrential rains caused significant floods. The rainy season in the Sahel began late, but ended with higher-than-normal rainfall across much of the region and floods were also recorded in Sudan. In the July to October 1999 rainy season period, heavy rains and flash floods wreaked havoc in parts of western Africa. Thousands were left homeless, hundreds dead, and there was extensive property damage across large areas (<http://www.wmo.org/climate/1999>). In July 2001, heavy rains in the coastal areas of Ghana including the capital, Accra, provoked floods and water logging. 139,000 people were affected and 15,000 seriously so and were temporally displaced. Some roads and bridges were damaged and due to lack of clean water sources, flood posed health threats such as cholera, diarrhoea and typhoid. By the time weather conditions improved, 12 people were reported dead (<http://www.cidi.org/disaster>).

4.5 Forest and Wild Fires

Bush fires are mostly due to human activities but are to a lesser extent caused by lightning. Burning of bush is an age-old practice employed by man to boost yields in the crop and livestock sub-sectors as well as in game hunting. Farmers use slash and burn techniques, which they consider essential for a good crop with minimum labour. Herders set fire to bush because it is believed that the regrowth or young offshoots are more palatable and contain more nutrients. Hunters set fires to drive out game to more open areas so that they become easy targets (IFFN, 1996).

Climatic factors, especially rainfall, vegetation and wind speed play an important role in bush burning. Weather extremes and rainfall variability make the natural vegetation vulnerable to wildfires. Where the wet season is short, and where potential evaporation exceeds rainfall for most of the year, the natural vegetation becomes vulnerable to bushfires. Other characteristics include high wind speed and high demand for graz-

ing land. The need for fresh green grass is an incentive for herders to burn off dry grass for more palatable pasture (IFFN, 1996). Thus bush fires are more extensive in the Sahel and savannah regions (IFFN, 1996). In Sahelian countries, the timing of fires coincides with the Harmattan winds, which carry hot, dry continental air from the Sahara desert and which dry out the herbaceous vegetation layer, thereby supplying a ready source of fuel.

In South Africa, apart from human induced fires due to agricultural practices, uncontrolled fires have largely been attributed to arson. Several major forest fires and bushfires occur in South Africa. Between 1993 and 1996, bushfires broke out repeatedly and particularly in 1994, when a massive loss of livestock was reported in addition to considerable property damage (WMO, 1998). In 1998, fires destroyed about 4000 ha of plantations, in the process destroying a whole rural settlement (IFFN, 1998). In Lesotho on the other hand, bushfires are generally characterized by low intensity. The reason being that the intensity of grazing by livestock is so high that germinated vegetation is browsed immediately and no accumulation of material takes place. Therefore, because of lack of fuels, extensive fires are not possible (IFFN, 2000).

In Ghana, serious bushfires were experienced during the Sahelian drought of 1973 - 1974 and again in the period 1984 - 1985. Available data on the 1984 - 1985 bushfires in all the country's ecological zones showed that the Guinea and Sudan savannah area suffered the most in terms of loss of vegetation, standing crops, farms, wildlife, habitat, human lives and property (IFFN, 1996). In Cote d'Ivoire, the government regards bushfire and forest fires as a serious national disaster since the drought of 1983. In that year, wildfires destroyed more than 60,000 ha of forests and 108,000 ha of coffee and cocoa plantations. Between 1983 and 1994, wildfires destroyed homes of more than 70,000 people and killed 77 people (IFFN, 1996). In the Central African Republic, soil erosion on the hills around the capital, Bangui, has been linked to cultivation and intensive burning. The deposition of acid rain over the forests downwind of the country's savannahs has also been linked to burning (IFFN, 2001).

In order to prevent the detrimental ecological, social and economic effects of bushfires, most governments in Africa have taken a number of measures to prevent and manage bushfires. These include: enactment of anti-bushfire legislation, setting up bushfire management committees, education and sensitisation campaigns, training and capacity-building programmes for professionals and local communities (IFFN, 1996, 1999, 2000, 2001).

Early warning systems are used in a number of countries, for example Senegal, to alert government authorities and local communities on the occurrence of bushfires for appropriate and timely interventions (IFFN, 1996). A computerised fire detection system controlled by a human operator was introduced in South Africa in 2000. The system was designed to be installed in remote areas for early detection of forest fires to ensure timely response.

Sub-regional cooperation is equally important in preventing and managing bushfires especially for countries that share the same basin. In the context of shared basins, Centre Suivi Ecologique (CSE) in Senegal and Forest authorities Guinea have been engaged in a trial programme aimed at raising awareness of the problems posed by

bushfires (IFFN, 1996). In the SADC region, a proposal on cooperative fire management was made and recommendations and project proposals for operationalization of a regional forest fire management system were drawn up in 1999.

4.6 Volcanic Disasters

Volcanoes in Africa are mostly found in the eastern, central and northern regions and as well as surrounding islands (http://volcano.und.nodak.edu/vwdocs/volc_images/africa). Volcanoes are well known as producers of poisonous or asphyxiating gases and, in some instances, these gases kill people caught in the volcanic plumes (<http://perso.wanadoo.fr/mhalb/nyos/nyos.htm>).

Only three lakes in the world are known to contain high concentrations of dissolved gas in their bottom waters. These are lakes Nyos and Monoun in Cameroun and Lake Kivu in East Africa. On 15th August 1984, gas (CO₂) release at Lake Monoun killed 37 people. On 21st August 1986, another gas (CO₂) release occurred at Lake Nyos causing at least 1,700 fatalities. The emissions of Lake Manoun and Nyos were attributed to overturn of stratified lake waters as a result of a non-volcanic process, or to phreatic explosions or injections of hot gas into the lake (http://vulcan.wr.usgs.gov/glossary/lakes/description_volcanic, <http://perso.wanadoo.fr/mhalb/nyos/nyos.htm>).

In order to avert such disasters recurring, scientists began investigations on how best to control the releases termed as “limbic eruptions”. Inspired by the methane and CO₂ extracting unit, which had been operating in Rwanda, on the shore of Lake Kivu, scientists began trial projects to degas Lakes Manoun and Nyos. The trials, having been successful, paved the way for a fully-fledged experiment at Lake Nyos, beginning in January 2001.

V. LAND AND FOOD

5.1 Introduction

Land and food are two important resources upon which Africa's economies are based. Land is used to produce food, raw materials for industries and for export, minerals, timber and several economic resources in Africa. Despite the rich store of land resources, Africa still remains the only continent that is very poor (and poverty is expected to increase), highly indebted, unindustrialized and with a malnourished growing population. In Africa, especially in rural areas, poverty is generally perceived as a state of deprivation with reference first to food, and then to housing, clothing and health. Poverty is largely perceived as a state of food insecurity (World Bank Institute - WBI, 2001). Poverty is endemic in Africa, especially in sub-Saharan Africa. "With more than 46 per cent of the population (about 300 million people) living on less than 1 \$US a day, (sub-Saharan) Africa remains - despite recent favourable trends in income poverty - one of the regions most affected by poverty" (World Bank, 2000). Moreover, 2/3 of Africans live in rural areas and the rural poor account for 80 per cent of African poverty (World Bank, 2000; WBI, 2001).

The challenge facing Africa rests in managing land resources in an environmentally sustainable manner such that food security and poverty eradication can be achieved. To achieve this would require pragmatic and participatory macro-economic, social and sectional policies that recognize the advantages of regional cooperation and international trade.

5.2 Resource and Uses

Africa has significant land resources of contrasts and extremes varying from deserts to the evergreen tropical forests. Land resources are the bases upon which African economies largely depend. The main land use categories in Africa are agriculture, rangelands, settlement and wildlife. About 90 per cent of African soils are deficient in phosphorus, a key nutrient in the production of biomass. The soils also have low content of organic matter, and low infiltration and retention capacity due to surface crusting. Moreover, about half the cultivable land is under arid and semi-arid conditions so potential for irrigation is limited (World Bank, 1995).

The majority of African countries depend on agriculture for their livelihood. Agriculture contributes 40 per cent of GDP, 55 per cent of total export value and employs more than 60 per cent of the labour force (IPPF/ United Nations Population Fund - UNFPA / The World Conservation Union - IUCN, 1993; UNEP, 2000d). In central Africa, 20 per cent of the land is under cultivation or grazing while in North Africa, 26 per cent of the land is arable and 19 per cent of this is under cultivation (FAOSTAT, 1999). In Southern Africa, about 5 per cent of the land is used for cultivation with 0.28 per cent being under irrigation and in Malawi, 14 per cent of the land is under cultivation (Griffin, J, et. al, 1999).

The main issues about land in Africa are its tenure systems and its degradation. In some countries, the farmers who use the land do not have access to land making it difficult for long-term investment in land improvement practices to be undertaken. This is more so with regard to women. In a world where women produce 80 per cent of food, but own only 2 per cent of all land, a reallocation of resources in favour of women will certainly be Pareto-Optimal and result in increased food production (Crowley, 1999).

5.3 Land degradation

Land degradation is a major problem in Africa. It is estimated that Africa accounts for 27.4 per cent of land degradation of the world and that 500 million hectares of land in Africa are moderately to severely degraded (UNEP, 2000d). Land degradation in Africa manifests mainly in the form of soil degradation, rangeland degradation, declining soil productivity and desertification. It has been linked to population pressures, mining, inappropriate agricultural technology, poor land management and droughts. Land degradation in Africa is extensive.

Soil degradation is the most serious effect of land degradation. It is estimated that 14 per cent of degraded soil result from vegetation removal, 13 per cent from overexploitation, 49.5 per cent from overgrazing and 24 per cent from agricultural activities (WRI, 1992). Soil losses are reported to be significant in North and Eastern Africa. In Ethiopia and Uganda, soil erosion accounts for over 80 per cent of the cost of environmental degradation, estimated at about 1-4 per cent of GDP. Ethiopia is reported to be losing 1.9 billion tonnes of top soil from the highlands annually, while Burundi is losing 80 to 150 tons/ha/year and Rwanda's is about 557 tons/ha/year (CT&E, 2000; CEDARE, 2000). In South Africa, soil losses are estimated to be as high as 400 million tons annually and in Malawi, soil losses range from 0 to 50 tons/ha/per/year (Griffin, J. et. al, 1999).

5.3.1 Causes of Land Degradation

Demographic and socio-economic factors such as poverty, attitudes and values, land tenure systems, overgrazing, agricultural activities, overexploitation of trees for fuelwood and deforestation are the main causes of land degradation. Population induced factors include clearance of vegetation for agriculture, overgrazing, deforestation, recurrent bushfires and extensive cultivation of marginal lands (Economic Commission for Africa, 1992). Where land is abundant, rapid population growth in the short term will not lead to degradation as farmers adopt shifting cultivation by leaving the cropped land to fallow for some years to replenish the lost nutrients. However, in many African countries land is scarce and rapid population growth without intensive cultivation leads to land degradation (Economic Commission for Africa, 1999). Population pressure is also leading to decline in per capita arable land. For example, per capita arable land declined from 0.6 ha/person in 1961 to 0.27 ha/person in 1993 (Griffin J. et. al, 1999).

Poverty renders farmers incapable of undertaking intensive agriculture that requires significant inputs or undertake other soil improvement investments. The only alternative left for them is to mine the soils till they become completely degraded. Poverty

also makes rural people depend on fuelwood for their main energy demands. Since there is no afforestation to take care of this, there is over-exploitation leading to degradation. Land tenure is closely connected to land degradation. In areas where people do not have title to land, incentives to invest in long-term land improvement are non-existent especially when they are on rented land. On rangelands, traditional methods of grazing management have become less effective and free-range grazing has led to over-grazing, especially in arid and semi-arid areas leading to deterioration of the land cover. The attitudes of people are very important in land management. Rural people who are normally poor and ignorant of conservation methods tend to have attitudes that may be land degrading.

5.3.2 Soil Degradation

Soil degradation, typified by soil erosion is made up of water and wind erosion, chemical degradation and physical degradation. Asia and Africa have the most degraded soils in the world composing of 37 per cent and 26 per cent respectively (Table 2). In Africa, water erosion is the major problem, (53 per cent) followed by wind erosion (30.5 per cent), chemical degradation (11.2 per cent) and physical degradation (5.3 per cent). Main causes of soil degradation are overgrazing (58.5 per cent), agricultural activity (18.2 per cent), over-exploitation (16.7 per cent) and deforestation (6.6 per cent) (UNEP, 1997).

Soil erosion comprises water and wind erosion. The most prevalent forms of water erosion are sheet and gully. They are widespread in all the sub-regions of Africa, especially the Mediterranean and arid North Africa, in humid and sub-humid West Africa, sub-humid and mountainous East Africa, and sub-humid and semi-arid southern Africa (see Table 3). Water erosion was estimated to have affected 170 million hectares by 1991 (Economic Commission for Africa, 1999). The major causes of water erosion are overgrazing, excessive deforestation and cultivation of hill slopes. Wind erosion is prevalent in Mediterranean and arid North Africa, Sudano-Sahelian Africa and the sub-humid and semi-arid southern Africa, and is estimated to have affected 98 million hectares. Wind erosion can either be human-induced or a result of prolonged drought (UNECA, 1999). Soil erosion is mainly associated with annual crops such as maize, millet, etc. Control of erosion is difficult without using narrow grass strips, terracing or some mulch of crop residues.

Regions	Water Erosion	Wind Erosion	Chemical Degradation	Physical Degradation	TOTAL
Africa	170	98	36	17	321
Asia	315	90	41	6	452
South America	77	16	44	1	138
North and Central America	90	37	7	5	139
Europe	93	39	18	8	158
Australasia	3	--	1	2	6
TOTAL	748	280	147	39	1214

Table 2:
World soil degradation by type (Classified as moderately to excessively affected)

Source: Extracts from World Agriculture: Towards 2010 Food and Agriculture Organization - FAO, 1995

Table 3 shows the categories of soil degradation and impacts on arable, grazing and forestlands for the various regions of Africa. It is apparent from the table that while water erosion is prevalent in the arable lands for all the sub-regions due to the cultivation of annual crops, wind erosion is common in the grazing lands that are more arid.

5.3.3 Chemical and physical soil degradation

Chemical soil degradation in Africa accounts for some 3.9 per cent of total susceptible drylands of Africa. It is made up of loss of nutrients (83.4%), salinization (11.4%) and acidification (5.2). Salinization and acidification are mainly the results of irrigation and inappropriate fertilizer application. Chemical soil degradation affects some 51 million hectares of land with 40 million hectares being nutrient deficient and salinity affecting 6 million hectares (Economic Commission for Africa, 1999). Physical soil degradation results in the deterioration in the structure of the soil and makes it more compact and harder to use because it is less permeable to rain and poorly drained. The soil also develops hardpans and surface crusting. This process has affected 17 million hectares of land in Africa (Economic Commission for Africa, 1999).

5.3.4 Land degradation and Food

Land degradation has significant impacts on soil productivity and food security. Soil erosion reduces soil productivity and plant nutrients to such an extent that if the problem is not addressed, the soil finally becomes unsuitable for crop production. Soil fertility is a major problem because about 56 per cent of Africa's soils are acidic and low in nutrients (Moran, 1987). Besides over-cultivation with reduced fallow periods, overgrazing and inadequate technological responses to replenish nutrients have led to

Table 3:
Sub-regional soil erosion and land types in Africa

Region	Arable land	Grazing land	Forest land
Mediterranean and North Africa	- Declining soil Fertility - Wind and water erosion - Stalination on irrigated lands	- General Degradation of vegetation - Wind and water erosion	- Degradation of Vegetation - Water erosion on degraded forest lands
Sudano-Sahelian Africa	- Decline in nutrient levels in the soil - Decline in soil physical properties - Wind and water erosion	- General degradation of vegetation - Wind erosion in sub-humid areas	- Degradation of vegetation
Humid and sub-humid West Africa	- Decline in nutrient levels in the soils - Decline in soil physical properties - Water erosion	- Degradation of vegetation - Wind erosion in sub-humid areas	- Degradation of vegetation
Humid central Africa	- Degraded soil physical properties - Degradation of soil chemical properties		
Sub-humid and mountain East Africa	- Water erosion - Degradation of soil physical properties - Degradation of soil chemical properties	- Degradation of vegetation - Water erosion	- Degradation of vegetation - Water erosion
Sub-humid and semi-arid southern Africa	- Water erosion - Degradation of soil physical properties - Degradation of soil chemical properties	- Degradation of vegetation - Wind and water erosion	- Degradation of vegetation - Erosion

Source: African Agriculture: the next 25 years, Food and Agriculture Organization - FAO, 1986.

this problem. The total nutrient loss between 1970 and 1999 is estimated to be 1.4 tonnes per hectare of urea fertilizer, 375 kg. of triple super phosphate and 896 kg. of potassium chloride (UNECA, 1999).

Soil erosion can also lead to sediment pollution of water supplies, cause flooding and reduce hydro-electricity power through siltation of dams. Loss of topsoil, terrain deformation and chemical deterioration of the soils account for 4.8 per cent of total land use. The productivity loss arising from this since World War II is estimated at 25 per cent for croplands and 8-14 per cent for cropland and pasture together. Irreversible loss of soil productivity of at least 20 per cent of lands due to erosion has occurred over the past century in large parts of Algeria, Ethiopia, Kenya, Ghana, Lesotho, Morocco, Nigeria, South Africa, Swaziland, Tunisia and Uganda. Crop yield losses in 1989 due to erosion ranged from 2 to 40 per cent with a mean of 8.2 per cent for all Africa. For instance, the estimated soil loss in Mali is estimated to range from 1 t/ha/year in the north to 31 t/ha/year in the south leading to yield losses of 2 to 10 per cent per year for the country (Economic Commission for Africa, 1999).

These effects from land and soil degradation have significant negative impacts on productivity of agriculture, food production and food security in Africa.

5.4 The State of Food in Africa

5.4.1 Food Security

Food security is defined as an “access by all people at all times to enough food for an active, healthy life” (Western Centre for Environmental Decision-Making - WCED). Food security has three components, namely: availability of food, access to food, and provision of adequate nutrition. In terms of food availability, food production in many African countries did not meet domestic demand from 1990-1998 (Ehui, 2001). The current situation is not different. The discussion below illustrates the food demand gaps in Africa. In terms of access to food, most vulnerable people in Africa have severe problems. Major constraints to food access and thus food insecurity in sub-Saharan Africa include limited access to basic infrastructure, domestic policy biases (high food prices) and conflicts (WDR, 2000).

Good nutrition is essential for people to be food secure and live healthy and productive life. A complementary factor for achieving good nutrition is access to safe water. A measure of chronic undernutrition is stunting, which also captures the effect of persistent malnutrition (Ehui, 2001). Malnutrition occurs when people cannot have the FAO stipulated minimum daily requirement of 2,300 calories. The picture in terms of malnutrition is not encouraging. It was estimated that in 2000, sub-Saharan Africa alone had a total of 30 countries with serious malnutrition problem (FAO, 2000). An International Food Policy Research Institute (IFPRI) report indicated that the proportion of malnourished children between 1996 and 1998 was 34 per cent for sub-Saharan Africa, and this proportion is expected to increase by 30 per cent to 40 million in 2020 (Andersen, 1999). It is worth noting that knowledge of the nutritional content of food is as essential as its availability and accessibility in achieving good nutrition.

Any strategy to address the multi-faceted nature of food security in Africa must consider the following issues:

- The issue of agricultural productivity
- The issue of HIV/AIDS and malaria
- The role of non-agricultural economic activities, and
- Land degradation.

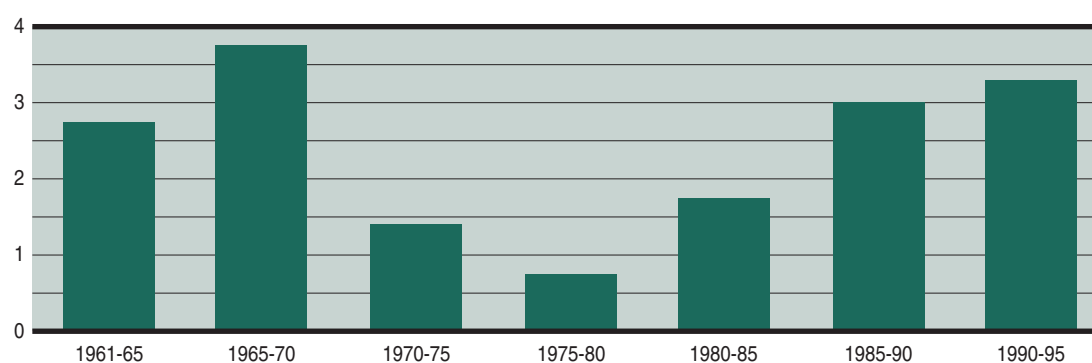
Ultimately, increasing agricultural productivity is key to achieving food security. With population growing at the rate of 2.8 per cent, agriculture has to grow at a higher rate. Africa's agricultural production has been poor but variable over the 1960-2000 period. The highest growth of agriculture occurred between 1950 and 1970, recording about an average yearly growth rate of 3 per cent. There was a slow down between 1970 and 1985 but bounced back in 1990s (see graph 1).

While agricultural growth rate was on average modest, productivity has been low over the period (Ehui, 2001). Agricultural productivity also has to do with reform of the land tenure systems, access to other resources such as credit, markets, research and extension systems. Low productivity is a result of low investment in inputs to agriculture. Only about 4.2 per cent of land under cultivation in Africa is irrigated. This compares with 13 per cent in Latin America and the Caribbean, a region with similar population densities and resource endowments. Fertilizer application today is the same as in 1980. At present less than 15 kg/ha of fertilisers are used in the region compared to more than 50 kg/ha in South Asia. The number of tractors per worker is lower than any other region, and endemic animal diseases reduce the use of animal draft power.

HIV/AIDS and malaria are exerting significant negative impacts on African countries in terms of mortality and morbidity, thus reducing the labour force for food and agricultural production. HIV/AIDS mostly affect the labour force. For instance, in nine countries in sub-Saharan Africa, more than 10 per cent of the adult population is HIV positive. In Botswana, Namibia, Swaziland and Zimbabwe, 20 to 26 per cent of the population aged 15-49 are living with HIV or AIDS while 83 per cent of all AIDS deaths occur in Africa.

High disposable incomes for Africans are important for food security. This implies addressing poverty, especially in the rural areas. Non-agricultural activities in the rural areas as additional sources of income for farmers are important since it will signifi-

Graph 1:
Trends in sub-Saharan Africa agricultural growth, 1961-1995
(Growth rates in %)



Source: World Bank Technical Paper Number 444

cantly enhance their incomes and address food insecurity. It has been discussed above that land degradation will reduce food production in Africa.

5.4.2 Food Production in Africa

Food production in Africa has been lagging behind the local demand for most countries from 1990 to 1998 (Ehui, 2001). The current situation is not different. Analysis of food production in the sub-regions shows most countries having food deficit in their production and consumption. In many east African countries the food situation has deteriorated. The conflict in southern Sudan has worsened the situation such that the number of people in need of food aid is currently estimated at some 2.97 million. This is expected to increase. In Ethiopia, despite the improved food supply situation in 2001, some 6.5 million people depend on food assistance due to successive droughts and the war with neighbouring Eritrea (FAO, 2001). Despite favourable weather conditions, food emergencies persist in the Great Lakes region due to conflicts. In the Democratic Republic of Congo, for instance, an estimated 2 million internally displaced people face very severe shortage of food and depend on provision of assistance (FAO, 2001).

In southern Africa, food production has significantly declined in several countries due to lower plantings and adverse weather. Maize output which accounts for over 90 per cent of the sub-region's total cereal production is estimated at 13.7 million tonnes, 26 per cent lower than in the previous year and well below average. In Zimbabwe, for example, maize output is estimated at over 25 per cent below the 2000 level reflecting lower plantings and reduced yields (FAO, 2001).

Several West African countries face food supply difficulties resulting from civil strife or localised weather adversities in 2000. The food situation is particularly difficult in parts of Burkina Faso, Chad and Niger following reduced harvests.

5.4.3 Food Balance for 2001

Cereal import requirements in sub-Saharan Africa in 2001 are set to remain high, reflecting mainly continued drought conditions in parts of eastern Africa, displacement due to escalation of conflicts and effects of adverse weather in southern Africa. The total food aid requirement in Africa is estimated at 2.7 million tonnes, almost the same as actual imports in 1999-2000. Total food aid pledges for 2000-2001, including those carried over from 1999-2000, amounts to 1.5 million tonnes of which 0.95 million tonnes have been delivered so far.

In West Africa, the estimated commercial food imports for the 2001 marketing year is 6.7 million tonnes with food aid contributing 400,000 tonnes, mainly wheat and rice. In central Africa the situation looks brighter with estimated commercial imports being 826,000 tonnes and food aid 17,000 tonnes for the 2001 marketing year. In southern Africa, commercial food imports are estimated at 3.7 million tonnes with food aid requirements at 389,000 tonnes while in eastern Africa, commercial imports are estimated at 3.9 million tonnes with food aid being 1.8 million tonnes.

5.5 Initiatives in Land Degradation and Food Security

Several initiatives have been taken to address land degradation and food insecurity in Africa. A famous successful one is the improved land resource management in the Machakos District of Kenya (see box 4). In the area of food security, one significant initiative is the World Food Summit (WFS) that took place in 1996. The Summit committed itself “to reduce the number of undernourished people to half their present level no later than 2015”. Despite this commitment, five years later, “little progress is being made in bringing about significant reduction in the number of the world’s hunger” (www.fao.org/news/2000/001001-ehtm).

Box 4: Improved land resource management in the Machakos District of Kenya

In the 1930s, the semi-arid Machakos District of East-central Kenya was characterized by soil depletion and erosion, reduction in fallow, use of marginal lands, leading to declining crop yields, landlessness, food shortages, malnutrition, unemployment, rural indebtedness and out-migration. Improved land management systems backed by adequate policies were put in place to address these problems.

The management systems included ox-drawn ploughs, short-duration maize varieties, stall feeding and fodder crops for intensive livestock rearing, mono-cropping of the main annual crops in rows to facilitate planting, weeding, terracing, contour cultivation with oxen and the use of animal manure for fertilizer (English, et al. 1994).

The policies included:

- Market-orientation to farm production and access to market outlets for products;
- Farmers’ access to information on the availability of a wide range of new crops and technically viable land use options;
- Farm households security and long-term rights to farmlands;·
Devolution to the local level of decisions concerning the allocation of resources and planning of agricultural development; and
- Public investments targeted at providing critical public goods and infrastructure that local communities and farmers cannot afford on their own.

Recent studies have shown that there is no evidence of soil depletion. While some erosion is occurring, there is no significant loss of productive capacity because of measures undertaken. There is no evidence of declining crop yields while farming systems in marginal lands do not lead to long-term degradation. Reduction in fallow has occurred but has been replaced by new and more productive indigenous systems. Out-migration has declined while there is no evidence of landlessness or rural indebtedness. Unemployment is a problem in some areas but food shortages occur only in exceptional years. Malnutrition is not severe except in socially deprived families.

(Source: English et al., 1994; Tiffen et al., 1994).

VI. BIODIVERSITY AND FORESTS

6.1 Introduction

The term biodiversity, a shortened form of the phrase “biological diversity”, refers to the variety and number of living organisms on Earth or parts thereof, along with the living and non-living systems that they depend on for survival. Biological diversity as we know it today is the product of millions of years of evolution, shaped by natural processes and, increasingly, by the influence of human beings.

The world’s biological resources include forests, wildlife and fisheries. As such the term biodiversity is used in this document to include the substantial forest wealth found in Africa. Biodiversity provides the basis for the livelihoods of many people, and for economic growth at both local and national levels. On the other hand, ecosystem services such as water supply and absorption of pollutants are essential for maintaining human health. In addition to being an essential resource for Africa’s peoples and economies, the vast and unique biodiversity on the continent is also an invaluable global heritage.

Forests exist in many different parts of the world under a wide range of conditions, meaning that no forest is static in space and time. While defined by the presence of trees, forests consist of much more - lower plants, fungi, bacteria, animals, water, soil, people and the ecological processes that maintain these components, and to which they contribute. In short, forests are part and parcel of biological diversity.

6.2 Africa’s Biodiversity

Africa has a large and diverse heritage of plants, animals and microorganisms. It is home to more than 50,000 known plant species, 1,000 mammal species, and 1,500 bird species. The biological diversity found in any one area or country varies in complex ways, depending on the physical size, local climatic conditions, topography, vegetation, and soil types. The estimated numbers of mammals, birds, flowering and non-flowering plant species found in African countries is presented in Table 3.

Eastern Africa contains 55 per cent of Africa’s endemic mammal species, 63 per cent of birds, 49 per cent of reptiles and 40 per cent of amphibians. In terms of species endemism, Madagascar is the richest country in Africa. It ranks sixth in the world for higher vertebrates (mammals, birds and amphibians), with more than 300 endemic species. The Democratic Republic of Congo is the most plant-species rich country in Africa, followed by Tanzania and Madagascar.

The tropical savannah is the most extensive ecosystem type in Africa and is inhabited by the largest proportion of the human population, livestock, and wildlife. They have a high incidence of indigenous plants and animals and host some of the world’s remaining great concentrations of large mammals. Many of Africa’s mountains and highlands have unique and rich biodiversity. The highlands of Ethiopia, Kenya and Tanzania present particularly rich centres of species endemism.

African wetlands, covering about one per cent of the continent's total surface area and found in every country, also have a rich biological diversity, with many endemic and rare plant and animal species. Wetlands are among the most biologically productive ecosystems in Africa. The Okavango Delta, the Sudd, many of the Rift Valley lakes, coastlines and, the basins, floodplains and deltas of Africa's major rivers provide important seasonal habitat for migratory birds species from the temperate biomes. Lake Malawi, Africa's third largest after lakes Victoria and Tanganyika, contains the largest number of fish species for any single lake in the world, with almost 500 species from 10 families. Many of them are unique to the lake, which is home to the world's largest population of cichlids, catfishes, minnows, mormyrids, true eels and spiny eels. The African coastal region is equally diverse, with more than 4,000 species of fish.

Table 3:
Estimated number of mammal, bird and plant species in African countries¹

Region/Country	Mammals	Birds	Flowering Plants	Non-flowering Plants
A. NORTHERN AFRICA				
Alegria	92	375	3,100	64
Egypt	102	439	2,066	10
Libya	76	323	1,800	25
Mauritania	61	541	1,100	-
Morocco	105	416	3,600	75
Tunisia	78	356	2,150	46
Western Sahara	32	162	330	-
B. EASTERN AFRICA				
Djibouti	-	326	635	6
Eritrea	112	537	-	-
Ethiopia	255	813	6,500	103
Kenya	359	1,068	6,000	506
Somalia	171	649	3,000	28
Sudan	267	937	3,132	5
Tanzania	322	1,005	10,000	8
Uganda	338	992	5,000	406
C. CENTRAL AFRICA				
Burundi	107	596	2,500	-
Central African Republic	209	662	3,600	2
Congo	200	569	4,350	7
Democratic Republic of Congo	415	1,096	11,000	7
Equatorial Guinea	184	322	3,000	250
Gabon	190	629	6,500	151
Rwanda	151	666	2,288	2
D. SOUTHERN AFRICA				
Angola	276	909	5,000	185
Botswana	164	550	-	15
Lesotho	33	281	1,576	15
Malawi	195	645	3,600	165
Mozambique	179	678	5,500	192
Namibia	154	609	3,128	46
South Africa	247	790	23,000	420
Swaziland	47	485	2,636	79
Zambia	229	736	4,600	147
Zimbabwe	270	648	4,200	240

¹ Source: World Conservation Monitoring Centre (Comp.), Groombridge, B. (Ed). 1994. Biodiversity Data Sourcebook.

World Conservation Press, Cambridge, UK. 155pp. - Revision 1 (6 January 1995)

Table 3:
Continued

Region/Country	Mammals	Birds	Flowering Plants	Non-flowering Plants
E. WESTERN AFRICA				
Benin	188	423	2,000	201
Burkina Faso	147	453	1,100	-
Cameroon	297	874	8,000	260
Chad	134	532	1,600	-
Côte d'Ivoire	230	694	3,517	143
Gambia	108	504	966	8
Ghana	222	725	3,600	125
Guinea	190	552	3,000	-
Guinea Bissau	108	319	1,000	-
Liberia	193	581	2,200	-
Mali	137	622	1,741	-
Niger	131	482	1,170	8
Nigeria	274	862	4,614	101
Senegal	155	610	2,090	24
Sierra Leone	147	622	2,090	-
Togo	196	558	2,000	201
F. ISLAND STATE				
Cape Verde	5	128	740	34
Comoros	12	91	660	61
Madagascar	105	253	9,000	505
Mauritius	4	81	700	178
São Tomé & Príncipe	8	111	744	151
Seychelles	-	170	1,139	1

Note: - Indicates lack of data

Africa holds five of the 25 identified biodiversity hotspots of the world. These are the Guinean hotspot which stretches from Guinea in the West to Cameroon in the East, the Madagascar and Indian Ocean islands hotspot, the Eastern Arc mountains and coastal forests of Kenya and Tanzania and, the Cape Floristic Province and the Succulent Karoo hotspots, both located in South Africa's western cape. It also contains part of the Mediterranean Basin hotspot.

The Guinean hotspot ranks first in mammalian diversity among the world's 25 hotspots. With 551 species, it is home to half of Africa's known mammalian species. The forests of West Africa are of global importance. The last significant remains of the structurally complex and species-rich forests of the upper Guinea zone include the forest relics at Gola in Sierra Leone, Sapo in Liberia, Tai in Côte d'Ivoire and, the Fouta Djallon, Mount Nimba, and Loma at the headwaters of Rivers Niger, Senegal and The Gambia.

Due to the diversity of the landscapes in Madagascar and the extremely high level of endemism of its flora and fauna, this country is on the list of environmental priorities in the world. The Madagascar and the Indian Ocean islands biodiversity hotspot is considered one of the richest, but its unique plants and animals are highly threatened by the loss of nearly 80 per cent of the original forest cover over the past 2,000 years.

The Eastern Arc mountains harbour the densest concentration of unique plants, birds and a variety of threatened primates. Cape Floristic Province contains an incredible

8,200 plant species of which 5,682 are endemic to the area, while the Succulent Karoo has 40 per cent of its nearly 5,000 succulent plant species being endemic. The Karoo is also a centre of diversity for reptiles and invertebrates. The Mediterranean Basin is the site of many ancient civilisations and is thus one of the most heavily impacted of the 25 hotspots in the world. It is host to 13,000 endemic plant and animal species.

6.3 Biodiversity and the of Concept of Protected Areas

At the IVth World Congress on National Parks and Protected Areas in Caracas (Venezuela) in 1992) a protected area was defined as “an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective mean”. Protected areas are a key element of strategies to conserve Africa’s rich biodiversity. They occupy slightly over 2,000,000 square kilometres of Africa’s surface area, or about 8.6 per cent of the continent. This reflects both the vast size of Africa and a high level of commitment by African nations to conserve biodiversity and promote sustainable development. In 1996, protected areas of greater than 1,000 hectares in extent occupied 5 per cent of the land surface in 48 African countries. Table 3 summarises the extent of African forests in different IUCN categories of protection. This information indicates that, as at June 2000, about 28 per cent of the total land area in Africa was forested of which less than 10 per cent are protected.

6.4 The Values of Biodiversity and Forests

The direct benefits of biodiversity include the provision of food, medicines and energy. Indirect benefits include the provision of essential life support services, such as the recycling of carbon, oxygen, and nitrogen, mitigating pollution, protecting watersheds, and combating soil erosion. Biodiversity is essential for ensuring food security, and its economic value is easily recognised. All of the world’s major food crops and livestock depend on new genetic material from the wild to remain productive and healthy. Modern agriculture is now a \$3 trillion global business, while nature tourism generates some \$12 billion in annual revenues worldwide. In 1988, the global commercial trade in wild plants (excluding timber) and animals was valued at \$5 billion.

Biodiversity is also important for human health. About 120 pure chemical substances used in pharmaceutical industry around the world are extracted from some 90 species of higher plants. In addition, biodiversity provides an array of recreational opportunities and aesthetic value.

In addition to providing food, fodder, timber, fuel wood, non-timber products, and genetic resources, forests generate oxygen, extract pollutants from the air, assist in nutrient cycling and, maintain watersheds for drinking and irrigation water. They also provide habitat for humans and other forms of life and, absorb carbon dioxide from the atmosphere, among other environmental services.

These values are explicitly recognized by African leaders as evidenced by their commitment to international obligations, and in the many declarations and pronounce-

ments. 53 African countries have ratified or acceded to the Convention on Biological Diversity (CBD), which was adopted at the United Nations Conference on Environment and Development (UNCED), in Rio (1992). The Convention's three main objectives are to ensure the:

- Conservation of biological diversity;
- Sustainable use of its components; and
- Fair and equitable sharing of the benefits that arise out of the use of genetic resources.

Under the convention, African countries have undertaken to conserve and sustainably use biodiversity. Towards this end, they have developed national biodiversity strategies and action plans, and are working to integrate these into broader national plans for environment and development, particularly in such sectors as forestry, agriculture, fisheries, energy, transportation and urban planning.

6.5 Threats to Biodiversity

At the dawn of the new millennium, there is increasingly little doubt that the planet is in the midst of a biodiversity crisis. It is clear that current species extinction rates are dramatically higher than background rates. The last two decades have witnessed a steady rise in concern over the rapidly increasing rate of species loss. Africa presents no exception. Rapid population growth, development of commercial agriculture, logging, fishing, and urbanization are causing large-scale losses of Africa's biological diversity.

The world's largest environmental gathering in the year 2000 - The Second World Conservation Congress - held in Amman (Jordan) reported that the loss of species has assumed dramatic speed and magnitude as more species move into the critically endangered category or go extinct. Overall, at least 11,000 species are threatened with extinction, according to IUCN's Species Survival Commission. The numbers of threatened mammal, bird and plant species are presented in Graph 2 (see also box 5).

The major human induced threats to ecosystems and biodiversity are unsustainable exploitation, habitat change, pollution, invasions by exotic species, and global climate change. Human beings are using many of the world's natural resources faster than they can replace themselves.

Some species require large areas of land or water in order to meet their nutritional, migratory, shelter and breeding needs. Human activities encroach on the natural habitats of many species. The loss, fragmentation and conversion of natural areas due to the spread of cultivation and pasture are a major contributing factor to the loss of Africa's biodiversity.

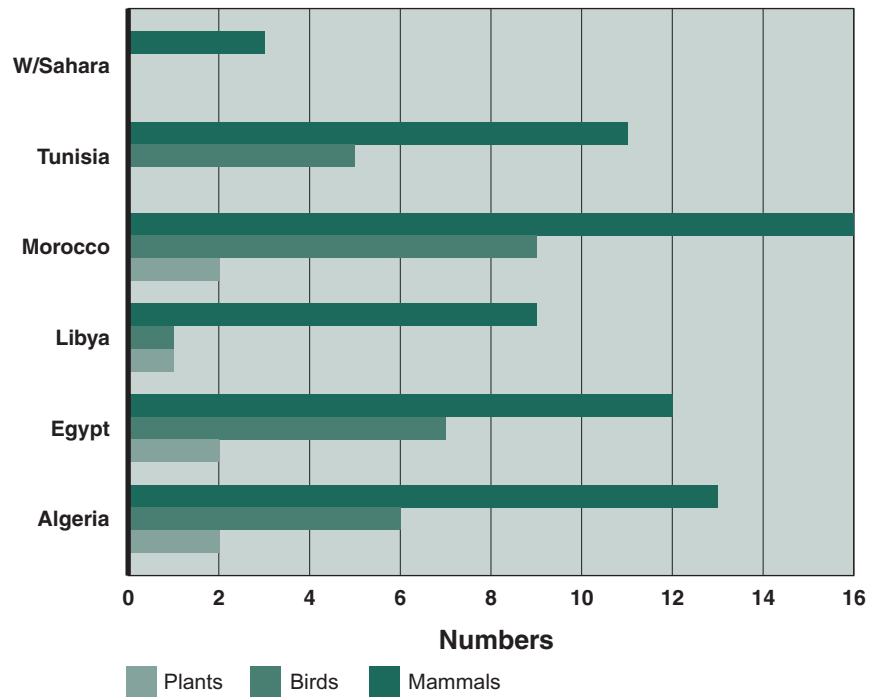
While Africa currently makes a relatively small contribution to global climate change, it is extremely vulnerable to the results of it. A significant change in climate over the next 50 to 100 years is likely to result in many natural populations of wild organisms being unable to exist within their natural ranges. Changes in temperature and precipita-

tion are likely to seriously affect the present distribution of many species. Thus, climate change is an additional factor threatening the survival of species. Some species - such as mosquitoes and other disease vectors and some pests may flourish and expand their ranges.

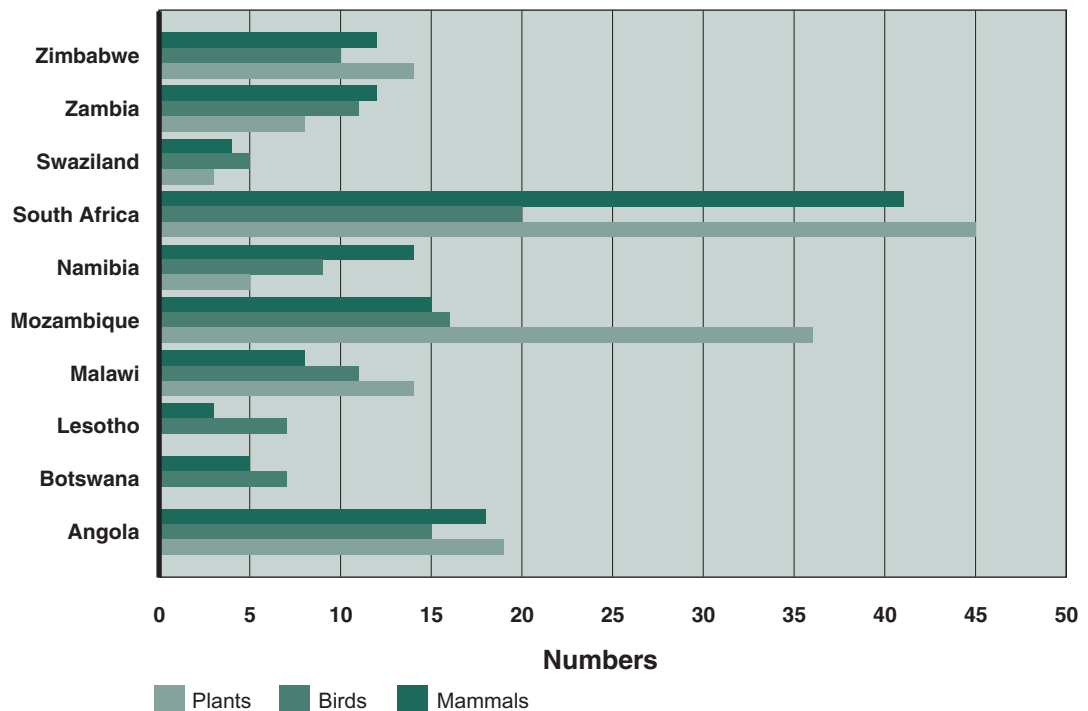
Various pollutants, including pesticides and other agrochemicals, can undergo biological accumulation in food webs. This does not only harm the species themselves, but also their food resources and predators.

Graph 2:
Numbers of critically endangered, endangered and vulnerable species of mammals, birds, and plants in African countries

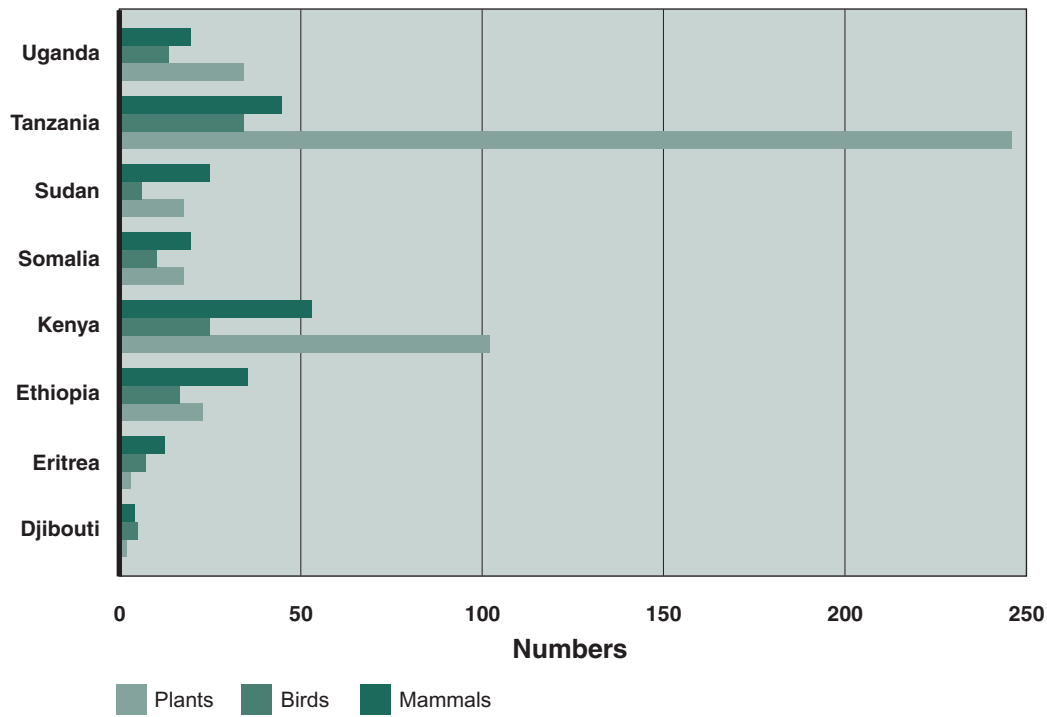
A. Northern Africa



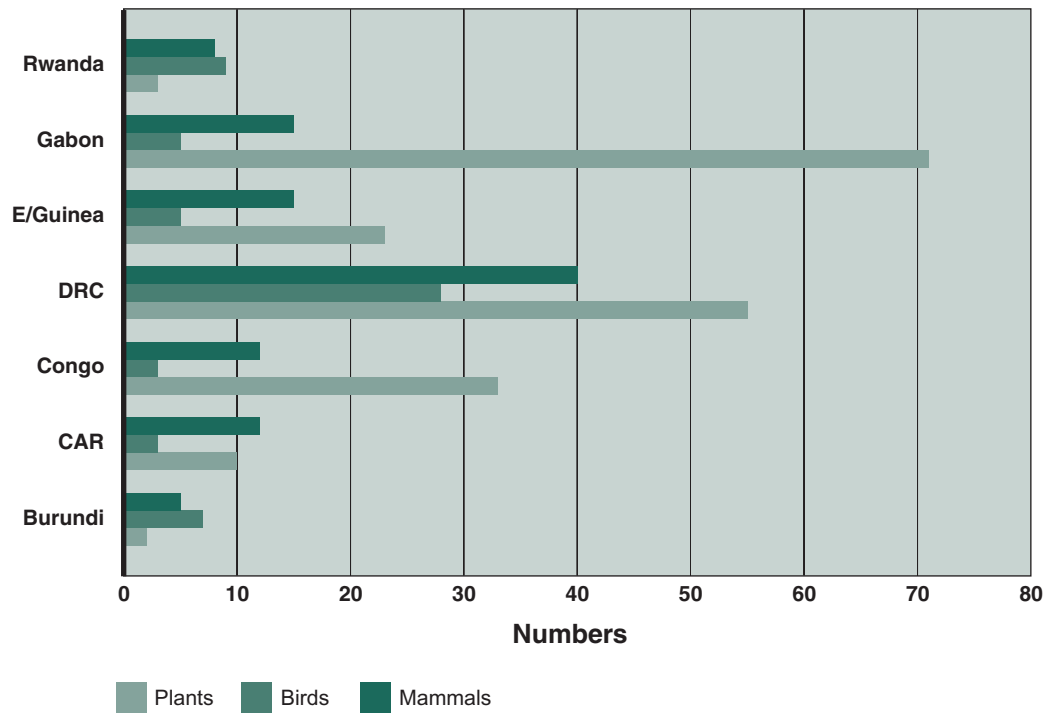
B. Southern Africa



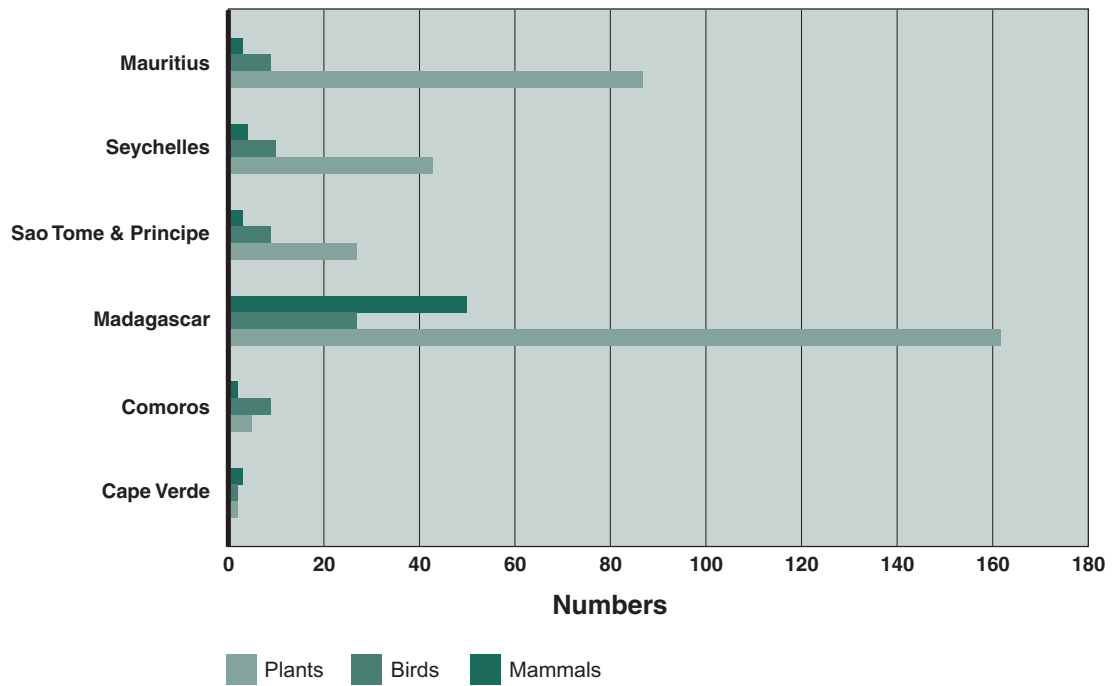
C. Eastern Africa



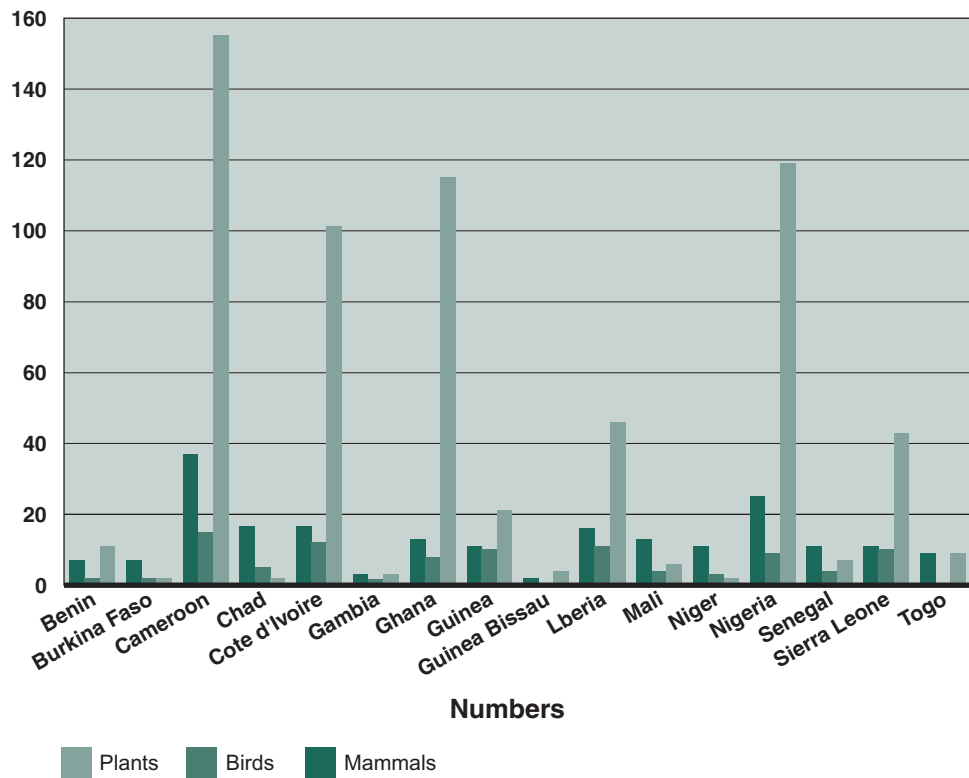
D. Central Africa



E. Island States



F. West Africa



The introduction of alien or invasive species has serious negative impacts on native species. Since they have no natural predators or diseases in their new habitat, their numbers increase rapidly, thereby leading to increased competition for resources. The impact of these threats are well expressed on a continental scale as well as at local scales (see box 6 for an example).

6.6 The Decline of Africa's Forests

The rate of decline in the world's forest cover has commanded a tremendous amount of respect over the last few decades. At the end of 1990, Africa had an estimated 528 million hectares, or 30 per cent of the world's tropical forests. According to the FAO, tropical deforestation occurred at an average rate of 0.8 per cent per annum between 1980 and 1990. This global annual rate was exceeded in many sub-Saharan African countries. The decline has resulted mainly from the rising demand for agricultural land, timber, other forest products and livestock. These proximate causes of deforestation are the result of underlying driving forces, which include the policies and attitudes of governments and social-political institutions that influence production and consumption patterns.

Box 6: Threats to biodiversity in the Zambezi Basin

The biodiversity of the Zambezi Basin is threatened by various factors, both direct and indirect. The factors can be grouped into six categories: pollution, fire, exotic (alien) species, dams and other hydrology structures, land clearance and overexploitation. The severity of each of these factors varies from place to place in the basin, and often more than one of these factors are experienced together.

The effect of pollution is usually felt after a lengthy period of continuous discharge of waste. Pollution emanates from definite sources called point sources such as mining compounds and industries, or from general or non-point sources such as pesticides and fertilisers in runoff from agricultural land.

Two examples of pollution observed in the basin include pollution of the Lake Chivero near Harare, where fish deaths were observed in 1995, and the effect of mining on tributaries such as the Kafue in Zambia.

Large areas of the Barotse Floodplains and many other parts of the basin are subject to regular fires. The vegetation in these areas has since modified to suit the prevailing conditions.

Introduction of alien species has mixed effects on the biodiversity of the basin. Pine trees have invaded the grasslands of Nyanga in Zimbabwe and Mt. Mlanje in Malawi.

The Nile Tilapia fish was introduced in the waters of the Middle Zambezi, and the Kariba Weed (*Salvinia molesta*) into the Chobe system. The water hyacinth weed is now in most tributaries of the Zambezi, reducing the biodiversity of indigenous species.

Box 6: Threats to biodiversity in the Zambezi Basin (cont'd.)

Introduction of the kapenta fish (*Limnothrissa miodon*) in Lake Kariba in the 1960s is believed to have had more positive effects than negative as it was introduced in a newly created habitat. The construction of dams has the greatest effect on biodiversity of wetland species as new habitats are formed and old ones destroyed or modified. The hydrology of the Zambezi River system was modified by the construction of the Kariba, Cahora and Itezhi-Tezhi dams.

Human settlements have sprung up in areas previously belonging to the natural environment. As the settlements expand due to population increases and other factors, more land is acquired and cleared for agriculture, urbanisation and expansion of human development initiatives.

Such large settlements include the Copperbelt towns of Zambia, the large urban settlements of Harare, Lusaka, Lilongwe and many other towns in the basin. Land is also cleared to make way for farms and plantations that replace a rich diversity with a monoculture of plants.

Associated with human development is overexploitation of species of particular interest to human needs.

Examples include the destruction of large mammals such as the elephant, rhino, and antelope over wide areas, harvesting of valuable timber such as mukwa, African ebony and Zambezi teak, overgrazing in various parts of the basin and overfishing in Lake Malawi.

Source: State of the Environment of the Zambezi River Basin 2000, Factsheet No#8: Biological Diversity

Southern African Research and Documentation Centre. <http://www.sardc.net/>
<http://www.sardc.net/>

The largest portion of Africa's tropical forest cover occurs close to the equator, where precipitation and temperatures are high and more or less evenly distributed throughout a year. The Congo Basin constitutes the second largest contiguous primary tropical rainforest area in the world, after the Amazon. Tropical forest soils are very easily leached of nutrients and quickly lose their production potential upon conversion to cultivation.

In its latest assessment, the World Resources Institute (WRI) concluded that almost 6.8 million square kilometres of Africa were originally forested. Only 8 per cent of Africa's original forest remains as frontier forest, comprising relatively undisturbed units and large enough to maintain all of their biodiversity, including viable populations of the wide-ranging species associated with each forest type. It also concluded that 77 per cent of Africa's remaining frontier forests are under moderate to high threat, and that almost 80 per cent of this threat is due to logging. These are summarised in Box 7.

At UNCED, the international community considered ways to slow down the rate of global deforestation and integrate sustainable development into forestry practices. Many countries, including African ones, agreed on a set of principles for a global consensus on the management, conservation and sustainable development of all types of forests. These principles have been elaborated upon further through a series of negotiations, culminating in a new United Nations Forest Fund (UNFF).

Box 7: The most important threats to frontier forests in Africa

- Logging, which can significantly “rewrite” the structure and composition of forests. In central Africa, over 90 percent of all logging occurs in primary forest - one of the highest ratios of any region in the world. Logging roads open up a forest to hunters, would-be farmers and other profit-seekers. (Africa 79 percent; World 72 percent)
- Overhunting, introduction of harmful exotic species, isolation of smaller frontier forest “islands” through development of surrounding lands, changes in fire regimes and plantation establishment. In Africa, one-third of the frontier forest, which is threatened, is at risk through commercial hunting, driven largely by urban demand for bushmeat. Overhunting removes populations of key species that help maintain natural forest ecosystems and can otherwise upset natural processes that shape forests, for example, by altering the ways that seeds are distributed and herbivores kept in check. (Africa 41 percent; World 13 percent)
- Clearing forest for agriculture. (Africa 17 percent; World 20 percent)
- Energy development, mining, and new infrastructure. (Africa 12 percent; World 38 percent)
- Excessive vegetation removal. (Africa 8 percent; World 14 percent)

Source: World Resources Institute - WRI. World Resources 2000-2001

Table 4:
Africa forest statistics - June 2000²

Forest type	Area Protected (km ²) in IUCN Categories I-VI:						Total forest (km ²)	Total protected (km ²)	% Protected	
	Ia	Ib	II	III	IV	V				VI
Temperate and boreal										
Mixed broadleaf/needle leaf forest	330.2	19.9	376.5	0.0	11.4	1,005.1	0.0	32,627.0	1,742.9	5.3
Deciduous broadleaf forest	267.3	0.0	1,505.7	0.2	2,092.1	25.8	631.4	140,727.0	4,522.5	3.2
Sclerophyllous dry forest	16.8	0.0	77.9	0.0	37.9	0.0	0.0	17,446.8	132.6	0.8
Sparse trees/parkland	141.7	1.5	1,009.2	0.0	2,003.9	27.5	1,568.9	253,001.3	4,752.6	1.9
Tropical										
Lowland evergreen broadleaf rainforest	1,426.9	596.0	75,428.3	0.0	27,203.9	0.0	22,516.0	1,685,243.8	127,171.0	7.5
Lower montane forest	0.0	0.0	124.3	0.0	96.5	13.8	149.5	33,232.3	384.1	1.2
Upper montane forest	876.9	0.0	8,166.2	0.0	3,890.0	0.0	12,211.5	156,341.3	25,144.6	16.1
Freshwater swamp forest	342.7	0.0	2,262.8	0.0	77.4	0.0	193.9	196,729.0	2,876.8	1.5
Semi-evergreen moist broadleaf forest	0.0	0.0	1,897.4	0.0	662.6	14.7	293.1	47,512.3	2,867.8	6.0
Mangrove	13.3	0.0	360.7	0.0	645.3	0.0	159.6	53,804.5	1,178.9	2.2
Disturbed natural forest	854.8	7.9	2,125.9	0.0	3,825.6	0.0	1,152.2	414,479.8	7,966.4	1.9
Deciduous/semi-deciduous broadleaf forest	1,280.5	358.6	95,146.6	48.4	82,752.0	225.7	91,375.6	2,243,589.8	271,187.4	12.1
Thorn forest	0.0	0.0	1,117.8	0.0	770.7	0.0	8,176.1	192,927.0	10,064.6	5.2
Sparse trees/parkland	927.7	7.6	144,383.8	1,477.4	87,759.2	9.1	64,838.9	2,714,396.3	299,403.7	11.0
Total	6,478.6	991.5	333,983.0	1,526.0	211,828.6	1,321.7	203,266.6	8,182,057.8	759,396.0	9.3

² Source: UNEP-World Conservation Monitoring Centre (WCMC) 2001: Forest Protection Analysis June 2000: [http:// www.unep-wcmc.org/ forest/afr.htm](http://www.unep-wcmc.org/forest/afr.htm)

VII. FRESHWATER

7.1 Introduction

Africa is seemingly endowed with abundant freshwater resources. However, their distribution is highly variable in time and space. While some countries have an abundance of water resources, others experience water scarcity and stress. The region's fast growing population places a high demand on water resources to meet domestic, agricultural and industrial requirements. There is high potential for water resources development but this has been grossly under-utilised due to financial and technological constraints. Due to various activities by man, the quantity and quality of the region's water resources is constantly being depleted, thus placing further stress on an already scarce but vital resource. In response to the growing challenges in the regions water resources, various initiatives have been taken at the national, sub-regional and regional levels with a view to improving on the development and management of the resource. There are constraints to realizing visions and implementing programmes but opportunities exist which can be maximized to yield desired results.

7.2 Water Resources

Africa's total available water resource seems abundant, however in actual terms, it is inadequate for a vast continent with high evaporation rates and a rapidly growing population. In addition, the distribution of water resources in different regions of the continent is highly variable in time and space. Average annual flow is over 4 000 billion m³, and includes the world's longest river (the Nile) and its second largest in terms of basin and flow - the Congo. The wet equatorial zone (mainly the central and south-western countries) produces 95 per cent of Africa's total flow, while the arid and semi-arid zones produce only 5 per cent (Lake and Soure, 1997). In terms of surface water bodies, Africa has 17 rivers with catchment areas greater than 100 000 km². It has more than 160 lakes larger than 27 km², most of which are located around the equatorial region and sub-humid East African highlands within the Rift Valley (The Africa Water Vision in the 21st Century, 2000).

Groundwater represents 15 per cent of Africa's water resource with the major aquifers located in arid zones of the northern Sahara, Nubia, Sahel, Chad Basins, and Kalahari. (Lake and Soure, 1997). Groundwater is a very important source of drinking water supply - used by more than 75 per cent of the population. This is particularly true in the North African countries such as Libya, Tunisia, and parts of Algeria and Morocco, as well as in some South African countries (The Africa Water Vision in the 21st Century, 2000).

The average rainfall, on a continental basis, is about 670 mm per year. At sub-regional level, the spatial distribution of rainfall is varied. The highest rainfall occurs in the Island States (1700mm per year), the Central African countries (1430mm), and in the Gulf of Guinea (1407mm). In contrast, the lowest rainfall occurs in the northern countries where the average rainfall is only 71.4mm (The Africa Water Vision in the 21st Century, 2000). The inequality in distribution of water resources is more striking

on the basis of per capita availability; while the per capita availability in Gabon, for example, is 136 000 cubic metres, in Libya it is less than 200 (Lake, E.B., Soure, M. 1997). The internal renewable resources is generally low for the continent - 20 per cent of total rainfall ranging from 5.9 per cent in the Sudano-Sahelian countries and 33.8 per cent in the island States (The Africa Water Vision in the 21st Century, 2000). Due to the sheer intensity of the rains, very little goes to recharge underground aquifers, most of it is lost as surface runoff. In Kenya, for example, only 6 per cent of the annual rainfall is available for use. The comparable figure for Ethiopia is a mere 3 per cent (Draft AEO, 2001)

7.3 Water Demand and Use

The variable and uneven distribution of water resources in Africa combined with the region's current state and pace of development and urbanization together pose significant challenges to meeting water needs. Africa has a population of more than 770 million people and with a growth of roughly 3 per cent per year, it is one of the fastest growing regions in the world. The rapidly growing population places a high demand on available water resources to meet domestic, agricultural and industrial needs.

The problem of water scarcity is not only caused by natural phenomena. It is also due to the low levels of development and exploitation of the water resources in spite of the growing demand from a rapidly growing population (see Table 5). The region withdraws only 3.8 per cent of its internal renewable water resources for agriculture, industrial and human consumption (The Africa Water Vision in the 21st Century, 2000). Of the world registered dams and large reservoirs, only 5 and 6 per cent respectively are found in Africa (www.wri.org/wr2000/freshwater).

In the South African Development Community (SADC) region, water demand is projected to rise by at least 3 per cent annually till 2020, a rate equal to the region's population growth. As a consequence, it has been estimated that by 2025, up to 16 per cent of Africa's population will be living in countries facing water scarcity, and 32 per cent in water stressed countries (The Africa Water Vision in the 21st Century, 2000).

Table 5
Africa
regional
distribution of
water
withdrawals

INDICATOR	1965-73	1974-79	1980-85	1986-93	1990-98	1999
Population growth rate	2.7	2.9	3.0	2.9	2.7	2.7
Growth rate of GDP (avg.)	5.7	3.5	1.8	2.5	1.9	2.7
Growth rate of agricultural output (avg.)	2.7	3.0	1.5	2.7	2.9	1.1
Growth rate of manufacturing output (avg.)	7.3	6.7	5.2	2.5	0.3	3.5
Growth rate of investment (avg.)	9.6	6.9	-4.8	1.2	1.4	6.4
Savings-GDP (avg.)	16.2	20.9	16.3	15.6	15.3	15.6
Growth rate of exports (avg.)	8.2	2.6	0.4	3.0	0.6	2.1
Growth rate of imports (avg.)	7.4	6.2	-2.4	0.7	.04	1.5

Source: FAO Irrigation in Africa in Figures, extract from Water Report 7, Rome 1995.

There is inadequate coverage of safe water and sanitation services especially among the peri-urban and rural poor. In rural Africa, about 65 per cent of the population do not have access to adequate water supply and 73 per cent are without access to adequate sanitation facilities. In urban areas, 25 per cent and 43 per cent do not have access to adequate water and sanitation facilities respectively (The Africa Water Vision in the 21st Century, 2000). In Lesotho, the coverage in water supply is in the range of 34 to 66 per cent and that for sanitation is 0 to 33 per cent (Economic Commission for Africa, 1999).

Sewage facilities always seem to be of lower priority than water. In urban and peri-urban areas, sewage networks are either non-existent or incomplete and people often resort to individual disposal facilities such as septic tanks. In Senegal, 76 per cent of the urban and peri-urban population have individual disposal units and similar figures have been recorded in other African cities and suburbs. Lack of safe drinking water supplies and adequate sanitation often result in disease and premature death from water related illnesses that kill an estimated 3 million Africans each year. (Lake and Soure, 1997).

In many parts of Africa, lack of adequate water resources is a major constraint to food security. During the past three decades, agricultural production has increased at an average of less than 2 per cent while the population has been growing at a rate of 3 per cent. As a result, food deficit particularly cereals have increased and imports are expected to rise from the current 10 million metric tons per annum to 30 million in 2025. In much of West Africa, average food supply (2 430 kcal/day/person) is below what is regarded as the optimum level, i.e. 2 700 kcal/day/person (West Africa Water Vision, in the 21st Century, 2000).

It is worth noting, however, that despite the high levels of food insecurity in the continent, most countries have grossly under-utilised their full irrigation potential. Two-thirds of African countries have developed less than 20 per cent of their potential. Ethiopia has a potential irrigable land area of about 3.7 million hectares, of which only 160,000 hectares have been developed (Draft AEO, 2001). In North Africa, expansion of irrigated areas is expected to continue in some countries such as Morocco and Tunisia to supply internal and external markets (The Mediterranean Water Vision in the 21st Century, 2000).

In Africa, much water is wasted; the average level of unaccounted for water is about 50 per cent in urban areas. As much as 70 per cent of the water extracted for irrigation is lost (The Africa Water Vision in the 21st Century, 2000) through evaporation and other means. For example, in Southern Africa, nearly half of the irrigated land is watered by highly inefficient flood irrigation methods, while more efficient methods such as micro jet and drip irrigation are applied on less than 10 per cent of irrigated farmland.

Water used for irrigation purposes represents 69 per cent of the total water use in the region. It is estimated that making the present irrigation systems 10 per cent more efficient would result in water savings of 2.5 billion cubic metres in the region each year. A comparison of irrigation methods in Zimbabwe and Israel revealed that for the same crop, while Zimbabwe uses 15 000 m³ of water per hectare, Israel uses one-third that amount (i.e. 5 000 m³ per hectare) because the latter employs more efficient

systems (Rothert and Macy, 2000). In the Mediterranean region (which includes North African countries) it is estimated that reducing unaccounted for water both in urban and irrigation networks can provide 30 to 50 per cent saving of irrigation water and 28 to 50 per cent savings in urban water (The Mediterranean Water Vision in the 21st Century, 2000).

Development in the fisheries sector (an important source of nutrition in Africa) is highly dependent on adequate water resources availability both in terms of quantity and quality. In Lake Victoria, there were major shifts in the fish population caused by eutrophication, which resulted from land-use changes in the watershed and pollution (www.wri.org/wr2000/freshwater). The livestock sub-sector also depends on water resources directly as a source of drinking water for herds and indirectly for fodder production. Drought conditions in Southern Africa have resulted in the death of many animals in the sub-region (RSAP for Integrated Water Resources Development and Management, 1999-2004).

The sustainability of the energy sector, which drives industrial development to a large extent, depends on assured water resources availability. In West Africa, river basins mainly in Nigeria, Ghana and Côte d'Ivoire have been harnessed to produce hydro-electric energy. Of the approximately installed capacity of 4 286 MW in the sub-region, these three countries account for 45, 25 and 21 per cent respectively. Lately, many reservoirs in southern Africa have experienced low water levels thus affecting electricity supplies. In Zambia, during the drought of 1992-1993, generation of electricity fell by about 12.2 per cent, recovered by 3 and 4 per cent respectively in 1993 and 1994, and fell again by 2 and 11.2 per cent in 1995 and 1996 respectively (RSAP for Integrated Water Resources Development and Management, 1999-2004). This decline in power output has adverse impacts on many economic activities in the commercial and industrial sectors notably mining and manufacturing. Decreasing water resources also has direct impact on mining and manufacturing activities that depend on bulk water supplies. This has however led to the adoption of water conservation measures. For instance, in Namibia, the Rossing Uranium Mine reduced its daily freshwater consumption from 30 000 m³ to 7 000m³ per day through conservation.

Other important uses of water within the region are transportation, recreation and tourism. Rivers, lakes and coastal waters provide transport services, especially in areas inaccessible to other modes of transport. Recreation, leisure and tourism have assumed an important place in the regions economy. Wetlands, Great Lakes and rivers, recreational fishing for leisure, sporting activities are major features in the tourism industry. In Malawi, water based tourism is the country's largest foreign exchange earner. (RSAP for Integrated Water Resources Development and Management, 1999-2004). In West Africa, the reservoirs that have been created on the Volta, Niger, and Senegal Rivers at the Akosombo, Kianji, and Malantali are providing opportunities for navigation of goods and passengers (West Africa Water Vision in the 21st Century, 2000)

7.4 Depletion of Water Quantity and Quality

The problems of water resources in the region are further compounded by the negative impact of human activities, which threatens the quality and quantity of an already scarce but vital resource.

7.4.1 Degradation of Wetlands

Wetlands are a key component of freshwater ecosystems and have great economic and ecological importance. Wetlands provide a wide array of goods and service, including flood control, nutrient cycling and retention, carbon storage, water filtering, water storage and aquifer recharge, shoreline protection and erosion control, and a range of food and material product, such as fish, shellfish, timber, and fibre. Wetlands also provide habitat for a large number of species, from waterfowl and fish to invertebrates and plants (www.wri.org/wr2000/freshwater).

However, wetlands around the world have undergone massive conversion with considerable ecological and socio-economic costs. Wetland changes with significant social, economic and ecological consequences include conversion to agricultural lands and construction of dams that curtail the seasonal replenishment of the wetlands. Notable examples of these include a large-scale irrigation scheme in the Hadjia-Jama' are river basin in northeastern Nigeria and the construction of a dam and development of a rice irrigation scheme in the Waza-Logone floodplain in northern Cameroon (www.wri.org/wr2000/freshwater). In southern Africa, many wetlands and floodplains are at risk of disappearing as a result of large-scale irrigation schemes and other water management activities. A case in point is the Okavango Delta in Botswana, which is a globally important wetland area. Water projects being proposed in the area if implemented, could be ecologically damaging and put the delta at risk from drainage and water extraction (www.wri.org/wr2000/freshwater).

7.4.2 Pollution of Water Bodies

Water bodies are being depleted due to poor waste management, agricultural and industrial discharges and over extraction. Pollution limits the regeneration of freshwater ecosystems and complicates water treatment for domestic use (Lake, E.B., Soure, M. 1997). Industrial and agricultural pollution release chemicals, pesticides and fertilisers into water bodies, thus compromising their quality. The levels of contamination in some water bodies such as Lake Malawi/Nyasa are so high that fish kills have been experienced (www.sadcwscu.org.ls/). Another water quality problem is salt-water intrusion. This is an issue particularly in the Mediterranean coast and on the oceanic islands like the Comoros that are highly dependent on groundwater resources. Nutrient enrichment or eutrophication of water bodies arising from pollution from phosphates and sulphate rich materials can result in the blooming of aquatic weeds particularly water hyacinth. This has seriously affected many water bodies such as Lake Victoria, the Nile and Lake Chivero (Africa Water Vision in the 21st Century, 2000).

Overgrazing and deforestation that result in severe soil loss and sediment loading into water bodies are problems causing serious concern. Desertification and erosion threaten much of Africa. In some Sahelian countries, rainfall has been declining by about 10mm annually. If the trend continues, and predictions of global climate change come true, some of the region's aquifers may be rendered unusable. Erosion results in soil loss thus affecting agricultural productivity. Erosion also shortens the useful life of reservoirs, lakes and ponds. In Kenya, sedimentation is cutting the lifespan of dams, reducing storage capacity, and impairing water supply downstream. In Western Africa, the Ibohamane and Mouela reservoirs on the Niger River are reported to have lost half their capacity because of siltation over the past 15 years (Lake and Soure, 1997).

7.5 Initiatives

In response to the socio-economic development challenges being posed by the water resources sector, many initiatives have been undertaken at national, sub-regional, regional and basin level. Nearly all countries in Africa have adopted water strategies, policies and legislation. Over the years, several sub regional consultations have been held and reports produced on various aspects of water resources management and more recently on Integrated Water Resources Management (IWRM). These include Expert Consultation on Water for Food on West Africa sub-region, Accra (Ghana) 1999; West African Conference on Integrated Water Resources Management, Burkina Faso, 1998; RSAP for Integrated Water Resources Development and Management for the SADC region, 1999-2004.

In preparation for the Second World Water Forum that was held in The Hague in 2000, the West and southern Africa regions formed advisory committees that discussed their respective strategies, approaches and visions for water. The output of the advisory committees together with those of river basin organisations and the outcomes of other regional forums provided a useful basis for the Africa Water Vision.

Africa's vision for water states: "Safeguarding Life & Development in Africa - A Vision for Water Resources Management in the 21st Century" (Africa Water Vision in the 21st Century, 2000). The framework for action has been well articulated but there are challenges; and these require systematic and well-defined approaches if the vision is to become reality and other water resources development and management initiatives satisfactorily implemented. However, an important opportunity within the region is that the political will is alive to strengthen regional cooperation.

The SADC Protocol on Shared Watercourses (1995) is a good example of the benefits of regional cooperation pertaining to trans-boundary water resources. The member States are now prepared to implement the protocol, whose main intent is to prevent conflicts over the region's shared waters (www.sadcwscu.org.ls/programme). Joint regional water projects in the region include the Lesotho Highlands Water Project - between Lesotho and South Africa (The Africa Water Vision in the 21st Century, 2000). River basin organizations have been established for the Niger, Senegal, Gambia Rivers and Lake Chad. In the case of the Volta River, there is an informal arrangement for consultations established between Ghana and Burkina Faso.

In North Africa, management of shared river basins such as the Nile has contributed to some regional tension but has also led to some important specific agreements. There are basin authorities and advanced water laws in countries like Algeria, Libya and Morocco (The Mediterranean Water Vision in the 21st Century). The Nile Basin Initiative is the most recent river basin initiative within the region. The initiative is a cooperative programme aimed at addressing poverty, environmental degradation and instability in the ten countries that are bound by the Nile (www.worldbank.org/afr/nilebasin).

7.6 Constraints and Opportunities

Major issues constraints and opportunities for water resources development and management are as follows:

- Weak legal and regulatory framework and lack of harmonization of national legislation on water resources management at the regional and basin level: opportunities for harmonization include agreements signed at subregional and basin levels.
- Inadequate institutional and financing arrangements: current institutional arrangements are often inadequate and the financing of investments is often unsustainable. There is lack of integrated plans and the multiplicity of government agencies involved in water resources issues. Efforts are usually not coordinated, hence creating a situation where conflict situations often arise. Public investments often exclude local communities who therefore see development and maintenance programmes as government's responsibility. This leads to unsustainability of projects. Public participation should be an integral part of policy and programme development as well as implementation. Opportunities include the adoption of IWRM by regions and establishment of regional water coordination units and basin authorities. Initiatives to encourage the participation of women's and youth groups in programmes are gaining momentum.
- Lack of economic instruments to provide monetary incentives, which will promote the conservation and sustainable use of water and as well as private sector investment in the water resources sector. Opportunities lie in the expansion of sound socio-economic policies and options explored to encourage private sector involvement.
- Data and information systems relating to water resources in Africa is generally inadequate. The limitation is linked to inadequate human capacity for the collection, assessment and dissemination of data on water resources for developing, planning and implementing projects. The skills for IWRM are not widely available in Africa. Under the Global Water Partnership, a capacity-building associated programme is being developed to provide strategic assistance for developing the necessary skills for IWRM. Other initiatives include the Hydrological Cycle Observing System (HYCOS), Flow Regimes from International Experimental and Network Data (FRIEND), and Global Environmental Monitoring Systems (GEMS) water programme.

In the region, there is a general lack of awareness of water resources issues, including the state of water resources, the economic, social and environmental issues. People need to be aware in order to understand and be committed to act. Implementation of various water-related agreements requires awareness creation at all levels.

Political instability in Africa has stifled the regions socio-economic development including development in the water sector. Opportunities lie in the success of regional and international peace initiatives to bring an end to hostilities. Missions have been largely successful thus giving regional and international organizations the opportunity to concentrate on much needed development programmes.

VIII. MARINE AND COASTAL AREAS

8.1 Introduction

Africa's coastlines are experiencing intense demographic pressures. Owing to poorly planned construction and other development activities, as well as over-exploitation of resources, the physical and ecological degradation of coastal areas is accelerating. The issue of coastal erosion is increasingly becoming a major social, economic and environmental concern to a large number of island and coastal States. Reversing and halting this threat requires comprehensive measures and strategies.

The often-irreversible alteration of natural coastal systems and extensive coastal pollution are caused by the concentration of industrial development, accompanied by inadequate environmental policies and sectoral development. The situation in some of Africa's small island states, which largely depend on development and use of coastal zones, is of particular concern.

The coastal zone needs to be considered as a finite economic asset, which can be used on a sustainable basis only, through prudent and rational exploitation. This intrinsic economic value of the coastal natural resources and amenities should be accorded a higher degree of importance in national policies on the marine environment. Declining catches in some of the continent's fishing grounds clearly demonstrate that increased fishing effort and investment as well as unmanaged small-scale fisheries can bring about the total dissipation of the value of fisheries.

Over the last two decades, African countries have been parties to intergovernmental agreements and arrangements, which have now provided the legally binding basis for action on the marine and coastal environment in Africa. These include the Abidjan, Nairobi, Jeddah and Barcelona Conventions and their respective protocols. Within these frameworks, African countries have adopted a number of intergovernmental programmes and are partners in similar initiatives, which constitute the substantive basis for action in the continent.

8.2 Physical Features and Biodiversity

The marine environment- including the oceans and all seas and adjacent coastal areas- forms an integrated whole that is an essential component of the global life-support system and a positive asset that presents opportunities for sustainable development (Chapter 17, Agenda 21, 1992). The African coastal environment contains diverse and valuable ecosystems of high productivity and biodiversity, and offers unique habitats for many species. These ecosystems contribute significantly to the livelihood of coastal communities and to the economy. These resources have intrinsic value including shoreline stability, beach enrichment, nutrient generation, recycling and moderation of pollution (Intergovernmental Oceanographic Commission - IOC Workshop Report No. 152).

The coastal zone in Eastern Africa is characterised by palm-fringed beaches, coral reefs, mangrove forests and bright blue waters (Waruinge, 1998). Mangroves, lagoon and estuaries are abundant in the West African coast (IOC, Workshop Report No. 136) and coral reefs along the coast of the Red Sea (Hanafy, 1998; IOC Workshop No. 165). The tropical East coast of South Africa is edged by coral reefs, dynamic sandy beaches, pristine coastal forests and cleared community lands (Jury and Govender, 2000; www.unesco/csi/initialsurvey). In central Africa, the coastal zone is characterised by coastal lagoons, mangroves, sea grass beds, sandy beaches, and estuarine wetlands, which constitute vital resources for subsistence and economic development (UNEP, 2001 - Draft AEO).

8.3 Population Pressure

Thirty seven per cent of the world's population live within 100 kilometres of the coast. Since the coastal 100-kilometre strip represents 18.7 per cent of the total land area of 146,874,796 km², the average human population density in coastal areas is about 80 persons per square kilometre, twice the global average. Considering that many coastlines are sparsely populated or uninhabited (e.g. Antarctica, the far North, etc.), the actual population pressure on the coast in the more habitable areas is very high (www.ioc.unesco.org/igospartners).

According to an FAO news brief (www.fao.org, 2001), a recent study found that more than half the coastal zones in most regions were already moderately to highly at risk of being threatened from human activities. In Africa, the figure stands at 52 per cent. In 1992-1993, the population in the Egyptian coastal urban aggregations was about 8 million, living no more than 60-km inland. It was estimated that there would be more than 15 million Egyptians by the year 2000 (Hanafy, 1998, IOC Workshop Report No. 165).

8.4 Economic Activities

The economic activities in the coastal zone are many and range from fishing activities, agriculture, tourism and other industrial activities. The coastal zone therefore attracts a lot of people thus leading to a rapid population increase in the zone. For example, in 1993, it was estimated that the population of the coastal zone of Madagascar was 36.6 per cent of the national population. Most of the economic activities of the country are in terms of fishing, aquaculture and tourism. Exports from fishing and aquaculture amount to more than 24,000 tons, representing about \$US 100 million annually, while tourism generates more than \$US 50 million (Antananarivo, IOC Workshop Report No. 165).

In 1999, it was projected that tourism would account for 7 per cent of the GDP in South Africa, (www.unesco/csi/initialsurvey). In Egypt, the coastal zone houses more than 40 per cent of the Egyptian industry and is subject to extensive urban and tourism development. Other important developments relate to irrigation and land reclamation, infrastructure and harbours (Hanafy, 1998, IOC Workshop Report No. 165). As regards port and harbour developments, Tanzania for example, has three main ports

and three small ones. In 1995, the number of shipping movements was 4107, which amounted to nearly 12 per cent increase over the previous year. Dar es Salaam harbour alone in 1995, handled a total tonnage of 4.4 million. (Francis. IOCINCWIO-IV/inf.8)

8.5 Resource Degradation

The many and varied activities taking place in the coastal zone without proper planning and without regard to their attendant impacts has resulted in several African countries being faced with serious coastal management and development problems. In Seychelles, for example, the environmental impact of the construction industry on marine and coastal ecosystems, especially on sea grass beds and coral reefs, is detrimental (www.unesco.org/csi/act/pasicom/pacsi1.htm). In Tanzania, activities identified include removal of coastal natural vegetation such as mangroves, destruction of offshore barriers such as coral reef, offshore dredging, sand and gravel mining along streams which drain the beaches (Mutakyahwa and Muhamed, 1998). In Toubacouta (Sine Saloum region, southern Senegal), mangrove forests have been almost completely destroyed by the local people with natural desertification processes playing a secondary role. As a result, oyster-farming and artisanal fishing have been affected in many villages (www.unesco.org/csi/region/desert). The annual marine fish production in Ghana has decreased from a peak of 370,000 metric tonnes in 1992 to 273,000 metric tonnes in 1995. The catch per unit effort has also decreased indicating that the stock is being depleted (IOC 1997,).

8.5.1 Pollution

Pollution is a common occurrence within the coastal zone as a result of direct discharges and spillage of both solid and liquid wastes. In North Africa, disposal of solid and industrial wastes and dumping untreated sewerage especially in coastal areas, have contaminated surface water and is threatening coastal and marine ecosystems (www.esd.worldbank.org/envmat). The Egyptian Red Sea is exposed mainly to oil pollution. The oil discharge from different sources into the Egyptian Red Sea averaged 3,918 tons/year, from a total of 6851 tons/year in the whole Red Sea (Hanafy, 1998; IOC Workshop Report No. 165). In South Africa, some 63 ocean outfalls are located along the coast and these discharge approximately 800,000 cubic metres of sewage and industrial effluent into the sea daily. Environmental pressures associated with such discharges include organic enrichment, increase in suspended solids, and toxic and carcinogenic effects to marine life (Department of Environmental Affairs and Tourism, 1999).

8.5.2 Coastal Erosion

Coastal erosion is a serious environmental problem for several coastal and island countries in Africa. In many places the rate of coastline retreat and the resulting environmental degradation and economic loss, is so rapid as to be alarming. Although natural coastal degradation has occurred since the formation of the oceans, this has been exacerbated by human actions (www.unesco.org/csi/act/pasicom/eafrica.htm). In The Gambia, coastal erosion has been estimated at a rate of two metres per annum.

Haphazard planning and construction works close to the mangrove areas in the Greater Banjul Area poses a threat to the stability of the mangrove ecosystem (National Environment Agency, 1997)

In the Western Indian Ocean, coastal erosion has been severe in many areas, but is concentrated in the coral-fringed coasts in the region. Various attempts have been made in all these countries to protect the coast from further erosion, but these attempts have only achieved temporary relief (Institute of Marine Science, Zanzibar, Tanzania, 1994). Since tourism is a major foreign-exchange earner in African countries and since coastal hotels and associated amenities such as beaches are major attractions to the tourist trade, coastal erosion is a serious threat to both national and local economies (www.unesco.org.csi/act/pacsicom/eafrica.htm).

8.6 Sea-Level Rise

Recent events such as the El Nino phenomenon, as well as assessments carried out by organizations such as the World Meteorological Organization (WMO), show that the expected impacts of climate change and sea level rise in particular will exacerbate the present problems. It has been concluded that these phenomena could impair future development and use of low-lying areas and coastal zones and cause setbacks in Africa's efforts to achieve sustainable development (Global Ocean Observing System (GOOS)-Africa, 1998). It was reported, for example, that at the present rate of sea level rise, the apparent loss of sediments along The Gambia coast is preliminarily estimated at some 75,000 m³/year (National Environment Agency, 1996).

8.7 Challenges and Responses

8.7.1 Challenges

Given the diverse activities taking place in the coastal zone, administration of the zone has been very fragmented with different government institutions mandated to carry out different functions. This state of affairs coupled with activities of local communities has resulted in haphazard planning and uncoordinated development of the coastal zone. Inadequate research and monitoring capabilities and facilities have been major constraints in acquiring necessary data and technical information for effective policy formulation and planning. Inadequate financial, technical and human resources have been major setbacks in the implementation of national and regional programmes. Another important challenge is the low level of awareness level on the part of local communities as regards the impacts of their activities on coastal and marine resources

8.7.2 Responses

In order to improve on the management of coastal and marine resources, African countries have increasingly adopted policies aimed at integrated coastal zone management and which take into account the marine environment. In South Africa, a draft White Paper was published in March 1999 with the objective of ensuring coordinated management and sustainable development of the coastal zone. Various laws to control

pollution at sea have been enacted. The development of oil spill contingency plans resulted in the production of the Coastal Sensitivity Atlas of southern Africa (Department of Environmental Affairs and Tourism, South Africa, 1999).

In the Gambia, a multidisciplinary working group on the coastal and marine environment was established within the framework of the National Environment Management Act (NEMA) of 1994 with a view to coordinating activities in the coastal zone. In 1996, a coastal profile was developed under the auspices of this working group. The next step is to develop an Integrated Coastal Area Management Project (National Environment Agency, The Gambia, 1996). In 1995, Ghana launched an integrated Coastal Zone Management (ICZM) Project to identify economically, socially and environmentally appropriate interventions and projects in the coastal zone that improve the prospects for human development. The initiative was a participatory process with inputs from national, local and community levels (www.worldbank.org/afr/finfindings/).

At the sub-regional level, cooperation exists for the protection, management and development of the marine and coastal environment. In eastern Africa, the Nairobi Convention was adopted in 1985 by the governments of Comoros, Reunion (France), Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia and Tanzania. This comprised the Action Plan for the protection, management and development of the marine and coastal environment of the eastern Africa region. These governments signed the Nairobi Convention and its related protocols on protected areas, wild fauna and flora, and the protocols concerning cooperation in combating marine pollution in cases of emergency in the eastern Africa region. The Convention entered into force on 30 May 1996, and a regional coordinating unit based in Seychelles was established in January 1997 (http://ioc.unesco.org/odinafrica/public_e/May2001/WWF-KMFRI/workshop.htm)

The Western Indian Ocean Marine Science Association (WIOMSA) and Fisheries Society of Africa (FISA) were established to provide a platform for fostering better communication among African scientists and institutions in the region, and with scientists and institutions from outside Africa. (Okemwa, 1998). WIOMSA gathers and disseminates marine science information, holds meetings to foster marine science development and information to enhance better communication among the marine scientists and other professionals involved in the advancement of marine science research and development in the WIO region. The West Indian Ocean (WIO) region comprises island and coastal countries such as Comoros, Madagascar, Mauritius, Reunion (France), Somalia, Kenya, Tanzania, Mozambique, and South Africa. (Jidawa, 1998; <http://ioc.unesco.org/iochtm/w117>).

West and Central African States adopted the Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region and related Protocol in Abidjan in 1981. The Convention entered into force in 1984 with the objective of protecting the marine environment, coastal zones and related internal waters of these States. FAO, in cooperation with UNEP is assisting countries in the region to implement projects within the framework of the Convention. One such project through which several countries benefited is “Integrated Coastal Areas: Training and Development of National Capabilities for Planning and Management of the West and Central Africa Region”.

In North Africa, there are several conventions and protocols related to the protection of the Mediterranean Sea of which states in the North African Region are parties (UNEP, 1996). A Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment was adopted in 1982 in Jeddah (Saudi Arabia) and entered into force in 1985. A recent programme formulated for the Protection of the Environment of the Red Sea and the Gulf of Aden (PERSGA) aims to prevent pollution and unplanned development in the Red Sea. The proposal will be submitted to the Global Environment Facility (GEF) for possible funding (www-esd.worldbank.org/envmat).

Regional level initiatives include: The Pan African Conference on Sustainable Integrated Coastal Management (PASICOM) organised in Maputo (Mozambique) in July 1998 by the United Nations Educational, Scientific and Cultural Organization (UNESCO), UNEP and the governments of Finland and Mozambique. Another such initiative is the Cape Town Conference on Cooperation for the Development and Protection of the Marine and Coastal Environment in sub-Sahara organized in December 1998 by the Government of South Africa, UNEP and ACOPS. The two events resulted in the strengthening of a unified political position for African governments, of the need to develop an integrated approach towards the development and preservation of coastal and marine resources (ioc.unesco.org/icam/ICAMinAfrica.htm).

With the assistance of WMO and IOC of UNESCO, a programme for Global Ocean Observing System (GOOS) was established in Africa. The programme is geared towards improving and strengthening marine data acquisition, analysis and interpretation capabilities in support of Sustainable Integrated Coastal Management (SICOM) in Africa. As an integral part of PASICOM 1998, a technical workshop on GOOS-Africa was held to lay the foundation for supporting organizational framework for GOOS in Africa. (GOOS-Africa, 1998,). UNESCO also supported an awareness raising campaign at PASICOM and has often formed an integral part of their support programmes at national and regional levels.

The Cape Town Conference adopted the Cape Town Declaration, which reflects widespread consensus on a range of strategic questions. One of the principal components of the Cape Town Declaration was the adoption of an African Action Plan and Strategy for the Development and Protection of the Coastal and Marine Environment in sub-Saharan Africa, called “the African Process”. The African Process had been widely endorsed both by African governments, and at the highest political level, in 1999, by the Organization of African Unity (OAU) Summit. Moreover, the Government of South Africa has adopted the African Process as a key element of its government programme, and has made it an integral part of the Millennium Africa Recovery Programme - MAP (ioc.unesco.org/marine&coasta.\regionalprogrammeme).

IX. URBAN ENVIRONMENT

9.1 Introduction

Definitions of “urban” and “rural” vary widely across Africa. Many African countries use a population figure of 2,000 to distinguish between urban and rural settlements. However, the figure varies from 100 in Uganda to 20,000 in Nigeria and Mauritius. The pattern of urbanization in West Africa differs somewhat from that in East Africa. In many West African countries there are few secondary cities, so the population is concentrated in one or a few large cities, while in East Africa, population is more evenly distributed over secondary or tertiary cities. But there, primary cities are going through a period of rapid growth.

By 2015, it is expected that Lagos (Nigeria), will have a population of more than 10 million inhabitants, and 70 cities will have populations of more than 1 million. The most important contributor to urbanization in both West and East Africa was until recently migration from rural to urban areas. In Southern Africa natural population increase is already the most important cause of urbanization.

In Africa, the urban areas account for 37.9 per cent of the total population of 766.6 million and are credited with 60 per cent of the region’s Gross Domestic Product (GDP). Municipalities, in sub-Saharan Africa, however, capture only a small percentage of GDP \$US 14 per capita in revenue, creating disparity between the requirements for municipal governance and available resources (United Centre for Human Settlements - UNCHS, 2001).

The African cities are undergoing rapid population growth (more than 3.5 per cent per year) accompanied by rapid development pressures with high demands for housing and infrastructures. Some of these cities are doubling in population and have more than doubled in area within the last decade. The rapid growth of the population and concentration in the urban areas has led to the deterioration of the human environment caused by the increasing gap between economic growth on one hand, population growth and concentration on the other. This urbanization has led to deteriorating human settlements, depletion of natural resources and increased discharge of unprocessed wastes into the environment, which is resulting in severe health problems.

The review of the urban development and planning processes and experiences in some African countries shows the evidence that over the past decades, the conventional forms of urban development and planning regulations have failed to provide orderly and sustainable urban development. Despite the various planning legislation that have been put in place to promote urban development, this has been disjointed. As a result, squatter settlements and informal sector activities have continued to mushroom due to inadequate development control mechanisms, poor planning standards and planning laws. Consequently, there are problems of overcrowding, inadequate water supply and sanitation, poor drainage, road transport and high unemployment levels, which are now common to most African cities.

It is evident that the limited management capacity of central and specially local governments result in failure to regulate urban development, inadequate infrastructure provision, and arrangements of land uses which may benefit individuals but give rise to cost, for the urban society as a whole.

The development challenge is to come up with strategies that promote sustainable urban development, to meet the needs of the present generations and improve their quality of life without compromising the ability of future generations to meet their own needs.

9.2 Environmental Sustainability

Cities have been demonized as the main cause of environmental degradation and at the same time mooted as the best option for environmentally sustainable development. This is because cities have much less impact on the environment than similar populations would if spread in smaller rural or sub-urban settlements. Since cities use space intensively, they need fewer infrastructures per resident (e.g. sewerage, water piping or transport infrastructure). They also use less land area than rural settlements. In most countries, urban areas take up less than one per cent of national territory, whilst accommodating significant proportion, if not the majority of its people.

In addition, cities can be better designed for recycling and efficient resource use because production and consumption take place in proximity. Cities are accused of profligate consumption of resources and excessive production of waste. The concept of “ecological footprint” (i.e. the land required to supply a population with food, timber and to absorb their CO₂ output) is frequently used to demonstrate that cities especially in the North, make an impact on disproportionately large areas of land.

9.3 Green and Brown Agendas

Either way, whether the negative impact of cities is to be reduced or the potential of cities for sustainable development is to be optimized, the environment is a major challenge for urban managers and urban residents alike. Cities are vital in tackling both the “green” and “brown” agendas.

The green agenda addresses issues that have long-term global impacts (e.g. the loss of pristine ecosystem, threats to biodiversity, the depletion of the ozone layer, or global warming). These are issues requiring global cooperation that an individual country or city cannot deal with on its own.

The brown agenda relates to those environmental issues that have an immediate local impact (e.g. air and water pollution or solid waste management). The brown agenda has immediate demonstrable effects on urban population. High-level environmental degradation raises various issues, from quality of life to economic performance. The scope for city governments to have a direct impact on these issues is straightforward. Urban managers thus have a critical role and responsibility in cleaning city environment.

9.4 Deterioration of the Urban Environment

The deterioration in the built environment is sharply in evidence throughout most urban areas in Africa. As more of the urban population was forced into unplanned settlements on the outskirts of large cities, or into more crowded living space in an already deteriorating housing stock in the more established high density areas; as lower proportion of the population had direct access to clean, piped water, regular garbage disposal and good health services, the quality of life for the vast majority of the population deteriorated during the 1990s.

The rapid urban expansion of the last decades, although it has greatly increased the economic importance of human settlements, has also increased the pressure on the urban environment and on surrounding regions and their natural resources. It has created immense and growing problems of air and water pollution, land degradation, traffic congestion and noise pollution. In some countries, as little as 2 per cent of sewage is treated while from 30 to 50 per cent of urban solid waste is left uncollected (UNCHS Habitat and the World Bank, *A New Focus on Aid for Urban Development*, November 1992).

Clearly, the environment problems which African countries face vary with their stage of development, the structure of their economies and their environment policies. Some problems are clearly associated with the lack of economic development, inadequate sanitation and clean water, indoor air pollution from biomass burning, and many types of land degradation have poverty as their root cause. Breaking the cycle of poverty and environmental degradation will require further economic and social development.

Yet, without rapid economic growth, African countries will not have the necessary resources to provide basic services for people living in poverty and for environmental infrastructure or to abate and mitigate environmental damage and pollution. Without economic growth there will be no increased in employment opportunities nor reduction in the level of poverty. Such new growth will have to be generated in Africa in such a way that it should not result in further environmental decline and in a rapid drawing down and misuse of natural resources.

9.5 Environmental and Ecosystem Impacts of Human Settlements

The relationship between human settlement development and ecosystem carrying capacities is receiving more attention among decision-makers, planners and environmentalists. It is recognized that the increase of the population and human settlement expansion is putting tremendous pressure on environmental resources in urban agglomerations. In cities, environment degradation take place through air pollution as a result of increased cars on the roads and rotting uncollected garbage, reduced water quantity and quality due to excessive use and contamination, land degradation and reshaping resulting from the need to accommodate the growing urban population.

Urbanization is largely associated with intensive domestic energy consumption, which is detrimental to environmental resources, as these are being destroyed to produce the

needed energy, and to the global ecosystem as the result of air and water pollution arising from the use of that energy.

Fuelwood is one important forestry product many households in the poorest and driest African countries are dependent on for energy - but other important forest derivatives like food production and building materials for urban housing also contribute to deforestation, which has a number of adverse effects on human settlements.

Most cities in Africa are currently more resource conserving than cities in developed countries. Per capita consumption levels are much lower, and many items of waste, which have source value, are reclaimed for reuse or are recycled. People living in poverty generally drive this process. Thousand of households depend for their survival on a meager income derived from selling materials obtained by collecting and recycling household waste or other garbage.

Despite considerable efforts in improving water supply in African countries, about 52 per cent of Africa's total population has access to safe water and the average water use per capita is about 226 m³ per annum. Water as a basic human need is far from being adequately accessible to many urban households in many countries in Africa. Northern Africa has the largest population with access to safe water (68 per cent) with an average annual consumption of 617 m³; southern Africa 56 per cent; western Africa 53 per cent; eastern Africa 45 per cent; and central Africa 37 per cent (World Bank, 1995).

According to the 1995 UNDP Human Development Report, sub-Saharan Africa per capita consumption of water and commercial energy in 1992 represented respectively 10.3 per cent and 6 per cent of the per capita consumption of the same resources in industrialized countries. However, it cannot be assumed that this relatively low level of per capita consumption will remain unchanged, especially if poverty-alleviation strategies are successful and development proceeds in the decades ahead. This underscores the urgency of mapping out sustainable environmental protection in development strategies.

9.6 Solid and Hazardous Waste

Human settlements in Africa, especially the cities, are confronted with the perennial problem of waste collection and disposal. Cities are places for high rates of consumption of resources; consequently they are also places of high rates of generation of solid, liquid and gaseous waste.

Solid waste disposal is a major problem with indiscriminate dumping by roadsides, under bridges and on vacant lands, sometimes situated over aquifers and near markets and other public places.

In Accra Metropolitan Area (AMA), about 750 tons or 75 per cent of municipal solid waste is collected daily; most of it is used for landfill with about 10 per cent being composted. Only 11 per cent of the population benefits from house to house collection; the overwhelming majority uses communal disposal sites or buries or burns their

wastes. Environmental problems include air and odor pollution from open burning of uncollected garbage, odor and disease vectors stemming from uncollected rubbish in poor neighborhoods, although all these problems have been significantly reduced in recent years with improved collection and disposal services.

Because of their poor infrastructure base, limited resources and lack of proper urban management, cities in African countries have not been able to set up adequate systems for the collection of domestic and industrial waste. Indeed, one common characteristic of African cities is the dirtiness of their streets. Whether walking or driving in Abidjan (Côte d'Ivoire), Nairobi (Kenya) or Dakar (Senegal), big heaps of uncollected and rotting garbage are obviously visible. If in Harare and Bulawayo (Zimbabwe) domestic waste collection coverage has remained above 90 per cent although in the emerging urban centers in communal lands, due to financial constraints, coverage ranges from 10 to 25 per cent.

Few African urban residents have access to sewage and domestic waste collection systems, which makes urban agglomerations constantly health hazards. Slum and squatter settlements are the most exposed to health hazards because of congestion, lack of piped water and poor sanitation services in these areas. Water and air borne disease are, therefore, very frequent among the urban poor.

X. THE ENVIRONMENT AND HUMAN HEALTH

10.1 Introduction

For a human being to maintain good health, clean water, food, and a clean environment are some of the most basic requirements. The continued availability of these is under constant serious threat. According to a report on environmental change and human health in the countries of Africa, the Caribbean and the Pacific (ACP), the 48 African ACP countries account for only an estimated 11 per cent of the world's population. But they shoulder 21 per cent of the global disease burden, about one third of which are associated with environmental factors.

Poverty has earned recognition as both a cause and consequence of environmental degradation in Africa. It is also a major factor in the morbidity and mortality profiles of the African population. Until recently, the environmental disease burden of the poor was directly attributed to water, sanitation and malnutrition. It is becoming increasingly clear, however, that a set of complex and interrelated environmental and socio-economic conditions is involved in determining the state of human health.

10.2 Implications of Environmental Change on Human Health

The World Health Organization (WHO) undertook an expert assessment of the state of environmental degradation, its root causes, and the specific consequences for human health as its contribution to the five-year follow-up to the Earth Summit. The report concluded that environmental factors were associated with almost a quarter of the total global burden of disease. Other recent works on the impacts of a changing environment on human health have elucidated discernible and predictable patterns on the distribution of diseases. The environmental factors of the greatest concern to Africa are water and air quality, toxic substances, and the effects of climate change.

10.2.1 Deteriorating Water Quality

Ground and surface water resources in many African countries are becoming increasingly contaminated with microbes and inorganic compounds. The most common disease causing microbes found in water include bacteria, viruses and protozoa. The inorganic contaminants include heavy metals and positive ions such as aluminium, arsenic, lead, mercury, calcium, magnesium, antimony, zinc and copper. The main direct causes of water pollution emanating from outflows from factories, refineries and waste treatment plants into urban water supplies. The main indirect sources of contamination include infiltration of fertilisers and pesticides into soils and groundwater systems.

Microbes cause a variety of waterborne diseases including cholera, typhoid, poliomyelitis, hepatitis, and various gastrointestinal infections. Infants and children are particularly susceptible to waterborne infections since they drink more water than adults relative to their size and are also less resistant. According to the WHO, sub-Saharan Africa experienced an increase in water supply coverage from 32 per cent to 46 per cent between 1981 and 1990. Sanitation coverage increased from 28 per cent to 36 per

cent during the same period. This progress has stagnated thereafter, and more African people were lacking safe drinking water in 2000 than was the case in 1990.

10.2.2 Deteriorating Air Quality

Although the detrimental effects of air pollutants on human health are best known in Europe and North America, it is becoming an increasingly important environmental problem in Africa. Rapid urbanization and industrialisation have increased regional concerns with regard to emissions of sulphur and nitrogen oxides. A major and growing source of sulphur and nitrogen pollution across Africa is the combustion of fossil fuels in the power generation and smelting industries. The burning of vegetation releases particulate matter, carbon monoxide, nitrogen oxides, sulphur dioxide and organic compounds into the atmosphere. In Africa, forest fires increase the risk of acute respiratory infections, a major killer of young children.

Many African cities have started experiencing serious pollution related health problems. Urban air usually contains complex mixtures of air pollutants. The major health impacts of pollutants such as nitrogen dioxide are an increase in the incidence of lower respiratory tract infections in children and reduced air passage responsiveness among asthmatic patients. Sulphur dioxide is often a local pollutant but can also be subject to long-range transport processes. In South Africa, one of the most industrialized countries on the continent, impacts of acid rain have already been reported on forests, crops and surface waters.

10.2.3 Toxic Substances

The production, use, trade, and transportation of many synthetic chemicals is now widely recognised as a global threat to human health. Industries continue to produce and release thousands of chemical compounds every year, in most cases with none or very little testing or understanding of their impacts on people and the environment.

The worst toxic substances in the environment today fall in the group known as persistent organic pollutants (POPs). In general, these are extremely poisonous even in small quantities. Because they are able to travel long distances in the air, they pose serious danger to people, livestock and wildlife in places far away from the locations of their production or release. Natural processes that allow them to persist and bioaccumulate in the food chains when released into the environment also cannot easily break them down. When breakdown does occur, it creates chemicals that are even more hazardous than the original substances.

POPs encompass many different and varied groups of man-made chemicals. 12 POPs, which are all organochlorines, have already been highlighted by national and international organizations as being chemicals of clear concern to human health. Dioxin, a by-product from combustion processes involving chlorine, is one of the most poisonous POPs known to science.

Exposure to POPs has been associated with a wide range of impacts on health in humans and wildlife. Effects include carcinogenicity, toxicity to the reproductive, nervous and immune systems and adverse effects on growth and development. Of greatest

concern in Africa are the organochlorine pesticides including aldrin, dieldrin, endrin, DDT, chlordane, mirex, toxaphene and heptachlor. Although the majority of these are banned or restricted in many countries, some like DDT, are still widely used in African countries particularly for mosquito control.

10.2.4 Climate Change

Global climate change is likely to have wide ranging and mostly adverse impacts on human health, with significant loss of life. The direct health effects of climate change are expected to include increases in mortality and illness due to an anticipated increase in the intensity and duration of hot periods. The indirect effects would include

Box 8: Examples of the impact of climate on human health in Africa

Climatic impacts on human health may be direct or indirect. Direct impacts include variations in physical comfort, tension, heat and cold stress, sunburn, sunstroke, skin cancer, frostbite and (possibly) cataracts. Direct impacts also include death and injury from floods, storms and other extremes of weather. Pollution and pollen levels are affected by climate and have been related to eye diseases, rickets, asthma and other respiratory problems and allergies. Through its influence on biological disease agents, climate variability has a major indirect impact on disease emergence and vector reproduction, and alters host and vector habitats.

An Intergovernmental Panel on Climate Change (IPCC) report published in February 2001 predicted an increase in disease as a result of heavy, monsoon-like rains and higher temperatures, which favour the breeding of disease-carrying mosquitoes, allowing them to thrive in higher altitudes (PANA 2001, <http://allafrica.com/stories/2001>). For example, malaria cases have increased by 337 percent in recent years in Rwanda, which is mainly highlands. About 80 percent of the rise in malaria cases were linked to changes in temperature and rainfall, which improves breeding conditions for malaria-carrying mosquitoes. A similar link has also been established in Zimbabwe. According to the WHO (1998), 90 percent of the worldwide prevalence of malaria cases, estimated to be 300-500 million each year, are in sub-Saharan Africa. Similarly, the vast majority of the one million deaths each year occur among children in Africa. The economic cost of the disease exceeds US\$2 billion, according to a 1997 estimate. In addition to the malarial parasite, mosquitoes transmit many viruses, which are known to infect humans. These include dengue fever, yellow fever, and severe, sometimes fatal, encephalitis and haemorrhagic fever.

Cholera, which is transmitted by water or food, could aggravate problems in many parts of Africa. During the 1997-1998 El Nino, excessive flooding caused cholera epidemics in Djibouti, Somalia, Kenya, Tanzania and Mozambique. Apart from cholera, there were increases in Rift Valley fever (<http://www.wmo.org/climate/wmo/statement98>). During the 2000 floods, outbreaks of malaria and cholera spread in Mozambican refugee camps and in Wajir District of Kenya. The disease claimed several hundreds of lives (<http://www.cnn.com/2000/world/africa>). The outbreaks were attributed to contaminated water, milk and food, exacerbated by the onset of the long rainy season.

increases in the potential for transmission of vector borne infectious diseases such as malaria, dengue fever, yellow fever and some viral encephalitis, resulting from extensions of the geographical range and breeding season for their vectors (box 8).

Some increases in non-vector borne infectious diseases such as salmonellosis, cholera and giardiasis could also result from the predicted elevated temperatures and increased flooding. Climate change is also expected to result in limitations on freshwater supplies and nutritious food, as well as increased air pollution, all of which will have negative consequences on human health.

The most profound effects of climate change on vector borne diseases will certainly occur where the diseases are newly introduced at the edges of the vector range. These are the areas where people have little or no resistance to such diseases. In Africa, this will often be at higher elevations that were formerly too cold to support these diseases.

10.3 Environmental Change and Incidence of Disease in Africa

The distribution of certain diseases reflects clear patterns of drastic environmental and social change, as many rely on animals or water for transmission. A recent report of the WHO showed that up to 30 new diseases have emerged on the surface of the Earth since 1976. Diseases once thought to be under control or eradicated have also reappeared. The incidence of drug-resistant tuberculosis has increased tremendously in Africa, exacerbated by HIV/AIDS. It is now reported to cause up to three million deaths worldwide annually. Childhood diseases like diphtheria, whooping cough and measles are also on the rise on the continent. Malaria, schistosomiasis, dengue fever, yellow fever, cholera and a number of rodent borne viruses are also appearing with increased frequency in places where they did not exist before.

The incidence of malaria provides a good example of the relationship between environmental change and disease prevalence in Africa. Malaria has played a significant role in the history of the continent, where it helped ward off foreign colonisers who lacked the natural defences found in local people, such as the presence of sickle cells in the blood. As a result, it helped deter deep penetration of the continent until the latter part of the 19th century.

Measures to control malaria included widespread changes to the environment, such as bush clearance and swamp drainage. There was a surge in the application of insecticides. By the 1950s, there were dramatic drops in the incidence of the disease. Dwindling investments in public health programmes, coupled with growing insecticide resistance and prevalent environmental change contributed to a widespread resurgence of the disease so that by the late 1980s, large epidemics were beginning to recur all over Africa. These were often associated with warm and wet periods.

Changes have also occurred in the geographical distribution of the disease, and it is now found at increasingly higher elevations in the highlands of Eastern and Central Africa where populations had not been exposed previously. In Rwanda, record high

temperatures and rainfall in 1987 brought malaria into the highlands. More than 100,000 people died in one malaria epidemic in the highlands of Madagascar in 1988, while the disease claimed the lives of hundreds of people in the Kenyan highlands in 1997. These expansions threaten some large cities such as Nairobi in Kenya and Harare in Zimbabwe, both of which currently lie just outside of the malaria range.

10.4 Urbanization and Human Health

In many African cities, solid waste collection and management often consumes as much as 20 to 40 per cent of municipal revenues and it often suffers more than other municipal services when budget allocation and cuts are made. The agencies responsible for the collection of disposal of household waste are often understaffed and under funded. Only 43 per cent of Africa's total population has access to sanitation. The average annual public health expenditure per capita in Africa in 1994 was about \$US23.00. These statistics indicate the poor state of sanitation and public health services, including refuse and solid waste collection and disposal in most countries in Africa. North Africa has the largest population with access to sanitation: 70 per cent; southern Africa 47 per cent; eastern Africa 42 per cent; western Africa 31 per cent and central Africa 27 per cent (UNCHS, 1995).

A safe and healthy environment implies provisions to protect against substances or pathogens that can damage human health, and to ensure the supply of natural resources essential for health such as air and water. The larger and more dense the settlement, the more important such provisions become.

It is difficult to establish precise relationships between health problems, housing and living environment because of the many factors that influence an individual's health status. However, there are three aspects of the house/work place environment which make substantial contributions to very high levels ill-health, disablement and premature death among poor groups; these are the lack of infrastructure and services to minimize the quantity of dangerous pollutants or pathogens in the human environment; lack of services essential for good health; and crowded, cramped housing conditions.

Although official figures suggest that people in urban areas are better served than those in rural settlements, public provision to remove and dispose of human excreta is usually not better in poor urban neighbourhoods than in rural areas, and the health problems are usually the most serious in urban areas, because high population densities makes it difficult to protect people from contact with excreta. Most poor groups live in crowded, cramped conditions meaning that diseases such as tuberculosis and meningitis are easily transmitted from one person to another. Household accidents are also common and where open fire or relatively inefficient stoves are used for cooking and/or heating, fumes can cause serious respiratory problems for inhabitants.

The impact on those spending most time in the house, usually women and children, is particularly serious. In a world increasingly dominated by market forces, the solution to the "needs - satisfaction" component of sustainable development depends on the ability of national economies to accelerate economic productivity, to see that this productivity occurs in such a way that the incomes of the least privileged groups are

sufficient to satisfy the demand for increasingly costly essential needs without putting so much pressure on the environment and resources.

10.5 Nexus of Poverty, Environment and Health

As the physical and natural environment in and around cities deteriorates, the most affected are the urban people living in poverty, whose substandard living environment does not protect them from human and other wastes and from pollution of all types. For the people living in poverty, the most important environmental priorities are access to clean water, sanitation and safe housing. The people living in poverty are both victims and agents of environmental damage. Because they lack resources and technology, land-hungry farmers resort to cultivating erosion-prone hillsides and moving into tropical forest areas where crop yields on cleared fields usually drop sharply after just a few years.

Agricultural stagnation in sub-Saharan Africa is a particularly clear example of the mutually reinforcing nexus of poverty, population growth and environmental damage. Low agricultural productivity, caused mainly by poor incentives and poor provision of services, has delayed the development transition and encouraged land degradation and deterioration, which in turn lowered productivity. The poor, especially poor women, tend to have access only to the environmentally fragile resources; they often suffer high productivity declines because of soil degradation or the loss of tree cover. Because they are poor, they may have little resource but to extract what they can from the resources available to them. The high fertility rates of poor households further strain the natural resource base.

However, the most disturbing misconception is the tendency to consider the people living in poverty as the culprits responsible for environmental degradation rather than its victims. Much has been seen about the environmental damage caused by over-grazing of herds belonging to pastoral population, by exploitation of forests and vegetation to obtain fuelwood, by occupation of ecologically vulnerable lands for agricultural or peri-urban settlement, by spontaneous settlements which pollute water sources and by overcrowded and unsanitary settlements which multiply health risks, particularly for women and children. All these problems are real and their aggregate impact can be considerable, but what is often not realized, however, is that they are the results of a lack of choice.

SECTION THREE: SUGGESTED ACTIONS

XI. RECOMMENDATIONS

The environment in Africa is undergoing different types of deterioration. In order to correct the continuing disastrous trend, African countries must address the root causes of the deterioration. In this regard, action must be taking in four major areas. These are:

- Transforming the agricultural sector to make it more productive;
- Safeguarding and sustainably utilizing the natural resource base;
- Pursuing accelerated socio-economic development to provide basic needs and alternative economic opportunities; and
- Reducing the high rate of population growth.

Governments should take advantage of the various multilateral agreements on the environment in addressing issues of sustainable development in their respective countries. Sectoral recommendations are provided below.

I. To control and reverse land degradation, countries should:

- Develop land use policies based on land suitability for different types of utilization and needs of the country;
- Develop institutional frameworks for monitoring, supervising and coordinating the conservation of the country's land resources;
- Implement education, training and extension programmes on soil degradation and its prevention;
- Establish links between administrators and land users for the implementation of soil policies;
- Strive to create socio-economic and institutional conditions favourable to rational land resource management and conservation; and
- Conduct research into solutions of soil degradation problems.

II. Countries should pursue actions necessary to ensure food security in Africa. Suggested actions should include:

- Assisting communities and farmers associations to develop legal authority and strengthen administrative and technical competence for all agricultural productive activities (e.g. contracting loans, initiating and implementing programmes and projects);
- Assisting communities to develop and maintain community-based credit associations and training systems;
- Investing in research in the areas of high-yielding crops, post-harvest technologies and biotechnology;
- Undertake research to secure water supply for agriculture by establishing small-scale irrigation facilities and improving local water management;
- Increase investment in rural transport systems and other social infrastructure such as schools and health facilities, and foster local participation in, and control over rural institutions; and

- Undertake research and development on disease-resistant and drought-tolerant crop varieties and livestock breeds, and on technologies to stop and reverse the rapid degradation of soil fertility.

III. Following initiatives that have been undertaken in the areas of biodiversity, forestry and land natural resource management, the following actions are being recommended:

- Countries should formulate and pursue policies that aim to give incentives to public and private agents to conserve and invest in environmental resources;
- Countries should prepare and implement national conservation strategies and action plans aimed at protecting endangered species,
- Countries should establish institutional arrangements to monitor resource use, with a view to bridging the gap between conservation efforts and access to resources;
- Undertake research into the use of bio-control agents to attack invasive species;
- Countries should integrate natural resources into their conventional accounts, and build capacity in natural resources accounting;
- The linkages and synergies among multilateral environmental agreements should be exploited through training and capacity-building programmes; and
- Countries should harmonize relevant policies and regulatory frameworks at national, sub- regional and regional levels so as to encourage consistency in the use, management and conservation of cross-border natural resources.

IV. To promote the conservation and development of freshwater resources, countries should:

- Strengthen and harmonize national legislation on the water sector, taking into account the principles of Integrated Water Resources Management (IWRM);
- At the regional and basin levels, co-ordinate efforts so as to ensure the adoption of IWRM and the establishment or strengthening of regional water coordination units and basin authorities;
- Promote public participation, education and sensitisation programmes in all water agreements, targeting all stakeholders;
- Promote international cooperation and collaboration in order to establish and strengthen monitoring systems for water resources management;
- Take advantage of opportunities available under the Global Water Partnership Programme to build and enhance capacities and skills in the IWRM. Wetland conservation should form an integral part of IWRM strategy;
- Develop or strengthen economic instruments to promote equity, efficiency and sustainable use of water, recognizing that it is a finite economic asset;
- Encourage private sector involvement in the management of water resources;
- Develop water resources as a stimulant for socio-economic growth; and
- Provide access to safe water and sanitation to all so as to reduce the disease burden in Africa.

V. To reverse the degradation and promote sustainable management of Africa's marine and coastal environments, countries should:

- Adopt holistic and coordinated approaches to the administration of the coastal zone and marine resources, thus ensuring a more systematic planning and coordinated development of these resources;
- Build research and monitoring capabilities and establish or improve facilities for data acquisition, analysis and interpretation, in order to improve the availability of relevant data and technical information for effective policy formulation and planning;
- Develop capacity for resource mobilisation as an integral part of national and regional programmes, taking into account the financial, technical and human resource constraints of the continent;
- Encourage collaboration between governments, the private sector and civil society at large, raising awareness on integrated development and preservation of coastal and marine resources; and
- Implement the African Action Plan and Strategy for the Development and Protection of the Coastal and Marine Environment in Sub-Saharan Africa adopted in Cape Town.

VI. To minimize the impact of climate change, global warming and natural disasters, countries should:

- Develop national and regional capacities to be able to assess changes in weather and climate patterns, to predict the continuous fluctuations in risk and vulnerability to communities, and to develop adaptive strategies that will increase community resilience;
- Develop drought and disaster mitigation strategies at local, national and regional levels. The capacity of local communities to plan, develop, and manage their own drought response strategies should be strengthened by developing drought preparedness and mitigation programmes in order to ensure rapid responses;
- Develop/strengthen drought monitoring centres to ensure provision of timely warnings and guidance to decision-makers and farmers;
- Promote mutually reinforcing collaboration at the national sub-regional, regional and global levels among the environmental conventions, i.e. UNFCCC, United Nations Convention to Combat Desertification (UNCCD) and Convention on Biological Diversity (CBD), given the strong interconnections among them;
- Promote measures aimed at preventing and managing bushfires, including enactment of anti-bushfire legislation, setting up bush fire management committees, embarking on education and sensitisation campaigns, and instituting training and capacity building programmes for professionals and local communities; and
- Establish early warning systems to alert government authorities and local communities on the occurrence of bushfires for appropriate and timely interventions.

VII. The following recommendations are made with a view to promoting environmental governance:

- Countries that have recently enacted environmental legislation and action plans should embark on their implementation immediately, while those that have not yet enacted effective environmental legislation should do so and aim to start implementing them.
- Environmental provisions should be integrated into national constitutions;
- Countries should establish appropriate environmental standards, management objectives and priorities and employ these to the environmental and developmental contexts to which they apply;
- National environmental governance systems that include state-civil society partnerships in the management of natural resources should be adopted by 2005;
- Policies, administrative and judicial mechanisms for dealing with public and private conduct that may have negative impacts on the integrity of the environment should be established at the national, sub-regional and regional levels; and
- Governments should further strengthen mechanisms for stakeholder consultations, and to facilitate and encourage public awareness and participation.

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