ANNEX
ENVIRONMENTAL (REP) CONTEXT OF THE REGION

2.5 Environmental Situation

2.5.1 Natural Resources & Environment of the ESA IO Region

INTRODUCTION

People and livelihoods are at the centre of concern for sustainable development. Human beings are entitled to a healthy and productive life in harmony with nature. People in the ESA IO region are wholly dependant on natural resources, for subsistence, to those who are entirely dependant on wage earning, or trade or industries concerned with natural resources.

The ESA IO region is richly endowed with natural resources many of high international value in terms of both monetary and global significance and which are an asset for sustainable development. The natural resources in the ESA IO region include fertile agricultural land, with forests, woodlands and orchards providing timber, food and other market produce, minerals, ores and precious stones, lakes, rivers, beaches and coasts and extensive marine exclusive economic zones. They have abundant and rare wildlife, inland and coastal scenic beauty prized for tourism as well. They have extensive seams of industrial quality ores and also precious metals and stones for the luxury market. They have ready access for world trade through navigable rivers, container ports, oceans and international airlines for freight and commercial passengers.

Despite the richness of its biological, mineral and human resources, the ESA IO region remains poor. Food security threatens millions each year, especially in the Horn of Africa and the region is home to a very high degree of malnourished people. Various processes of environmental degradation threaten agricultural and pastoral lands, watersheds, surface and ground water sources, and the rich forest and savannahs and the coastal and marine resources. Continued major constraints frustrate further progress in the pursuit of developmental objectives which includes the high population growth, expected to increase significantly (by one third by 2015), weaknesses in the establishment and maintenance of basic infrastructure and services, the extent of poverty and inequity. The interaction between the environment and human livelihoods is a complex one. Environmental change is affecting human vulnerability and therefore the need to initiate adaptive measures. Extreme environmental events which could have happened suddenly or that could have taken time to build up increase the vulnerability of people. SIDS constitutes a special case given their inherent characteristics as is confirmed by the UN through the regular organisation of an International Conference of SIDS, which lately culminated with the Mauritius Strategy. There is also a clear linkage between natural resources, population and security, particularly the issues of scarcity and or abundance or distribution of and access to natural resources and conflicts.

ESA IO countries adhere to national, regional and international environmental agendas and initiatives which are, inter alia:

- the World Summit for Sustainable Development Plan of Implementation
- the UN International Conference on SIDS – the Mauritius Strategy
- the NEPAD
- the MDGs
- the African Ministers' Conference on Environment (AMCEN)
- other international and regional Environment Agreements such as the Nairobi Convention, Convention on Biodiversity, UN Framework Convention on Climate Change, UN Convention to Combat Desertification, Convention on Wetlands of International Importance Especially as Waterfowl Habitat (RAMSAR), Convention on International Trade in Endangered Species of Wild Fauna and Flora, and the revised Algiers African Conservation of Natural Resources.

These agreements aim at:

- Adding value to the resources that still exist or remain
- Using natural resources efficiently and sustainably to derive maximum benefits
- Mitigating the constraints and negative effects
- Maximising the total value of ESA IO's natural assets; and
- Making a case for safeguarding and improving the remaining assets

Though the member states of the ESA IO adhere to most of these regional and international environment agreements, they clearly lack the capacity to implement these agreements.

There is nothing inherently wrong or unsustainable about the exploitation of natural resources, provided that such use results in a sustained overall increase in the overall wealth of the concerned society, including its natural capital, social capital and physical and monetary assets. Particularly in the early part of their development, most societies draw on their 'natural capital', sometimes to a very high degree. In the broad view of sustainable development, this is acceptable provided that the conversion of this capital into other forms of shared wealth is efficient (for instance, the long-term increases in social capital through education and health improvements, or manufactured capital through the development of industries, agriculture or a service sector is at least as large as the loss of natural capital). This efficiency is largely a function of the governance of resource use rights. Where individuals are able to use the common wealth without returning a sufficient fraction through taxes or local reinvestment (often by corrupting the natural resource regulation institutions), the efficiency is low.

Regional cooperation and integration is one of the main responses to such challenges. The principal benefits to be gained from economic integration in ESA IO countries should be the steady achievement of further region-wide economic and social development focussed on harnessing benefits from the sustainable exploitation of these natural resources. **See in Annexe a summary of ESA IO resources.**

2. BIODIVERSITY

African biodiversity is in need of wise management, not simply to satisfy international pressures and obligations, but because it is the basis of most rural livelihoods in the region and is the foundation of major new economic sectors that offer the prospect of better, more sustainable lives for millions of African people. The NEPAD view is that African development will be achieved not by dependence on outside resources, but on best use of uniquely African resources. Biodiversity is one of these, and represents a formidable natural asset. To give one small example, the international trade in flowers bred from a large number of plant species originating in Africa is worth billions of dollars annually, almost all of which accrues outside Africa.

Biodiversity can be considered at three major levels of organisation: the genetic variation within populations; the number, relative abundance and uniqueness of species; and the variety, extent and condition of ecosystems. Although the attention in the past has been mostly on compositional diversity (i.e. how many different species are present, also known as "richness"), the current policy focus is broadening to include structural and functional diversity – the variation that is necessary to ensure the integrity of ecosystems and the ongoing flow of benefits to humanity. The conservation of ecosystems (including human-altered ecosystems such as agricultural landscapes) is increasingly seen as a necessary condition for the effective protection of species.

The concept of "ecosystem services" – the benefits that humans derive from nature – has provided a compelling and policy-relevant new way to think about the links between biodiversity and human well-

being. Biodiversity has “intrinsic value” (in other words, value for its own sake), but it also has a very large value in all cultures for the things that it provides to people: food, medicine, building and craft materials and spiritual, cultural and aesthetic services. Less obvious, but just as important, are the services that allow natural and human-altered ecosystems (such as agricultural and urban landscapes) to function properly – regulating the climate, soil fertility, the outbreak of pests and diseases, for example. Some level of biodiversity – the exact amount is at his stage unknown - is a necessary condition for the delivery of all ecosystem services, but it is especially important for maintaining functional ecosystems. The value of ecosystem services can sometimes be expressed in monetary terms (Costanza et al. 1997; UNEP 2002) but these estimates are very contentious, and are not the only way of expressing importance. Value can, for instance, be measured in terms of other aspects of human well-being, such as health, security or good social relations.

Biodiversity underlies the provision of a large variety of benefits that people obtain from ecosystems. These ‘ecosystem services’ include biological products, such as the foods we eat and the wood we burn for energy. They also include ecosystem functions that depend on particular organisms, for example pollination by bees, or nitrogen fixation by symbiotic bacteria in the roots of legumes. Furthermore, it is now recognised that living organisms are critical in creating the environmental conditions on Earth that make it habitable to humans and many other species (Lovelock 1979; Steffen et al. 2004), by for instance regulating the climate and atmospheric composition.

In addition to the ecosystem services provided by specific living organisms, certain benefits also accrue from the diversity of biological life itself. A particular ecosystem function can often be performed by several different organisms. This is known as functional ‘redundancy’, which should not be seen as wasteful, but as a sort of insurance policy against failure of critical functions. At a given time, typically one or two species are responsible for delivering most of the service. However, should critical ecological components be lost or environmental conditions change, due to for example a disease outbreak or climate change, other organisms are able to take over the function. The diversity of genes, species and ecosystems on Earth therefore reduce vulnerability to such events. A reliable flow of ecosystem services underpins most components of human well-being, including health, security, satisfactory social relations, freedom and choice.

Several important staple food crops originate in Africa. These include several species of millet and sorghum, one species of rice, the grain crop *teff*, and the oil palm. Globally, about 7,000 of the 270,000 described plant species have been used as food for humans (FAO 1998b), but only about 200 have been domesticated, and only about twenty of these are crops of major economic importance (Groombridge and Jenkins 2002). In line with this pattern, about two-thirds of the calorie intake in Africa is provided by ten crops (FAOSTAT[1]). Of the approximately 15,000 species of mammals and birds, some 30-40 have been used extensively for agriculture, with fewer than 14 accounting for over 90% of global livestock production. Currently, some 30% of domesticated breed found internationally are at risk of extinction (Wood et al. 2001). Nearly three-quarters of the recorded protein consumption in Africa is derived from plant rather than animal sources (FAOSTAT). The variety of species eaten is more related to production and cultural factors, such as tradition and palatability, rather than to nutritional value (Groombridge and Jenkins 2002).

Africans rely on a large variety of foods for proper nutrition, many of which are sourced from natural and semi-natural ecosystems. In addition to carbohydrates and protein, human health and development requires small quantities of ‘micronutrients’ such as iron, iodine and vitamins. Especially in rural

[1] FAO Statistical Databases. Food and Agriculture Organization of the United Nations. http://apps.fao.org/. access April 2005.

Africa, micronutrients are derived from a large diversity of food plants, individually consumed in small amounts. Studies in Africa and elsewhere indicate that rural people obtain about one third of their nutritional requirements from wild foods such as fruits and insects (DFID 2002; Lesotho VAC & SADC-FANR 2002; SCF-UK 2002). This proportion rises at time of stress, such as when crops fail or employment is scarce. The use of multiple varieties spreads production and market risks, stages maturity dates and caters to different uses (Wood et al. 2001). The ecosystem therefore acts as a food security safety-net, particularly in hard-to-service rural areas.

Most of the animal protein consumed in Africa is either directly harvested from wild populations or produced through grazing of natural ecosystems by domestic livestock. Freshwater fish is a key source of protein in parts of Africa: for example, in hyper-arid Mali, fish makes up 60 percent of the total animal protein consumed annually (Quensière 1994; FAO 1998a). Important freshwater fisheries, largely consumed on a subsistence basis, are also located in the rift valley lakes (Lakes Victoria, Tanganyika and Malawi) and the extensive wetland systems of Lake Banguelu, the Kafue floodplain and the Okavango delta. Important commercial marine fisheries are located off the west coast of southern Africa (South Africa, Namibia and Angola), the Horn of Africa, and West Africa off the coast of Mauritania, which collectively provide about half the catch. These fisheries are centred on commercially important species such as hake, anchovy and pilchard, and the associated industries are an important source of employment. Particularly in Central and West Africa, 'bushmeat' (wild animals and birds hunted outside, and sometimes inside, protected areas) is a major source of animal protein, making up more than 80% of consumption in some areas (Robinson and Bennett 2000). The issues associated with bushmeat harvesting are further elaborated on in the regional overview of Central Africa.

Natural ecosystems provide a wide variety of plants and animals that are important both for traditional medicines and modern pharmaceutical products. Up to 80% of people in Africa make use of traditional medicine (WHO 1993), which draws on a wide variety of indigenous plants and animals, and especially on rare or unusual organisms. Important modern pharmaceutical products are already derived from certain African species.

Many plants and animals originating in Africa are important commercial trade products. Coffee (*Coffea arabica* and *Coffea robusta*) originates from Ethiopia and ranks among the five most valuable agricultural exports from developing nations (FAOSTAT[1]), employing about 25 million people worldwide (O`Brien and Kinnaird 2003). *Rooibos* tea (*Aspalathus linearis*), originating from South Africa, is now traded globally in the fast-growing speciality tea industry. The world's ornamental flower market includes a substantial number of species derived from Africa: *Gladiolus, Pelargonium, Geranium, Strelitzia, Viola, Protea, Kniphofia,* and *Zantedescia*. The growing international pet trade includes several African species, including many endemic chichlid fish species from Africa's rift valley lakes for aquariums. Key issues with regard to the trade of species are: the illegal (and often wasteful) harvesting from wild populations of often rare species; the accrual of benefits to individuals, whereas the costs are borne by society as a whole; and international intellectual property rights and patent agreements which can deprive local people of benefits. Currently, relatively little of the value derived from species originating in Africa accrues to Africa. Ensuring that such benefits are captured in future represents a major opportunity for expanding biodiversity-based development on the continent.

Biodiversity underpins key ecosystem processes such as biomass production, nutrient and water cycling, and soil formation and retention. Such processes can be classified as 'supporting ecosystem services' as they are necessary for maintaining the conditions for life on Earth and hence the production of all other ecosystem services. Many of these services depend not so much on the absolute number of species present, but on the diversity of the ecological functions performed by the ecological community.

The abundance of the various functional types present is also crucial, as the level of most ecosystem processes, for example biomass production, is strongly related to the total number of organisms performing that function. There is increasing evidence that greater functional diversity is associated with increased productivity and increased reliability of production.

Preservation of the natural biodiversity of an area and genetic diversity of crop species can enhance resistance to invasion by pests and diseases. Planting a variety of crop species and crop varieties and preserving their wild relatives, increases resistance to pests and diseases, and increases the probability of meeting food needs**.** Ethiopia and the Upper Nile are recognized as global centres of genetic diversity of crop plants (Hawkes 1991). The agro-biodiversity farming practices in many parts of Africa can enhance biological control and reduce the dependency and costs associated with biocides in mono cash cropping systems. Similarly, natural and semi-natural ecosystems, both terrestrial and marine, appear to be more resistant to invasion by non-native species if the number, types and relative abundance of native species are preserved.

A quarter (1229 species) of the approximately 4700 mammal species in the world occur in Africa and Madagascar (Brooks et al. 2001), including about 960 species in sub-Saharan Africa and 137 species in Madagascar. The eastern and southern African savannas host large populations of mammals, including at least 79 species of antelope (Klopper et al. 2002). Most of the exceptionally diverse mammal regions are savannah woodlands with inclusions of other habitats, such as wetlands. Africa's conspicuous megafauna, in particular the "big five" (Elephant, Rhinoceros, Buffalo, Lion and Leopard), as well as three of the four globally existing anthropoid apes, the closest animal relatives to modern man, are one of the main drivers of tourism in Africa.

More than 2200 bird species (including migrants), occur in Africa and Madagascar, constituting more than a fifth of the approximately 10,000 bird species in the world, (Burgess et al. 2004). About 1600 bird species are endemic to sub-Saharan Africa (Jetz and Rahbek 2001). Bird species richness is highest in eastern Africa around the Albertine Rift Montane Forests, Victoria Basin Forest-Savanna Mosaic, East African Montane Forests, Northern Congolian Forest- Savanna Mosaic, and then into the *Acacia-Commiphora* Bushlands and Thickets and the Central Zambezian Miombo Woodlands. The large size of these ecoregions, their high level of habitat heterogeneity, and their presence on a migratory flyway explains this pattern. The next highest band of species richness is found across the remainder of the tropical belt, with the exception of the western portion of the Upper Guinea forests and the centre of the Congo Basin. The ecoregions of Madagascar and other offshore islands all have much lower bird species richness than the continental mainland (Burgess et al. 2004)

According to most recent estimates from the Global Amphibian Assessment[2], there are about 950 amphibian species in Africa**,** though numbers vary considerably between different authors. Numerous new species and even genera are described every year. The highest levels of amphibian species richness occur in the forests of coastal Nigeria, Cameroon, and Gabon, the lowland and montane forests of Madagascar, the Central Zambesian Woodlands, and Eastern Arc Forests. The fauna of Madagascar is particularly under-sampled: In the period from 1990- to 1999 only, discoveries of new amphibian and reptile species alone increased the number of known species by 25% and 18%, respectively (Goodman 2004).

Africa´s overall plant richness at species, genus and family level is somewhat lower than that of other tropical continental areas. The African mainland has between 40,000 and 60,000 plant species (Beentje et al. 1994; Beentje 1996), of which approximately 35,000 are endemic. South America, by comparison,

[2] www.globalamphibians.org/index.html

has an estimated total of 90,000 plant species (Frodin 2001) in an area 40% smaller than that of African mainland, but with a more favourable climate. Vast parts of the Congo basin have moderate levels of plant species richness, comparable to many parts of Central Europe (Barthlott et al. in press). This has been interpreted as a consequence of major extinction events due to historic climate variations (Hamilton and Taylor 1991; Davis et al. 1994) and fewer major tectonic events which are thought to having triggered the evolution of many species in the South American Andes (Burgess et al. 2004). Five of the 20 global maxima of plant diversity are located in Africa. More than 3000 plant species per 10,000 km² occur in the Cameroon-Guinea centre, the Capensis centre, the Maputaland Pondoland centre, the Albertine Rift centre and the Madagascar centre (Barthlott et al. in press).

Certain regions of Africa are very rich in endemic plant species. At least a sixth of the estimated 270,000 plant species on Earth (Groombridge and Jenkins 2002) are endemic to Africa and Madagascar combined. The Cape Floral Kingdom in South Africa is a global centre of plant endemism (Barthlott et al. in press). Here, about 9,000 vascular plant species occur in an area of 90,000 km² (Goldblatt and Manning 2000), of which about 69% are endemic. More than 12,000 plant species occur in Madagascar, at least 81% of which are endemic (Davis and al 1994-1997), an exceptionally high proportion of endemics by global standards. More recent studies suggest that even these figures for the species richness and endemism in Madagascar may be clear underestimates (Goodman 2004).

A cost efficient and robust strategy for biodiversity conservation in Africa would have two pillars: protected areas, and actions taken in the intervening matrix. The first pillar is the classical approach of identifying those parts of the land, waters and sea where the conservation value exceeds any other conflicting use value, and providing effective protection for them. The other pillar recognizes that even with such a safety-net in place, the majority of wild organisms will live in places that are used primarily for purposes other than biodiversity conservation. Adjustments to the way in which these ecosystems are used can lead to a high degree of biodiversity preservation, without unacceptable decreases in the output of other services.

The key issues for establishing an effective protected area network are prioritization of protected areas, and ensuring effective application of policy within protected areas. The *ad hoc* identification of protected areas is not an efficient strategy. Sufficient knowledge exists to apply more refined techniques to identify locations that are critical for many species, robust to climate change, and have a good chance of being economically viable. In general, consolidated reserves are more viable than the equivalent area of isolated patches. Where the habitat needs of the target organisms straddle international boundaries, transfrontier parks have proven to be a workable solution. There are known priority areas for conservation in every country in Africa, but overall, the greatest current urgency relates to multitaxon centres of endemism in mountains, particularly in East Africa such as the Eastern Arc in Tanzania, but also in other parts of Africa, including for example Mt. Cameroon. Reserves will not fulfil their desired role unless adequately resourced with personnel, infrastructure and operating budgets, and with a supportive legislative framework and culture. The parks in Africa that are now net generators of income and jobs have only reached that position after years of sustained investment and support.

The current biggest biodiversity gains in the management of African ecosystems are to ensure avoidance of ecosystem degradation. This is most successfully achieved by collaboration between the state, representing the needs of society as a whole and those of future generations, and those people and groups that get all or part of their livelihoods from use of the resources supplied by the ecosystem. The role of the state is to set the use standards and provide oversight and correction if these are exceeded, and to administer, in a fair and transparent way, the granting of use rights. Experience in several parts of Africa and elsewhere is that when use rights for biodiversity (within appropriate limits, an including the authority to decide on what to use and how to use it) are devolved to groups of people who have a

vested interest in the maintenance of the resource in the long term, the outcome for biodiversity and livelihoods is favourable and reduces burden on governments.

These two approaches are complementary, not competing. The coincidence of areas of high cultural diversity with areas of high biological diversity in many parts of Africa mean that an integrated approach to parks and people, based on the concept of 'biosphere reserves' is likely to be the best solution in many cases.

Despite the long history of protection in East Africa, the long-term viability of the ecological systems and processes on which such areas depend or are part remains questionable. The exclusion of humans and most of their activities notwithstanding, species loss has continued in the region's protected areas. In nearly all cases, park boundaries were established with little regard for the year-round needs of resident fauna. Examples abound where a protected area comprises only a small portion of a wider ecosystem. For example, the Nairobi National Park and Maasai Mara reserve in Kenya were originally designed to conserve populations of migratory mammals whose movements have since been severely restricted. Land conversion and encroachment onto the boundaries of these and virtually all other protected areas in the region led to serious ecological isolation or insularization, resulting in clearly deleterious effects on species richness, abundance and genetic vigour. Similar negative impacts are exerted on ecosystems through segregation effects, following the removal of human activities (Western and Gichohi 1993). A recent study of human – wildlife interactions around the Western Corridor of Serengeti National Park found that people were acutely aware of these relationships (Kaltenborn et al. 2003).

As large mammal populations become more compressed, it has been found that both animal and plant species diversity decreased even when no area losses are involved, for instance in Nairobi and Mkomazi parks. Rapid biodiversity loss in some of Kenya's protected areas is also closely linked with the explosion of mass low cost tourism, rapid coastal development, and spread of human settlements since the 1970s. The large mammal populations of Uganda's Murchison Falls National Park came under heavy pressure during the years of civil strife in that country, leading to huge declines and directional vegetation change. In Ethiopia's Awash, Abijata-Shalla and Nechisar National Parks, encroachment and settlement forced many wildlife species out of the park due to increased competition for forage (Hilman 1991; GebreMichael et al. 1992; Jacobs and Schloeder 2001).

Although biodiversity loss in the region can be attributed to multiple causes, a large part is accounted for by the real and widespread conflict pitting people (particularly cultivation and livestock) against wildlife. Eastern Africa has witnessed one of the fastest human population growth rates in the world during the last five decades. The spread of cultivation and settlement meant that pastoralists and their livestock have been squeezed into increasingly smaller areas. Cases of intense competition for grazing land, wood and water resources are legion. Local people and their livestock are still viewed as alien to parks, reserves and sanctuaries. Despite sharing many adaptations and a common evolutionary history, concerns over disease transmission means that wildlife and livestock husbandry are still largely considered incompatible. The loss of key dispersal areas for wildlife lead to greater pressure within the protected areas, and heightened human-wildlife conflict. Hostilities have built up as consecutive governments ignored the hardship that wildlife causes people (Yeager and Miller 1986; Western 1997). Despite the obvious economic benefits that wildlife holds, many farmers, herdsmen and ranchers living adjacent to parks look upon wild animals with considerable disdain. Wildlife periodically decimates their crops and tramples the rest underfoot. They also cause injuries or death to people and livestock, as well as spread diseases.

Since the early 1990s, countries of the region have embarked on policy change in favour of sustainable use and more local participation. Governments in the region have been responding to the realisation that a "fences and fines" approaches to strict preservation could only lead to even more conflicts, unacceptable social inequity and, the ultimate destruction of the resources themselves. A "use it or loose it" philosophy has taken root (Swanson 1992). The various community-based natural resource management approaches have yielded mixed results (Agrawal and Gibson 1999; Gibson 1999; Songorwa et al. 2000). Broader reforms are under way throughout the region to reconcile the conflicting interests of people and biodiversity. Nearly all countries in the region are providing greater legitimacy for the involvement of people natural resources management. A slow but steady change in focus is under way, shifting from the biological challenges to confronting the social and economic issues. In Kenya**,** for instance, a national land policy is being formulated through a consultative and participatory process. This should open new opportunities for people wishing to invest in conservation and sustainable use of biological diversity.

The biodiversity features of selected countries in ESA

Eastern Africa		**Biodiversity opportunity**						**Threat**	**Response**
Country	**Area**	**Mammals**		**Birds**		**Plants**			
	(km^2)	**Endemic**	**Total**	**Endemic**	**Total**	**Endemic**	**Total**	**% of land transformed**	**% of land protected**
Burundi	27830	0	107	0	451		2500	37	5
Djibouti	23200	0	61	1	126	6	826	1	1
Eritrea	117600	0	112	0	319			19	4
Ethiopia	1104300	31	277	28	626	1000	6603	39	5
Kenya	580370	23	359	9	844	265	6506	13	6
Rwanda	26340	0	151	0	513	26	2288	52	8
Somalia	637660	12	171	11	422	500	3028	6	0
Uganda	241040	6	345	3	830		4900	36	7
All countries	**2758340**	**72**		**52**		**1797**		**24**	**4**

In Zimbabwe, the CAMPFIRE programme targeted sparsely populated communal land adjacent to national parks or hunting areas. It demonstrated that economic returns from sustainable use of wildlife (largely through trophy hunting) exceeded the returns from marginal cultivation or cattle ranching, and schemes were devised to return the proceeds of wildlife utilisation to the local communities.

The biodiversity features of selected ESA countries:

ESA Country		**Biodiversity opportunity**						**Threat**	**Response**
Country	**Area**	**Mammals**		**Birds**		**Plants**			
	(km^2)	**Endemic**	**Total**	**Endemic**	**Total**	**Endemic**	**Total**	**% of land transformed**	**% of land protected**
Angola	1246700	7	276	12	765	1260	5185	4	4
Malawi	118480	0	195	0	521	49	3765	29	9
Mozambique	801590	2	179	0	498	219	5692	11	4

Swaziland	17360	0	47	0	364	4	2715	0	2
Tanzania	945090	15	316	24	822	1122	10008	25	15
Zambia	752610	3	233	2	605	211	4747	9	8
Zimbabwe	390760	0	270	0	532	95	4440	32	8

Madagascar and its neighbouring island groups are among the most globally important priorities for conservation, mainly due to the outstanding levels of endemism. The island of Madagascar has been separated from the African mainland and subsequently from India for 160 million years and 80 million years, respectively (Goodman et al. 2003). As a consequence, most of the plant and animal species present there have evolved in long isolation. Madagascar's most striking feature is its exceptionally high endemism in nearly all groups, particularly at the generic and family levels. Many groups also show very high levels of species diversity on Madagascar (Lowry II et al. 1997). Plant species richness is currently estimated to be at least 12000 species, and possibly as many as 14000, of which more than 90% are endemic (G. Schatz and P. Lowry, unpubl.). Among vertebrates, the extant mammal fauna comprises 101 native terrestrial species, none of which is found anywhere else on Earth (Goodman et al. 2003). The Indian Ocean archipelagos are composed of relatively recent volcanic islands (the Mascarenes and the Comoros) or fragments of older continental material (the main group of the Seychelles). They add important endemic biodiversity for the total land area of 600461 km^2 (including the Iles Esparses, a series of small French-held islands surrounding Madagascar. The Mascarenes have 1300 vascular plant species, of which 585 are endemics, the Comoros have about 1000 species (150 endemics), and there are about 310 species in Seychelles of which 75 are endemics.

Madagascar and its neighbouring island groups have a total of eight endemic plant families (with seven families endemic to Madagascar and one to Seychelles), four endemic bird families, and five endemic primate families (Mittermeier et al. 2004). The Indian Ocean islands are biologically closely linked to Madagascar, and reveal important endemic biodiversity.

The main threats to natural habitats in Madagascar and the Comoros are forest loss through slash-and-burn agriculture and fire, with logging and mining on the rise in Madagascar. In the Mascarenes and Seychelles, conversion of land for housing and other uses presents the biggest threat**.** The proliferation of aggressive exotic plant species is also an increasing threat affecting the biodiversity of Madagascar and especially the more recent and highly vulnerable Indian Ocean islands. Freshwater ecosystems in particular have been seriously impacted by alien plants such as *Eichornia crassipes* (Langrand and Goodman 1995). In Madagascar, the most destructive exotic animals are cattle, sheep, and goats, which have caused important changes in native plant communities and have helped drive many endemic terrestrial herbivores to the brink of extinction (Dewar 1997). Important human activities are thought to be primarily responsible of the current pattern of the vegetation: 1) grassland wildfires set by herders either to stimulate re-growth during dry season or to eliminate unpalatable herbaceous species (Kull 2000); and 2) forest clearing to create agricultural fields and for timber and charcoal production.

There is a renewed political commitment to conservation in Madagascar. On September 2003, at the World Parks Congress in Durban, South Africa, Madagascar declared its intention to triple the total land area managed for conservation purposes. More recently, during the International Scientific Conference on "Biodiversity, Science and Governance", held in Paris in January 2005, the intention was reiterated, and the cause of biodiversity protection was confirmed to be an essential element in decreasing poverty and increasing opportunities for Madagascar's people. This declaration offers a unique opportunity to address Madagascar's critical biodiversity conservation issues. With support from scientists and conservationists, the government is now identifying priority areas for conservation, and

will establish a new category of protected areas called “Conservation Sites”, which will guide activities carried out under the third 5-year phase of the National Environmental Action Plan.

A multi-disciplinary group of non-governmental organizations is collaborating on biodiversity management and conservation in Madagascar. Representing a broad range of stakeholder groups, these non-governmental organizations have joined forces to assist the Ministry of the Environment, Water and Forests. The decision to link conservation biology with “public ecology” has stimulated participation from experts in economics, sociology, and other disciplines concerned with the social environment in which conservation efforts must operate(Robertson and Hull 2001). In addition to identifying potential priority sites for conservation, the group is examining the legal aspects of implementing management plans and the adoption of IUCN protected area categories.

Biodiversity data are being used to develop strategies for conservation and sustainable management of natural resources. As of 2002, Madagascar’s protected areas network included 46 sites covering 2-2.7% of the country’s total surface, depending on which classes of “protected area” are included (Randrianandianina et al. 2004). Current approaches for area selection are based on biological collections and as well on a range of eco-geographic parameters that analyzed using GIS and other tools. This has led to the recognition of both large and small areas harbouring unique biodiversity that are in need of immediate protection.

During the process of identifying priority conservation areas, scientists were able to identify important gaps in the available information, in particular regarding marine, freshwater and mangrove environments, and also non-vascular plants. In many cases, data are unavailable, have not been collected over a sufficiently long time, have been gathered at only a few localities, or have not been recorded in a format that can be used to inform decision-making on the management, use, and conservation of the nation’s biodiversity (Committee on the Formation of the National Biological Survey 1993). However, the identification of these gaps will help scientists to prioritize future studies. Knowing that Madagascar has decided to incorporate biodiversity data into formulating national strategies, researchers are being encouraged to conduct further inventory work in priority sites.

Minimal rules have been adopted for a conservation management system that gives the local community an important role. The newly designated conservation sites will operate based on some improved management principles. First, dynamic and flexible management will be encouraged, rather than the current system that strictly forbids forest resource use by the local population in some categories of protected areas. Within the new conservation sites, right-of-use zones will be assigned. Sustainable uses of non-timber forest products, such as medicinal plants and ecosystem services, will be permitted. The sites will be managed for multiple uses. Second, the local population will be involved as direct managers of the forest resources in their area. Local people are the principal actors in natural resource use, so they will contribute to site management, starting with the identification of boundaries and the establishment of various zones, defining the permitted activities and working with partners on projects to derive benefits from the sustainable use of local biodiversity as a means to improve the local economy while also promoting conservation.

Causes of threat and responses vary regionally. Outside Madagascar, protected area coverage varies among the Indian Ocean islands. The Seychelles have about 208 km² of National Parks of varying degrees of implementation. Taking together all parks irrespectively of the IUCN category they are in, they represent about 42% of the land area with a further 228 km² of marine national parks. As for Mauritius**,** there are10 protected areas within the IUCN category I – II, for a total area of 70 km^2 in addition to 90 km^2 of marine and littoral protected areas. In these economically better-off areas the factors threatening biodiversity differ substantially from those operating in Madagascar, and

conservation strategies are likewise different, with less emphasis placed on rural development and poverty alleviation, and more on the political process leading to the establishment of protected areas and improved land use planning. In the Federal and Islamic Republic of the Comoros, the situation has more in common with Madagascar, there are 3 protected areas covering 400 km^2 that represent 24.3% of the total land area. Although levels of diversity and endemism are more modest in Comoros, biodiversity conservation is nevertheless a high priority. In this context, the approach developed in Madagascar, in which carefully compiled and analyzed data are being used to inform the process of identifying new conservation sites, could serve as a valuable model.

3. COASTAL AND MARINE RESOURCES

The coastal and marine resources are potentially the most important social and economic assets of western Indian Ocean Island States (WIO) with 5,836 km of coastline, 6.7 million people living near the coast, a total land area of 592 thousand square km, of which 99% is in Madagascar, they command a marine area of around 6 million km^2 of EEZ. As island states, they have no land boundaries with other states. The seas are endowed with rich and varied coastal and marine ecosystems. There are extensive coral reefs, covering some 5 000 km^2 with 320 species of hard corals (UNEP-WCMC 2000), with high biodiversity and, notably on Madagascar, coastal wetlands. The reefs constitute an important resource for fishing, tourism and recreation, as well as providing protection to vulnerable shores against potentially damaging waves. There are many endemic species; also endangered species including turtles, dugongs and cetaceans.

Fringing coral reef at Tanjon i Masoala, northeastern Madagascar (NASA Worldwind)

Coral reefs collectively cover an area of more than 5 000 km^2, with 320 species of hard corals. They constitute an important resource for fishing, tourism and recreation, as well as providing protection to vulnerable shores against potentially damaging waves (Ahamada, Bijoux, Bigot, Cauvin, Kooonjul, Maharavo, Meunier, Moine-Picard, Quod and Pierre-Louis 2004). Fringing reef almost surrounds the islands of Mauritius (including Rodrigues) and the Comoros islands, while many fringing and patch reefs occur around the granitic islands of Seychelles. The island of Aldabra, a designated World Heritage site (UNESCO 2005) in the western Seychelles, is a classic atoll. In Madagascar there are extensive coral reefs in the south-western and north-western parts of the island (UNEP-WCMC 2000), all affected by the bleaching event of 1998 as a result of unusually high sea-surface temperatures. Live coral cover was reduced to less than 10 per cent around some of Seychelles' granitic islands, while Mauritius was relatively lightly affected (Linden and Sporrong 1999). The deep waters surrounding

Comoros are home to the coelacanth, a living representative of a family of fish known to have existed 370 million years ago (UNEP 2002b). Coastal wetlands are extensive in Madagascar where mangroves cover an estimated 340 000 ha (Figure 00). More than 30 km^2 of mangrove stands are present in Comoros (UNEP 2004). In the Seychelles, remaining mangrove totals only 29 km^2, the largest areas being on the western islands including Aldabra (UNEP-WCMC 2003). In the sub-region as a whole, there are fifteen, mostly coastal, MPAs, established for different purposes and with different styles of management (Francis and others 2002, UNEP 2004).

All countries have important marine fisheries resources. As well as the inshore and reef fisheries traditionally exploited by artisanal fishers, these include the offshore demersal fishery of the banks of the Mascarene Plateau and the Chagos Archipelago as well as extensive oceanic tuna fisheries that support commercial industries in Mauritius and Seychelles.

Offshore geophysical and geological exploration for oil has taken place on the Seychelles Bank since the 1970s with minor exploration drilling (SNOC undated). The geochemical analyses and exploration data from its offshore acreage indicate potential for commercial production (MBendi 2000a). In Madagascar the existence of oil and gas reserves has been confirmed; Bemolanga and Tsimiroro are exhumed oil fields, while numerous other wells include oil shows (MBendi 2000b). It has a modest production of crude and gas (MBendi 2000b), with reserves of 70 x 10^9 cubic feet of natural gas (EIA 2004). A field off the west coast containing heavy oil was proved in 2003 but deemed to lie too deep and to be too heavy to be commercially viable. Offshore exploration has continued over the last decade in the Majunga basin, off the west coast (EIA 2004).

Fisheries

Inshore and reef-related fisheries have been a traditional mainstay of the coastal populations and continue to be an essential resource for their livelihood (UNEP 1998, FAO 2002c, FAO 2004c, PERSGA/GEF 2003). The Red Sea coasts of Eritrea and Djibouti support extensive reef-based artisanal fisheries; there are also productive offshore fisheries due to the seasonal upwelling in the Gulf of Aden.

Industrial fishing practices dominated by foreign fleets are becoming prevalent, with production far outstripping that of the artisanal fishers (FAO 2002c). Most commercial operations in the prolific fisheries of the Somali Current upwelling are carried out by foreign vessels, many of them illegally (Coffen-Smout 1998, Hassan 2001, UNEP 2002). In Kenya, most fishing activity takes place close inshore along the reef, with mainly reef- and sea-grass-associated fish species being exploited, while a few freezer trawlers fish for shrimp in the shallow waters of Ungwana Bay (FAO 2001a). Little is known of the potential of the offshore fisheries resource in southern Somali and Kenyan waters.

The Socio-economic context of small-scale marine fisheries in Kenya

Small-scale marine fisheries in Kenya are multi-species and multi-gear. They are economically very valuable, generating in excess of US$ 3.2 million/a for local fishers, which would represent significantly more for the wider community if the income for traders was known. The small-scale fishers land at least 95% of the marine catch. It is estimated that more than 60 000 coastal people depend on these fisheries. In some coastal communities over 70% of households depend on fisheries, but an estimated average for the coast as a whole is 45% of households. It is highly likely that the numbers above, which have been extrapolated from a few detailed studies, are greater.

Although very few coastal households depend solely on fishing for their livelihood, many depend only on fisheries resources for income. Fishing and trading fish is one activity amongst a range livelihood activities (both subsistence and income earning) carried out by coastal households. Fish is an important source of animal protein for coastal communities, 70% of fisheries dependent households and 50% of non-fisheries dependent households

eat fish more than once a week. Fisheries dependent households in Kenya are poor, which is the perception of fishers and is reflected by food security and material style of life indicators.

Fisheries resources are thus very important for food and income in rural Kenyan coastal communities. The high levels of dependence reflect the paucity of alternative income earning options. This situation makes coastal communities highly vulnerable to mismanagement or loss of fisheries resources. The lack of effective management, by both formal and informal institutions, and the high dependence on these resources have been identified by fisheries stakeholders as important contributors to poverty in coastal communities. The prevalence of destructive fishing gear, primarily small meshed nets, coupled with growing numbers of fishers are key management issues to tackle.

Source: A. King, based on Malleret-King and others 2003; Malleret-King 2003a, 2003b.

While artisanal and inshore fisheries are generally over-harvested, some countries have not yet developed the capacity to fully exploit or enforce regulation of their offshore fisheries. While artisanal and inshore fisheries are generally over-harvested, not all countries yet have the capacity to fully exploit or enforce regulation of their offshore fisheries. But this is changing. Eritrea now places a high priority on the development of commercial fisheries (Kotb and others 2004), aiming to increase production three- to four-fold, up to between 50 000 and 60 000 t/a. Some 80-85 per cent of this production is expected to be generated by the foreign industrial fleet, especially trawlers, but the contribution from artisanal fisheries may also be increased (FAO 2002c). In Djibouti, pelagic and small tuna species are considered to be significantly under-exploited (FAO 2004c). Djibouti is aiming for an annual Maximum Sustainable Yield of 5 000t, compared with a 2001 level

Fisheries contribute significantly to all the national economies in the IO States. Stocks within EEZs are exploited under licence by foreign fleets, licence fees forming a significant proportion of national revenue (FAO 2004a). The fisheries are known to be nearly fully exploited and localized overfishing may have already occurred in many coastal areas, with most of the largely artisanal coastal fisheries being exploited beyond their Maximum Sustainable Yield (UNEP 2004). Overall catches in the region have increased over the past three decades to a level that has been more or less stable in recent years, but with a decline in Mauritius and Comoros (Figure 00; FAO 2004b). It is not known if fisheries production has reached its limits, but there are indications that many stocks are now severely depleted.

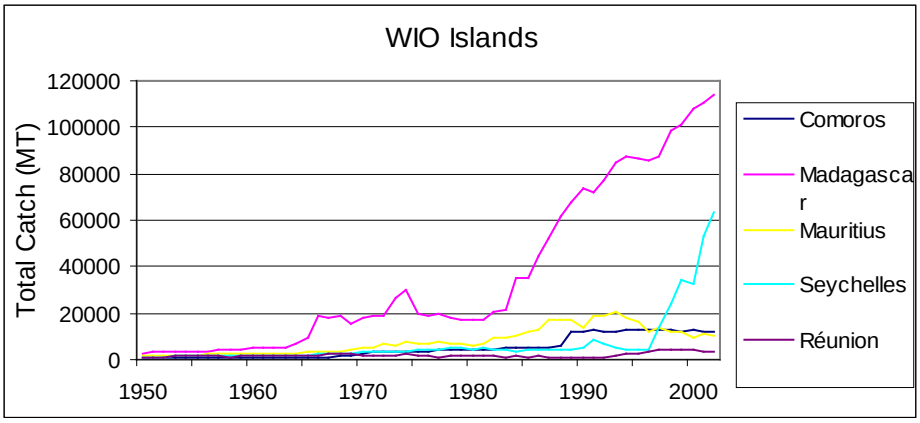

Figure: Marine fish catches in the Western Indian Ocean countries since 1950 (FAO 2004b)

There is scope for improvement in the quality of fisheries catch data for the purposes of policy making and management. Some marine fisheries may have scope for development, subject to enforcement of regulation at national and international levels. In Seychelles, where there is now a highly developed

tuna industry including a canning factory employing 1 800 workers (FAO 2001b), fishing has become the largest money earner after tourism, contributing 12-15 per cent to GDP (Seychelles Fishing Authority, unpublished data). Licence fees of US$8 million are collected every year, with income from indirect expenditure (port dues, food supplies, services, etc.) amounting to over US$2 million. Seychelles, particularly, and Mauritius also have important canning and trans-shipment facilities for tuna.

Fisheries Management in Seychelles: Combining Traditional and Novel Approaches

Seychelles has well-developed industrial and artisanal fisheries. As a regional hub for the Western Indian Ocean tuna fisheries, the industrial fishing sector constitutes a main pillar of the economy, contributing more than 40% to foreign currency earnings in 2003 (Seychelles Fishing Authority, 2004). The economic importance of the industry, combined with the hosting of the Indian Ocean Tuna Commission in Seychelles, affords a sophisticated management system based on comprehensive data collection and stock assessments. Revenue from industrial fishing has also enabled development of artisanal fisheries, which are subject to one of the most comprehensive monitoring systems in the region, allowing timely assessment of trends in catches and fishing effort. Despite slight fluctuations between years, the total catch has general fallen between 4 000 and 5 000 tonnes and the overall composition of the catch has remained fairly stable. However, utilising traditional stock assessment methods for multi-species, multi-gear artisanal fisheries are not without problems and novel approaches need to be adopted to deal with the uncertainty inherent to these approaches.

Ecosystem-based approaches to management are increasingly viewed as a tool to complement traditional methods. Applied research projects are being undertaken to locate and protect spawning aggregations, and there is now a greater emphasis on the role of marine protected areas in fisheries management. Co-management of resources and the institutionalization of property rights regimes are further avenues that may be explored in order to promote a more representative management regime, where traditional ecological knowledge complements scientific information to set fisheries objectives. Fisheries management in Seychelles will require a dynamic and adaptive approach to find solutions to the many complex problems inherent to this diverse and economically important sector.

Source: J. Robinson (Seychelles Fisheries Authority)

Aquaculture

Aquaculture is a developing industry in all countries except Comoros. The islands' coastlines are well suited for several types of aquaculture development (Rönnbäck, Bryceson and Kautsky 2002). Such developments present scope for increasing food security, in particular for coastal populations, and provide new sources of income for local economies and export markets. In Madagascar, there has been extensive conversion of coastal wetlands and mangrove areas to pond culture (UNEP 2004). In Mauritius, commercial aquaculture, mostly in freshwater ponds, consists of the production of giant freshwater prawns and red tilapia (FAO 2000a).

Agriculture remains an important sector except in the Seychelles, where the shift to tourism has reduced its contribution to GDP to about four per cent. Sugarcane cultivation dominates in Mauritius, cattle-rearing and rice production in Madagascar. On the Comoros, agricultural production employs 70-80 per cent of the total population and accounts for 98 per cent of the export revenue (UNEP 2004).

Marine aquaculture is increasing becoming an important activity in the region, though it is still at an infancy stage of development.

Science in support of management

Complex decision-making processes required for managing coastal and marine environments in the WIO region are generally weakened by inadequate information and research inputs. Therefore, it is essential that appropriate scientific information is available for assessment of impacts of activities, and that a sound scientific base exists which can accommodate the changing needs of management institutions as well as society at large and upon which policies and practices of resource management are built. Consequently, input from the scientific community needs to be developed in collaboration with relevant stakeholders. In addition to the information needs, it is necessary that research capacity building is continued to meet long-term scientific development and the environmental needs of the region

Source: WIOMSA 2005.

Coordination of coral reef monitoring at national level in Seychelles

The Seychelles National Coral Reef Network (SNCRN) was setup in 1998 a few months prior to the catastrophic coral bleaching event of that year with a view to coordinate coral reef monitoring in Seychelles. Whilst it groups organisations working in the marine sector ranging from the government institutions to conservation NGOs, academic institutions and the dive and fishing industry, each organisation have their own monitoring programmes. It also provided links into regional programmes and with GCRMN and ICRI. The network is currently implementing a monitoring programme as part of a regional initiative, and several training activities have been organized. The SNCRN has provided an essential platform for partnerships to be made in monitoring and also sharing of knowledge and experiences. At first many organisations were doubtful the process would work, but it has proved to be critical in encouraging wider support from NGOs and the private sector. However the network has yet to address several critical questions related to coral reefs - such as sustainable financing of monitoring, monitoring methods, centralised database management or not, and coverage of existing network.

Source: J. Bijoux (Seychelles Centre for Marine Research & Technology)

Fisheries management issues are being tackled by two important initiatives. These address the need to build local capacity in all sectors of the fishing industry, to reduce the reliance on distant water fleets, and to adopt regional approaches to fisheries management, including high seas issues and the problems posed by transboundary and highly migratory stocks. A long-term project due to begin in 2006–the GEF-World Bank-supported South West Indian Ocean Fisheries Project (SWIOFP), designed to interface with a GEF-UNDP initiative to study the Agulhas Current and Somali Current LMEs–should bring an unprecedented level of scientific and management cooperation. In another project, a framework for regional fisheries management of non-tuna species is being developed, through the establishment of the South West Indian Ocean Fisheries Commission (SWIOFC). A non-binding coastal arrangement is in place within this framework and negotiations are underway for a binding high seas arrangement.

Coastal erosion due to the impact of large waves is a major issue, particularly in the SIDS where it has serious implications for tourism development. The extent to which upward reef growth and platform sedimentation might keep pace with sea-level rise is unknown but it is likely that the protection from large waves offered by reefs will become less effective. In the extreme case of the Indian Ocean Tsunami impact of 26th December 2004, damage in the Seychelles was estimated at US$30 million (UNEP 2005b). Even where shores are fringed by extensive reef platforms and lagoons, as around Mauritius, they may be susceptible to erosion. The most critical coasts are those formed by low-lying beach plains, where former beach sands have accreted on rock platforms (the so-called ‘plateau’ sands of the Seychelles islands such as Praslin and La Digue) (Kairu and Nyandwi 2000, UNEP/GPA 2004).

Attempts have been made to stabilize shorelines in the Seychelles by the installation of groynes, and in Mauritius by the use of rock-filled wire gabions. The erosion of beaches and non-rocky beachhead materials is likely to be aggravated by rising eustatic sea-level and an increasing frequency of storm surge events arising from global climate change (IPCC 2001). In the Seychelles, a national beach monitoring programme was launched in 2003.

Ecological Restoration of Islands in Seychelles

The environment of most of the islands of the Western Indian Ocean has been severely degraded. An island restoration programme, initiated in 1999 in the Seychelles, points the way to sustainable mechanisms of island restoration. A collaborative effort between an NGO–Nature Seychelles, private island owners and the Seychelles government, the program is ongoing. Components include biological assessment of islands, socio-economic valuation of restored ecosystems and eco-tourism, cost analysis of restoration and maintenance, education and awareness, island management plans, removal of alien predators and other invasive alien species, establishment or rehabilitation of native coastal habitats and translocation of globally threatened endemic species. Islands in the programme include Fregate, North and Denis islands, private 5-star hotel resorts. Establishment of new populations of endangered species will not only lead to the down-grading of the threat status of these species on the IUCN Red List but also to enhancing ecotourism potential, thus inducing hotel owners to contribute to conservation efforts. The program has been financed by the GEF, the Seychelles government and island owners and has involved international partners such as Bird-Life International.

Sources: Shah 2001, Henri, Milne and Shah 2004.

Opportunities and constraints for coastal and marine resources

Opportunities for development	**Issues, threats and constraints related to development** NEPAD issues in italics
Oil and gas production	Resource sustainability Marine and coastal pollution, water- and airborne Coastal habitat loss Invasive species from tanker ballast waters
Coastal mineral extraction	Habitat loss through excavation, siltation, pan construction Restoration of industrial mining sites Coastal erosion from beach sand mining
Urban, industrial and port development	Urban sprawl and habitat loss through construction, siltation Solid waste, sewage discharge and industrial effluents; hazardous waste Pollution of coastal wetlands and seas Invasive species especially from shipping ballast waters Coastal erosion Inundation due to sea-level rise; extreme wave events
Tourism growth	Urban sprawl and habitat loss from construction and tourist pressures Solid waste and sewage discharge; chemical effluents Loss of amenity value Coral bleaching Coastal erosion, beach loss Sea-level rise; extreme wave events
Marine fisheries growth and sustainability	Over-harvesting and use of destructive methods By-catch and endangered species Regulation and enforcement; illegal fishing Protection of nursery areas Land-sourced pollution of coastal waters Reduced freshwater discharge from rivers (prawn fisheries)

Coastal aquaculture growth	Wetland drainage and reclamation for agriculture and urban growth Habitat and biodiversity loss, especially from pond construction Urban, industrial and agricultural pollution; pollution from aquaculture Lack of freshwater input Institutional constraints Coastal erosion; sea-level rise
Coastal agriculture sustainability	Habitat and biodiversity loss Coastal siltation from increased run-off Reduced freshwater discharge from rivers through irrigation Reduced flooding and sedimentation through damming Salinization of groundwater Control of fertilizers and pesticides Impact of urban sprawl Coastal erosion; sea-level rise
Governance and management goals	Management of fisheries resources including regulatory and enforcement regimes Management of MPAs and protected wetlands Planning, regulatory and enforcement regimes for coastal urban and tourism development Waste management and pollution control (including invasive species) in the urban, industrial (including port and shipping), tourism, oil and gas and agricultural sectors. Sharing the benefits of development for the wellbeing of coastal communities Inter-sectorial cooperation at catchment, national and international scales Human and operational capacity building for coastal and marine resource management

The inclusion of Madagascar and Comoros in the project entitled Reduction of Environmental Impact from Coastal Tourism through Introduction of Policy Changes and Strengthening Public-Private Partnerships would be desirable, with a strong emphasis on ecotourism ventures such as have been pioneered in Seychelles.

The issue of the sustainability of the artisanal inshore and reef fisheries demands urgent attention. There is a clear need for coastal states to adhere to regional cooperation in the management of shared resources/stocks such as tuna in the Indian Ocean under the auspices of regional fisheries management organizations.

Recognizing the potential for aquaculture development, appropriate regulations are needed to protect coastal ecosystems, and to promote sustainable production practices.

The issues of solid waste management and of marine-transported litter impacting the islands' shores need urgent attention, the latter requiring international commitment and cooperation.
The monitoring of shoreline change and the identification of shorelines vulnerable to extreme waves (including tsunamis) are priorities. Coastal development, particularly tourism infrastructure, should be permitted according to the shoreline's susceptibility to erosion, with setback regimes as appropriate and with the relocation of vulnerable communities. If engineered hard defences are to be installed, these should be of a design that does not exacerbate erosion.

Better management of solid waste

In the African Small Island Developing States (SIDS) of the Indian Ocean, at least 2.8 million tonnes of solid wastes are generated annually, of which only 30 per cent are collected routinely. Beach deposited rubbish is estimated to be about 40 640 tonnes (Payet and others 2004). The dumping of solid wastes in rivers, on beaches and in the sea has become common practice, particularly in the Comoros and Madagascar. However, such practices have been discontinued in Seychelles and Mauritius, both of which have adopted a national solid waste management plan. The have also invested in infrastructural development with Seychelles spending between US$6-8 million in solid waste management over the last 10 years (Payet and others 2004).

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4. LAND RESOURCES

The most important issue linked to land resources is land degradation.

Mineral deposits (Kenya)

Titanium mining

Following the discovery of five large titanium deposits, large-scale open cast mining at the Kenyan coast may commence soon. TIOMIN, a Canadian mineral company, completed an integrated exploration programme and is now ready to start exploitation of the deposit at Kwale in 2006 with a 21-year lease. The mining method proposed by TIOMIN will be excavating sand and feeding it into a concentrator. At the concentrator the economic minerals are separated from the sand by using water. The sand will be placed back into the excavation from which it came and the surface will be restored. Rehabilitation will be a continuous process as mining progresses and land will be returned to the original form for farming activities. The concentrate containing the economic minerals will be transported by road to the harbour, where the concentrate will be treated in a mineral separation plant by using electrical and gravity methods. The company has indicated that there will be no pollution produced at either the concentrator or during the mineral separation process as no harmful chemicals will be used. Local tribes people are concerned about the desecration of the graves of their ancestors and the fate of their sacred forests. Kenyan scientists are also concerned about sulphur dioxide emissions from the mining plants, the release of radioactive elements, and the impact on the groundwater. Although the company plans to return the land to its owners when the lease expires, some of Kenya's best farmland might no longer support arable crops because of changes in the soil structure.

Sources: N. Opiyo-Akech, Pages 217-220 In UNESCO 2000; http://news.bbc.co.uk/2/hi/business/3870247.stm (July 2004)

Mountains

African mountain ranges are the headwaters of most of the large African rivers such as the Nile, and support the livelihoods of millions of people in the region. For example, the Mount Kenya range, are the headwaters of the Tana River. Mountains are often described as nature's water towers, which intercept air circulating around the globe and force it upwards, facilitating cloud formation and ultimately rain and snow. According to FAO, one out of two people worldwide drinks water that originates in mountains. About 250 million people in Africa are among the 3 billion people worldwide who rely on the continuous flow of mountain water (FAO 2002aa).

In terms of economic activity, mountains support forestry and tourism, enhancing birding, hiking and climbing among other recreational activities. They are therefore, key in both local and national economies. Mountain water generates hydroelectricity, facilitates industrial processes, and is critical in irrigated agriculture.

Table: Some selected mountain ranges in Africa

Mountain	Mountainous chain	Height (m)	Countries
Mount Kenya	Rift Valley	5 199	Kenya
Ruwenzori	Mitumba Mountains	5 119	Uganda/ Dem. Rep. of Congo
Ras Dascian	Simen Mountains	4 620	Ethiopia
Karisimbi	Mitumba Mountains	4 507	Rwanda
Kinyeti	Al Istiwa'iyah	3 187	Sudan
Jabal Marrah	Jabal Marrah	3 088	Sudan
Piton des Neiges	Reunion Island	3 069	Reunion (France)
Satipwa Peak	Mulanje Mountains	3 002	Malawi
Maromokotro	Tsaratanana	2 876	Madagascar
Jabal Hamoyet	Red Sea Hills	2 780	Eritrea
Nyangani	Manicaland Mountains	2 593	Zimbabwe
Kartala	Grande Comoros Island	2 361	Comoros
Makutu Mountains	Makutu Mountains	2 164	Zambia
Musa Ali	Danakil Mountains	2 063	Djibouti/Eritrea/Ethiopia

Global GeoAfrica 2004

Land and land-based ecosystems

Direct values	Indirect values	Option values	Non-use values
Consumptive and non-consumptive use of resources	Ecosystem functions and services such as:	Premium laced on possible future uses, including:	Intrinsic significance in terms of:
Domestic use	Land quality	Pharmaceutical	Cultural
Industrial input	Soils	Agricultural	Aesthetic
Commercial use	Micro-organisms	Industrial	Heritage
Mining	Water flow	Mining	Bequest
Oil extraction	Water storage	Tourism	Etc.
Growing crops	Water recharge	Forestry	
Human settlements	Flood control	Human settlements	
Wood fuel	Storm protection	Leisure	
Wild plants	Nutrient retention	Etc.	

Wild animals	Moisture retention
Tourism	Micro-climate
Waste disposal	Natural sink
Etc.	Etc.

Adapted from SADC, IUCN, SARDC and IBRD 2002

In the Democratic Republic of Congo (DRC), where 75 per cent of the total population of 51 million people was reported to be undernourished, 50 per cent of infant mortality is related to malnutrition (WFP 2004).

- A mere 7 per cent (barely 3.7 per cent in Sub-Saharan Africa) of Africa's arable land is irrigated compared to 10 per cent, 29 per cent and 41 per cent for South America, East and Southeast Asia and South Asia respectively.

- Sixteen per cent of all soils in the region are classified as having low nutrient reserves while in Asia the equivalent figure is only four per cent.

FAO Corporate Document Repository 2002

Agriculture in Africa is not limited to food crops and livestock production but cash crops as well such as tobacco, cotton and flowers. Horticulture, which includes vegetables, fruits and cut flowers, has become a major activity in Africa. It has grown to be the single largest category in world agricultural trade, accounting for over 20 per cent of such trade in recent years (World Bank undated). While in Sub-Saharan Africa, horticultural exports now exceed $2 billion, this is only 4 per cent of the world's total (World Bank undated). Significant opportunities for expansion, therefore, exist in Africa to boost employment as well as foreign currency earnings. The challenges would be to adequately deal with environmental problems, which include pollution from chemicals.

Horticultural products have become Kenya's second largest merchandise export, after tea. The country itself now only trails South Africa in Sub-Saharan in terms of horticultural exports. About 135 000 Kenyans are directly employed in the sector (World Bank).

Opportunities for irrigation

An opportunity which is yet to be fully exploited is irrigated agriculture. Only six per cent of the total cultivated land is under irrigation in Africa, compared to 33 per cent in Asia. In a region where droughts are prevalent often destroying crops and exacerbating food insecurity, irrigation could be a key factor in enhancing food security. Irrigation increases yields of most crops by between 100-400 per cent, and it has been projected that in the next three decades, 70 per cent of gains in cereal production globally would be from irrigated land (FAO 2002a). According to the ECA (2004), little progress towards sustainable development can be achieved until Africa reaches a minimum level of developing and managing water resources for secure food and agricultural production.

The NEPAD policy for CAADP

One of the major responses is the Comprehensive Africa Agriculture Development Programme (CAADP), which was endorsed by African governments in late 2002 in the NEPAD context. The CAADP has three immediate "pillars" and a long-term one which together can help tackle Africa's agricultural crisis (FAO Corporate Document Repository 2002). The mutually reinforcing pillars on which to base the immediate improvement of Africa's agriculture, food security and trade balance are:

- **Extending the area under sustainable land management and reliable water control systems**. Building up soil fertility and the moisture holding capacity of agricultural soils, and rapidly increasing the area under irrigation, especially small-scale water, will not only provide farmers with opportunities to raise output on a sustainable basis but will also contribute to the reliability of food supplies.

- **Improving rural infrastructure and trade-related capacities for market access.** Roads, storage, markets, packaging and handling systems, and input supply networks should be improved to raise the competitiveness of local production vis-à-vis imports and in export markets.

- **Increasing food supply and reducing hunger.** Africa, which currently lags behind all other regions in terms of crop and livestock yields, and has limited use of irrigation and other inputs, needs to improve access to technology by small farmers. They can play a major role in increasing food availability close to where it is most needed, raising rural incomes, and expanding employment opportunities and contributing to a growth in exports. It is also important to respond to the growing frequency and severity of disasters and emergencies in the region. It has been reported that in addition to natural disasters, more than 50 African countries were facing or had recently undergone civil or cross-border conflicts, including some 20 poorest countries. As a result, more aid is being diverted to emergency relief than to necessary long-term development.

- **Agricultural research, technology dissemination and adoption.** This is the long-term pillar to achieve accelerated gains in productivity and requires: (a) enhanced rate of adoption for the most promising available technologies by linking, more efficiently, research and extension systems to producers; (b) technology delivery systems that quickly bring innovations to farmers and agribusinesses through appropriate use of new information and communication technologies; (c) renewing the ability of agricultural research systems to efficiently and effectively generate and adapt to Africa's new knowledge and technologies, including biotechnology; and (d) mechanisms that reduce the costs and risks of adopting new technologies.

A budget of US$251 billion was estimated for the period 2002-2015 to successfully implement these four pillars. If Africa were to invest in agriculture the total of about S$22 billion (ECA 2004) it spends annually on food imports and food aid, it would take the region less than a decade to implement the four proposed agricultural pillars highlighted in the CAADP.

5. ECO-TOURISM

Ecotourism in Africa varies widely, from viewing gorillas in the Great Lakes region and lemurs in Madagascar, trekking in Ethiopia and birding in Botswana, looking at rock paintings in South Africa, visiting rainforests in Ghana, mountain-climbing in Eastern Africa (Mt Kilimanjaro and Mt Kenya, for example), scuba diving in the Seychelles and photographic safaris in Eastern and Southern Africa (Vieta 1999). In the Great Lakes region, for example, revenue from tourism based on gorilla viewing and other activities can bring about $20 million to the region annually (Pickrell 2004). Tourism in the area is certain to be boosted with the news in 2004 that the first census since 1989 revealed that the population of the apes in the Virunga mountains has grown by 17 per cent, increasing from 324 in 1989 to 380 by the end of 2003 (Pickrell 2004).

In Madagascar, where tourism is the country's second largest foreign-exchange earner, the country had by 1998 established 40 new protected areas, covering roughly 2 per cent of the country's land area (Vieta 1999).

Tourism not only generates revenue to support conservation and management of natural environments but also generates many jobs. For example, hundreds of people live off the Bwindi Impenetrable Forest in Uganda, where foreign tourists trek to view gorillas. It has been argued that tourism has larger multiplier effects, with revenue spreading from hotel accommodation, food and beverages, shopping, entertainment and transport to income of hotel staff, taxi operators, shopkeepers and suppliers of goods and services (UN undated).

Despite the growth of tourism, the region still only accounts for less than 4 per cent of world tourism, with its revenue share at only 2.5 per cent - about $16 billion in 2002 of the annual sales of about $4.5 trillion (Saunders 2003). Therefore, opportunities for further investment and development are vast in the region. In Kenya, for example, new regulations that will allow sport bird shooting are expected to attract up to 2 000 sport hunters annually, boosting revenues by $5 million each year. New Kenya Wildlife Service (KWS) rules provide for private landowners to obtain special authorization to manage their own game bird populations, including breeding, as well as determine open and closed seasons (African Environmental News Services 2003).

In Ethiopia, the government is touting "pale-tourism," which promotes the country's prehistoric sites to generate revenue (IRIN 2004). Ethiopia, which is home to probably the most famous prehistoric remains ever found, and the world’s oldest human remains, has been described by scientists as the cradle of humanity. According to experts, Ethiopia’s discoveries chart man's prehistory from his first use of tools more than 6 million years ago to modern ancestors. Tourism officials in Afar believe that pale-tourism could generate an additional US$2 million in revenue annually for this region alone (IRIN 2004). The Ethiopian tourism commission has reported that the sector generated more than US$77 million in 2003 (IRIN 2004), and is an important weapon in the fight against poverty. It plays a key role in the government’s poverty reduction strategy paper.

The tourism industry in Africa also has human and environmental costs, contributing to the displacement of communities, and generation of waste, pollution and possible overuse of water. In Africa, for example, tourism's effects on indigenous peoples have been profound: communities have been evicted from their lands in addition to economic dislocation, breakdown of traditional values, and environmental degradation. Pastoralism has been attacked as primitive and destructive (Third World Network 1999). The massive influx of tourists and their vehicles in the Masai Mara National Park in Kenya and in the Ngorongoro Conservation Area in Tanzania has destroyed grass cover, affecting plant and animal species in the area. Hotels have dumped their sewage in Masai settlement areas while campsites have polluted adjacent rivers (Third World Network 1999).

The island states of the ESA IO region are valued for their outstanding natural beauty and tropical biodiversity, but are under local pressure from land based pollution and degradation of coastal wetlands and beaches. In the WIO countries between 1990 and 2002 there was a 98% increase in tourist arrivals. As a consequence of tourist development, coastal built infrastructure is putting increasing pressure on environmental services and natural resources especially water, sanitation, energy, roads, bridges, beach facilities, boats and road transport, and the fragile ecology of coastal areas. Despite increased numbers of tourists in all the countries, reported earnings in Madagascar fell by 10% in the period 1990 to 2002. In the Seychelles there was no increase, whilst the increase in income in Mauritius was 185 per cent and in the Comoros 450 per cent. In the Seychelles, a new tourism plan – Vision 21- has been formulated to maintain a sustainable approach to tourism development. Standards included in the plan cover a

minimum setback building from the high water marks of 25 m in coastal areas, a building height limit of below the tops of coconut trees in rural areas and a maximum of four-storey building in the capital, Victoria, and the use of Creole style architecture. Much emphasis is now being laid on new forms of tourism in Mauritius and in the Comoros, related to their diverse cultural and environmental heritage.

Tourism befits local people and conservation

One way of promoting conservation at community level is to ensure that local people benefit financially from the protected area. In addition those who may have become poachers or who would have opposed the management of the protected area receive legitimate livelihoods. Cousin, a small island in Seychelles, is a good example. A sea and island Reserve established by law in 1968 and run by an NGO, Nature Seychelles, initiation of eco-tourism in 1972 has grown to become a modern practice run under internationally accepted principles. It has won numerous accolades including the Condé Nast Ecotourism Award for 1994. A wholly Seychellois team runs the Reserve and only local people are involved in eco-tourism there, ranging from small boat operators to larger tour organizations. Other small businesses on the neighbouring island of Praslin such as shops, cargo service, mechanics, small contractors and boatyards also benefit from business associated with Cousin. Poaching is virtually zero. Eco-tourism brings sufficient revenues to run the Reserve and also for implementation of other conservation and educational programs including the Local Environment Action Program (LEAP) and the Special Program on Learning and Awareness on Species and Habitats (SPLASH).

Source: Shah 2002.

The challenge facing policymakers in this industry and other land-based activities is to critically assess the costs and benefits to ensure that all options are fully weighed and that the policy responses contribute to sustainable development and minimize overexploitation.

6. DESERTIFICATION

Box: Thematic Programme Networks

The UNCCD has also facilitated the establishment of Thematic Programme Networks (TPNs) in the context of the Regional Action Programme (RAP) to combat desertification in Africa. The TPNs are networks of institutions and agencies linked together via an institutional focal point. Regional, sub-regional and national focal institutions will involve all key actors at regional, sub-regional and national in the respective affected countries.

The following are the TPNs:

- Integrated management of international river, lake and hydro-geological basins
- Promotion of agro-forestry and soil conservation
- Rational use of rangelands and promotion of fodder crops development
- Ecological monitoring, natural resources mapping, remote sensing and early warning systems
- Promotion of new and renewable energy sources and technologies
- Promotion of sustainable agricultural farming systems.

UNCCD Secretariat 2004

7. WATER RESOURCES

At the national level, responses regarding increased competition over freshwater resources include revision of water resource development policies and greater involvement of stakeholders in water resource management and water-supply.

Ethiopia's Water Resource Policy (1999) will certainly contribute to improving the low level of clean and safe water-supply. However, there are no appropriate directives and regulatory instruments to enforce the legislation. In 2001, Ethiopia engaged stakeholders to provide input in the development of a sectoral strategic action plan to realize the objectives of the national water policy. The General Water Resource Development Programme (2002-2016) was initiated which addresses water quality management as part of integrated water resource management with the river basin as the planning unit. Under this programme, institutional set-ups are to be strengthened and new ones established for effective water quality management and monitoring, such as laboratories at national and regional levels, River Basin Commissions/Authorities and a National Water Resource Council.

Kenya has made progress with its reforms in the water sector, especially in the water and sanitation sub-sector. Goals for the water sector, as stated in the 2002 Water Act, are enhancement of the provision, conservation, control, apportionment and use of water. The reforms saw the establishment of the Water Resource Management Authority and the first National Water Resource Management Strategy was drafted in 2004 to provide a clear road map for assessing, developing and managing the limited available freshwater resources in an integrated and sustainable manner. Devolution of responsibilities to the lowest appropriate levels is gradually taking place. Kenya is also well on its way to preparing a national IWRM and water efficiency plan.

Uganda's water policy (Water Action Plan 1995, Water Statute 1995) is geared towards privatization and decentralization. The water sector's goal and strategy aim at managing and developing water resources in a sustainable manner enhanced by community participation, capacity-building and a demand-driven approach. The major areas of concern pertaining to water resources management are: poor watershed management; inadequate water accessibility and quantity; poor water quality; inadequate institutional capacity; and international water rights.

Major international programmes for water resource management in the sub-region are the Lake Victoria Environmental Management Programme (LVEMP) and the Nile Equatorial Lakes Subsidiary Action Programme (NELSAP). The LVEMP was established in 1995 by Kenya, Uganda and Tanzania to improve sustainable use of the Basin's natural resources. It primarily focused on fisheries management, pollution control, control of invasive weeds and land use management. A more detailed account of the LVEMP is given in Box below.

Box: Lake Victoria Environmental Management Programme

Lake Victoria is the world's second largest body of freshwater. The Lake and its catchment support 30 million people and fisheries and agriculture are the main economic activities. In 1995, the three riparian countries Kenya, Uganda and Tanzania established the Lake Victoria Environmental Management Programme (LVEMP), a long-term programme which aims at improving the sustainable use of the Basin's natural resources.

Results of the first phase include:

- A water quality model for Lake Victoria for various uses, the establishment of 56 water quality monitoring stations and standardized monitoring procedures
- Reduction in the infestation of water hyacinth by 80% from 1998-2002 and establishment of a Regional Water Hyacinth Surveillance System.

Three major transboundary issues associated with the two upstream countries Rwanda and Burundi were identified during LVEMP-1: influx of water hyacinth, siltation and deforestation. Both countries will therefore be included in the second phase of the project. Some of the other issues to be considered in LVEMP-2 are:

- Establishment of national steering mechanisms
- A focus on investment for high priority environmental issues (e.g. effluent treatment)
- Development of a management information system.

Source: www.lvemp.org; Nyirabu (2002)

Intervention areas for an improved management water resources

- Ensure sustainable access to safe and adequate water and sanitation services
- Secure food production:
  - Potential for irrigation expansion??
  - Consider focusing on small-scale irrigation projects in the short term
- Utilize economically feasible hydropower potential
- Ensure sustainable forest and watershed management (include multidisciplinary and multi-stakeholder approaches linking forest, water, environment and people)
- Conserve water:
  - Invest in development and maintenance of infrastructure in urban and rural
- water-supply
  - Improve agricultural techniques (eg modify cropping patterns and select crops that consume less water)
  - Introduce water demand management measures (eg apply intermediate technologies, new technologies based on traditional systems and involve the community; introduce water pricing)
  - Enhance public awareness
- Control pollution:
  - Invest in domestic and industrial effluent treatment and disposal facilities
    - Introduce economic incentives and disincentives (polluter-pays and user-pays principles)
- Explore and expand alternative technologies (eg water harvesting including artificial recharge and wastewater recycling).
- Implement cost-recovery approaches to provide water services to urban and rural areas (eg water tariffs that take into account the costs of investment, operation, maintenance, system expansion and renewal):
  - Improve collection of water revenues
  - Introduce water meters
- Introduce financing schemes:
  - Trust funds
  - Micro-financing for small-scale projects
  - Encourage (international) commercial lending
- Conduct market research with a focus on the nature and maturity of micro-finance institutions to further strengthen financial services for water-supply
- Encourage private sector and NGO participation in water and sanitation sector
- Enhance the capacity of the public sector in the preparation and implementation of projects and programmes and absorption/handling of increased funding

8. FOREST AND WOODLAND

Forest and woodlands occupy an estimated 650 million hectare or 21.8 per cent of the land area in Africa and the region accounts for 16.8 per cent of the global forest cover (FAO 2002). The distribution of forest and woodlands varies from one sub-region to the other, with Northern Africa having the least cover while Central Africa has the densest cover in the region. The Congo Basin in central Africa is home to the second larges contiguous block of tropical rain forest in the world (FAO 2003).

Forests and woodlands in the region are generally classified under the following categories: tropical rain forests, tropical moist forests, tropical dry forests, tropical shrubs, tropical mountain forest, subtropical humid forests, subtropical dry forests, subtropical mountain forests and plantations (FAO 2003). Of the total area of forests and woodlands, 5 per cent is protected area.

The forest sector plays an important role in economic development of many countries and livelihoods of many communities in Africa, particularly in Western, Central and Eastern Africa. Africa has higher per capita forest at 0.8 hectares compared to 0.6 hectares for the world (FAO 2000).

On average, forests accounts for 6 per cent of GDP in the Africa region, which is the highest in the world (NEPAD 2003). Forests and woodland contribute to the long term social and economic development goals of NEPAD. They are resources for use as energy, food, timber and non-timber products and potential for wealth. The values of forests are at national, sub-regional, regional or even global in scope.
Forests and woodlands are key environmental components, and are critical to the success of the other NEPAD progammes, for combating land degradation, combating climate change, conserving wetlands, coastal and freshwater resources and controlling alien invasive species.

Some of the national values include catchment protection for water quality, hydropower, regulation of river flows, prevention of soil erosion (water and wind), timber products, non-timber forest products

(food, materials, medicinal substances), energy, leisure. Forest and woodlands are the principal sources of woodfuel, which is the most important forest product in many countries in Africa as a source of household energy

In Kenya, the value for catchment protection for forests was KSH 2050 per ha per year, at 1994 exchange rates, and for soil conservation KSh 3050 per ha per year, or Ksh2.01 billion per year in soil conservation benefits (1994 estimates). (Wass 1995). The forest sector in Kenya contributed about 1 per cent and 13 per cent to the monetary and non-monetary economies respectively.

At the sub-regional level, forests and woodlands play an important role in climate modification, catchment protection/ regulation of hydrological networks and biodiversity. At the local (community) level forests and woodlands have multiple uses, which vary extensively with the type of forest, and the community. These range from construction materials, foods, energy, medicines, catchment protection, soil protection, shade, habitat for wildlife and bees, grazing as well as cultural values (sacred groves, shade, peace trees and plants, meeting places, boundaries, training areas). it was estimated that 2.9 million people (530,000 households), lived within 5 km of closed canopy forest in Kenya in 1995, and depended on forests to provide wood and non-wood products. The woodcarving industry, for example, supported over 80,000 people with approximately 400,000 dependants, and was worth UK Stg. 14 million pounds (Waithaka and Mwathe 2003)

(Wood products) production is however characterized by trade in un-processed products, mainly logs and plunks, which considerably undermines the value of the forest products. A huge opportunity therefore exist in investing in value adding processing of wood products particularly in the Democratic Republic of Congo (DRC), Congo Brazzaville, Gabon, and Cameroon, which are currently exporting huge volumes of round wood. A number of countries have already imposed restrictions on log export to encourage domestic processing. Domestic processing however has to be supported by strict quality control if the products are to gain any inroads into the international markets.

As charcoal becomes an important tradable commodity in many countries in the sub-Sharan Africa, there is an opportunity for governments to recognize, regularize and tax charcoal production as well as put in place long-term plans for sustainable production, to mange it more effectively and improve revenue collection. There is on-going research to reduce waste, and develop alternative products from wood-waste like saw-dust as source of energy, in the Eastern and Southern Africa regions, as well as developing more efficient charcoal production methods using improved kilns. These initiatives need to be supported and private sector involvement encouraged as part of the long term sustainable production strategy.

Urban market for wood products is already attracting investment from the private sector and this interest is growing in many countries as wood becomes scarce. There is opportunity for medium and long term investment. Commercial plantations for fuelwood and construction timber is big business in South Africa, Zimbabwe, Ethiopia, Kenya, Zambia and many Sahelian countries like Burkina Faso, Chad and Mali.

The forest sector is also supporting other activities such as ecotourism, crafts industry, medicinal plants and bushmeat trade, which have become very significant in enhancing household incomes. In Uganda, Forests and woodlands have been recognized as an important component of the nation’s economic stock of resources. The gross economic output attributable to forestry, tourism, agriculture and energy sectors in the country, for example, is estimated to be in excess of US$ 546.6 Million a year (Emerton and Muramira 1999). The Support to economic output indirectly as it provides secondary inputs, ecosystem

services and functions that support and maintain human production and consumption is worth at least US$ 200 million a year (UNBSAP, 2002).

Forest and woodlands are also a major source of a variety of non-wood products which are contributing to house hold incomes and, in some cases, international trade. These are gum and resins, medicinal plants, honey and beeswax and bushmeat. Sudan is the biggest producer of gums and resins in the world and the potential for increased production in the country and other neighboring states like Kenya, Chad, Eritrea, Ethiopia and Central Africa Republic is huge.

Table on non-wood forest products

Sub-region	Main NWFP	Selected national statistical data available
East Africa	Exudates, medicinal plants, bee products	*Eritrea:* Export of 49 tonnes of gum arabic (*Acacia senegal*) and 543 tonnes of olibanum (*Boswellia papyrifera*) in 1997
		Ethiopia: Annual honey production of 20 000 tonnes in 1976-1983 and annual production of gum arabic of 375 tonnes in 1988-1994
		Tanzania: Export of 756 tonnes of *Cinchona* sp. bark, worth US$258 000 in 1991
Insular East Africa	Edible plants, medicinal plants, ornamental plants, living animals	*Madagascar*: Export of 300 tonnes of *Prunus africana* bark worth US$1.4 million in 1993
Southern Africa	Edible plants, medicinal plants, bee products, fodder	
		Zambia: Honey production of 90 tonnes and beeswax production of 29 tonnes worth US$170 000 and US$74 000, respectively, in 1992
Central Africa	Edible plants, medicinal plants, bushmeat, rattan	
		Rwanda: Production of 23 000 tonnes of honey in 1998

FAO (2000) Global Forest Resource Assessment 2000: Non-wood forest products.

Plants of high economic value

The coordinated sustainable management of natural resources in the region also includes R&D in, and the harnessing of, high economic value botanical, zoological, and sea-borne products with a view to promote the collective regional development of new higher value-added sectors, in particular in the biosciences and including biotechnology, seafood, and pharmaceuticals. The Indian Ocean Commission (IOC) has been engaged in this direction by supporting likewise initiatives already since the 6th EDF. The IOC undertook a project to identify aromatic and medicinal plants.

This traditional healer to Western-trained medical doctors' situation is prevalent in most Sub-Saharan African countries showing how important traditional medicine is to African health delivery situation (FAO 2000).

As research advances, the role of medicinal plants in the pharmaceutical industries is increasing exponential. The natural stock will not be able to sustain the demand. There is therefore a great

opportunity for investing in the growing of medicinal plants to supply the growing demand, as well as emerging home grown pharmaceutical industries for high value added transformation in conformity with WIPO. In Uganda, a number of farmers are already establishing plantations of *Prunus Africana*, whose bark is important in the manufacture of a cancer drug.

Recognizing the social, cultural, and growing economic importance of medicinal plants in the one hand, and threats to their survival on the other, IUCN and the Swiss Development Cooperation are working with countries in North Africa to promote the conservation of endangered and economically useful medicinal and aromatic plants in the sub-region, as well as promote indigenous knowledge, and equitable participation of people in the management and conservation of these plants (IUCN 2002). An increasing number of people in Southern Africa sub-region are also relying on medicinal plants for their primary health care needs as modern drugs are becoming either unavailable or prohibitively expensive. The increased use of medicinal plants is also due to harsh economic circumstances, high population growth and the prevalence of incurable diseases such as HIV and AIDS.

Given the trend of the price of fossil fuel, there is scope to explore certain plants for the production of bio-fuel.

It is important to study the capacity with the ESA IO region for developing the pharmaceutical industry and ensuring that the region maximises benefits.

More R & D needed on use of forests

Africa's forests play a very important role in carbon sequestration and a number of countries with significant forest cover can benefit from carbon trading. A number of corporate institutions from foreign countries are already benefiting from carbon trading by investing in tree planting in some parts of Africa. There is a potential for indigenous companies to also benefit from this activity.

Unfortunately, Africa has not been able to take advantage of its wealth of raw materials and traditional knowledge and invest in processing, undermining opportunities for employment and income generation (FAO 2003). With the increasing private sector involvement, particularly foreign based companies, there is a good opportunity for governments to foster viable partnerships with the communities and civil societies in the protection of traditional rights of forest adjacent communities, and equitable sharing of benefits from forest resources to promote livelihood security and ensure sustainable use of the resources.

As forests and woodlands continue to play a key role in sustaining livelihoods and generating household incomes the nice for strengthening local institutions for forest management and developing information, through research, on multiple uses of forests, and new products of potential commercial value has potential investment opportunities for the scientific community and the private sector.

Shortage of forest professional and technical staff and managers

Almost in all countries in Africa, Forestry Departments are experiencing acute shortage of manpower and equipments. Forestry education has declined in the past two decades. National governments never invested much in it and now donors have practically abandoned it (Temu, A., Rudebjer, P., Kiyiapi, J. and Lierop, P. van. 2005). Political instability and budget problems force many institutions to close for long periods. Students that manage to graduate are poorly equipped to meet the needs of governments, communities, or the private sector. Many end up unemployed.

A report by FAO and IUCN shows a worrying situation in Central Africa, which has the richest forests in the region. The Democratic Republic of Congo has only one hundred professional foresters to manage forests covering an area three times the size of France. Congo-Brazzaville's faculty of forestry was ransacked in 1997/98 and only re-opened three years ago. The Central African Republic's faculty was also pillaged (FAO, RIFFEAC and UICN. 2003).

WIO forests and woodlands

In some of the Small Islands Developing States (SIDS) forests and woodlans are being subjected to severe stress as a result of agricultural encroachment. Comoros has only 4 per cent forest remaining as most of the lowland forest has been cleared for agriculture and charcoal making. The largest remaining block of forest is on the slopes of Mount Karthala on Grande Comoro. On Anjouan there are two remaining forest tracts of approximately 10 km^2. This provides the only remaining habitat for the surviving population of the Anjouan scops owl (*Otus capnodes*) as well as the major habitat for the Livingstone's fruit bat (*Pteropus livingstonii*) (WWF 2004). Protection of the remaining forests such as those on Mount Karthala, Mount Ntringui on Anjouan and Mount Koukoule on Moheli, is therefore a priority for the conservation of endemic species on the island.

Bush fires are a particular threat to the woodlands, causing enormous destruction to both flora and fauna. In Eastern and Southern Africa, it is responsible for the widespread occurrence of grasslands. Observations from Mbeya, Tanzania, indicate that burning encourages growth of grass and prevents regeneration of woody plants (Chenje 2000). Total fire exclusion, can, however, impoverish forest biodiversity because there may be no external forces to check species that grow vigorously and multiply, choking others out. On Mount Mulanje in Malawi, *Widdringtonia nodiflora (*Mulanje cedar) succumbs to intense fire, and yet without infrequent "cool" fires, it is not able to establish itself and compete with other vegetation. In such cases, fire is used as a woodland management tool (Chenje 2000).

Three countries, namely Sudan, Zambia and the Democratic Republic of Congo, all in the ESA IO region, accounted for almost 44 per cent of Africa's deforestation (FAO 2002). The deforestation is particularly rampant outside protected areas on communal land where regulatory and enforcement frameworks are inadequate due to the general breakdown in traditional community arrangements in most parts of Africa.

On a local level: In Kenya, there has been an influx of squatters and settlers in some forests, whereas other communities have suffered from loss of security, loss of access to goods they relied on in the forest, and traditional medicines. In the Mt. Kenya area, farmers at the base of the mountain are complaining that their streams have dried up, resulting in severe hardship for them in acquiring drinking water for themselves and for livestock, or if they are using irrigation methods for cropping..

When forests in catchment areas are destroyed, water quality, quantity and stability can suffer. The loss of water quality will increase the incidence of waterborne diseases (*ECs will provide examples to illustrate the health impacts).* Reduction of water supply can have serious impacts, especially in cities. Flooding, apart from loss of life and property can increase the likelihood of diseases such as rift valley fevers, and malaria. In addition, many communities rely on medicinal plants for health treatments, and food products for a varied diet.

In Central Africa, there is evidence of a connection between logging, bushmeat and ebola, and also the loss of protein from loss of forest animals. There might be similar problems in other sub-regions. If, for example, there is movement of refugees from war torn areas in Central Africa into Rwanda, Burundi

and Uganda**,** these groups might bring in different eating habits, and a similar process could start in Eastern Africa.

The NEPAD Environment Initiative locates forests and woodlands in Programme Area 6 "Transboundary conservation or management of natural resources" which emphasizes the protection and sustainable management of Africa's forest resources through:

- Strengthening national plans and programmes for forest management, inventory and monitoring. This includes the participation of stakeholders such as communities and the private sector, new approaches and initiatives, and the promotion of the wide range of roles and values played by all forest areas. Also included here are measures to improve and integrate mapping and knowledge (scientific as well as traditional knowledge, and strengthen monitoring and assessment).
- Maintenance of protected areas (by improving capacities, forming partnerships with other countries, and the restoration of landscapes, etc.).
- Strengthen forest law and governance, by encouraging sharing of information on trade in illegally harvested forest products, participation in international fora and international agreements, and implementation of measures to cut corruption.

It is also recognized that although situated in Programme area 6, forests and woodlands are key environmental components, and will be critical to the success of the other NEPAD progammes such as combating land degradation, combating climate change, conserving wetlands, coastal and freshwater resources and controlling alien invasive species. Special attention therefore needs to be directed at enhancing the quality of forest resources both at sub-regional and national levels and maximizing the benefits that can be derived from forests and woodlands.

While forests are valued for their timber, fruits and medicinal values, the opportunity presented by agroforestry to communities in the region is still very little known. Options such as fertilizer trees, the domestication of indigenous fruit trees, medicinal trees, live fences and woodlots for timber and fuel are technologies that can be readily adopted through the adoption of agro-forestry. Importantly is the fact that agro-forestry technologies are cheap.

Opportunities for regional cooperation do exist to harmonize exploitation of these resources. The strengthening of the East African community is a good opportunity for the countries of Uganda, Kenya, Tanzania and Burundi to share experiences and lessons on effective resource management.

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Need to strengthen professional development and deployment programmes

Man power capacity development in terms of professional training has not been consistent with the region's needs. Over the last decade from 1993 to 2002, the number of forestry bachelor's handed out by most forestry institutions has been increasing steadily. However, the number of post graduate degrees has declined significantly. Meanwhile, it has become much harder for students to get visas and scholarships to go for post graduate education abroad. Certificate-level forestry training has practically disappeared. The continent is generally not training the foresters it needs. Unless it begins to do so, the downward spiral of declining funding and results will accelerate (FAO, RIFFEAC and UICN. 2003). The international community should not leave African governments to wrestle with this problem alone. Donors need to provide greater support to African institutions and bring more students to study in their own countries, considering the global value of Africa's forests.

At present, taking into account the deforestation rates averaging about 2 per cent per year for the five countries, Forests and woodlands cover about 9 per cent of the sub region; which comprises the countries of Uganda, Kenya, Ethiopia, Eritrea and Burundi. This percentage is not equally distributed among the countries, and range; for example, from 24 per cent of the total land area in Uganda to 5 per cent in Burundi. At the current levels, and basing on the availability as reported in AEO1, if management does not improve, forests and woodlands will be depleted by 2015. In some countries of the sub region, such as Eritrea, forests are not in protected areas and this makes them more vulnerable to degradation.

Forests and woodlands are economic stock of resources. The gross economic output attributable to forestry, tourism, agriculture and energy sectors, for example in Uganda, is estimated to be in excess of US$ 546.6 Million a year (Emerton and Muramira 1999). The Support to economic output indirectly as it provides secondary inputs, ecosystem services and functions that support and maintain human production and consumption is worth at least US$ 200 million a year (UNBSAP, 2002). The market value of wood products was in 1997 estimated to be US$ 115.3 Million of which some 80 per cent or US$ 92 Million may be accounted for by indigenous forest resources.

Forests and woodlands resources offer an opportunity of savings to countries for monies that would otherwise have been spent. Opportunities for regional cooperation do exist to harmonise exploitation of these resources. The strengthening of the East African community is a good opportunity for the countries of Uganda, Kenya, Tanzania and Burundi to share experiences and lessons on effective resource management Afforestation is an opportunity for investment. Opportunities do exist in the region at various levels; policy, institutional, and ecosystem level management.

Forests resources mismanagement and incomplete or lack of inventory and monitoring, are a hindrance to effective use of the opportunities offered by forests and woodlands. Poor Governance (community involvement, decentralization) and valuation of natural resources (goods and services) may lead to unsustainable exploitation of forest resources. Alien invasive species are also a threat to the sub region's forests and woodlands.

Forests and woodlands are a vital resource for the sub-region and their effective utilization is important and should be based on the principle of equitable sharing of benefits, costs and knowledge.

International, regional and national co-operation including sharing of information and appropriate technology is crucial.

As a general recommendation for policy reform, countries need to initiate a multi - sectoral and participatory policy reform programme to facilitate policy harmonization and consolidation as well as integration of ecosystem management issues in all sectors.

Forest and woodland cover in selected ESA countries: Year 2000

Country	**Total land area (000ha)**	**Forest cover in 2000 (000 ha)**	**% of land area**	***Total forest Plantation (000 ha)**
Angola	124 670	69 756	55.9	141
Malawi	9 408	2 562	27.2	112
Mozambique	79 409	30 601	38.5	50
Swaziland	1 720	522	30.3	161
Tanzania	88 604	38 811	43.8	135
Zambia	74 339	31 246	42.0	75
Zimbabwe	38 667	19 040	49.2	141

Non-timber forest products provide a wide range of goods for subsistence and trade. The products include medicinal plants, fruits, exudates, bee products, insects, roots, thatch grass, forage and mushrooms. Since these products are largely traded on the informal market, very limited and reliable statistics exist on their production, consumption and trade. However, there is a growing international trade in medicinal plants and indigenous fruits.

An increasing number of people in the region are relying on medicinal plants for their primary health care needs as modern drugs are becoming either unavailable or prohibitively expensive. In 2003, annual trade in medicinal plants in South Africa was estimated at about US$60 million, while in Zambia annual exports were valued at about US4.4 million (FAO 2003).

Indigenous fruits are of great importance in the diets of both rural and urban people. Their role in the cash economy is also growing. Such fruits assume greater significance in drought years when agricultural performance is poor. However, the unprocessed fruit generates little income to the gathering communities. This is giving rise to a drive to process and market indigenous fruits, particularly in Malawi, Mozambique, Tanzania, Zambia and Zimbabwe. A number of value added products from indigenous fruits are now being commercially produced at the local level (through cottage industries), and joint venture partnerships between local communities and private companies. According to Gondo (Gondo 2004), some commercially viable ventures have been developed in Zimbabwe to process baobab oil, marula juice and herbal tea (from *Fadogia ancylantha*).

Forest and wood lands in the IO region

Although the humid tropical climate in most parts of the Western Indian Ocean Islands is conducive for forest growth, the extent of closed canopy forest on islands is limited due to population pressure, frequent cyclones and recurrent droughts on some islands like Madagascar and Mauritius (UNEP 2002). The major types of forests and woodlands found on the islands include evergreen broadleaf rainforests, upper and lower mountain forests, semi-evergreen moist forests, mangroves and savanna woodlands.

Inventory of forest and woodland resources

The forest cover on the islands ranges from 20 per cent in Madagascar, with 12 per cent woodland, to about 4 percent in the Comoros, with 13 per cent woodland (UNEP 2002). In the Comoros, only 4 per cent of forest is remaining as most of the lowland forest has been cleared for agriculture. Charcoal making has been blamed for extensive deforestation in the country (UNEP, 2004) for which reason the largest remaining extent of forest is on the slopes of Mount Karthala on Grande Comoros. Only about 4 per cent of forest remains in the Comoros since most of the lowland forest has been cleared for agriculture. Between 1990 and 2000, there was a steady decline in deforestation rate to less than 1 per cent per year for most of the island states. However, Comoros is an exception with deforestation rates exceeding 4 per cent per year. Logging, deforestation, and conversion of forests to agricultural or other forms of land use and the making of charcoal have reduced the original forest cover and quality (UNEP 2002).

Opportunities provided by Forests and Woodlands

Forest and woodlands on the islands have a high animal and plant species endemism, making some of them among the most important biodiversity hotspots in the world. In the Seychelles, the Coco-de-Mer palm (*Lodoicea maldivica*) is found on Praslin Island and is endemic to this environment whereas some of the larger islands have dry palm forests unique to the country. On Anjouan island in the Comoros, there are two remaining forest tracts of approximately 10 km^2 which provides the only remaining habitat for the surviving population of the Anjouan scops owl (Otus capnodes) as well as the major habitat for the Livingstone's fruit bat (*Pteropus livingstonii*) (UNEP 2004).

Medicinal and ornamental plants, fruits, honey, essential oils, meat, and animal fodder form the significant non-wood forest products in the island states accessed from the forests. Fuel wood is a vital resource for local communities, especially in countries such as the Comoros.

Threats to the Opportunities

The frequent occurrence of cyclones and droughts in the island states is a threat to the forest resources as they can cause extensive damage to forest cover. During droughts, the risk of fire is also high which can wipe out large areas of forest. The major concern regarding forests in the island states though is the high rate of deforestation and its environmental consequences such as soil erosion, desertification, and loss of ecosystem processes such as regulation of soil and water quality.

Strategies to enhance benefits from Forests and woodland resources

In reacting to the pressures that being exerted over natural resources on the island, governments in these countries have given emphasis to measures that promote the integrated management of forests and woodlands. This includes the establishment of Conservation Management Areas in Mauritius which are zones that have lately been infested with alien plant species. In pursuance of the desire to implement sustainable management of forests and forest resources, two countries, Mauritius and the Seychelles have also joined the Dry Zone Africa process which aims at establishing criteria and indicators for sustainable forest management.

Further to these programmes, some countries such as in the Comoros, have attempted to reforest those areas which were previously logged bare even though the speed and extent of these measures has been slow and small. While only 500 ha of land were reforested in the Comoros in the 1990s the trees were being harvested even before they reached maturity. Since information arising from research, mapping and biological inventories carried out by several organisations in the island developing states is available (UNEP 2004), an insight into the development of protected areas should be possible. The Food and Agriculture Organisation through its FAO Plan of Action (FAO 2004) intends to achieve sustainable management of the forest resources in the island developing states by:

- Establishing a holistic and integrated approach to the use of forest resources;
- Promoting the rehabilitation and conservation of forest lands;
- Enhancing coastal protection;
- Promoting agro-forestry systems;
- Strengthening integrated planning; and
- Developing ecotourism.

Future challenges and recommendations

The high endemism of biological resources in the islands forests and woodlands and their uniqueness among other species, is a crucial asset to these countries. However, the threat of extinction of some of the species due to the loss of forest cover demands that strong policies be put in place and the necessary resources needed to enforce the policy are provided. Conservation and sustainable use and management of island biodiversity is necessary as the basis for promotion, development and growth of other sectors. In this regard, it is important that the island developing states have ratified the Convention on Biological Diversity and initiated national biodiversity strategic action plans and developed national nature reserves and protected areas. The accomplishments of set targets on Biological Diversity are of particular importance to the island and require that the following actions are taken (UNEP 2005):

- Integrating biodiversity protection into national sustainable development strategies;
- Building effective partnerships between all relevant stakeholders for the conservation and sustainable use of forest biological resources;
- Addressing island biodiversity along the threats related to climate change, land degradation and their particular vulnerabilities;
- Implementing the Convention on Biodiversity's guidelines on biodiversity and tourism development;
- Strengthening national efforts in implementing the programme of work on protected areas as provided for by the Convention.
- Controlling major pathways for potential alien invasive species;
- Supporting and encouraging local capacities for protecting and developing traditional knowledge of indigenous groups for the fair and equitable sharing of the benefits arising from the use of genetic resources;
- Developing human and institutional capacity for research in biodiversity, including forest inventory and taxonomy at the national and regional levels;
- Supporting, through the Convention and its Cartagena Protocol, the development and implementation of national bio-safety frameworks; and
- Strengthening national efforts in building local capacity to conserve important species, sites and habitats.

The accomplishment of these activities will certainly need resources and therefore it is important that the necessary support in the form of financial, technological, human and other resources are extended to the island developing states by the international community.

ANNEXE

ESA countries, natural resources for development and environmental issues

The table below provides an overview of the rich variety of natural resources in the ESA countries and the potential for further development. ESA countries principal industries, agricultural products, natural resources, percent GDP from agriculture, current account balance and principal exports.

ESA Countries	Principal industries[3]	Principal agricultural products	Natural resources	GDP from Agriculture %	Current account balance % GDP	Current environmental issues	Principal exports and imports
Burundi	Light consumer goods such as blankets, shoes, soap; assembly of imported components; public works construction; food processing	Coffee, cotton, tea, corn, sorghum, sweet potatoes, bananas, manioc (tapioca); beef, milk, hides	Nickel, uranium, rare earth oxides, peat, cobalt, copper, platinum (not yet exploited), vanadium, arable land, hydropower	40	0	Soil erosion as a result of overgrazing and the expansion of agriculture into marginal lands; deforestation (little forested land remains because of uncontrolled cutting of trees for fuel); habitat loss threatens wildlife populations	**Exports:** Coffee, tea, sugar, cotton, hides ***Imports*** Capital goods, petroleum products, foodstuffs
Comoros	Tourism, perfume distillation, textiles, furniture, jewellery, construction materials, soft drinks	Vanilla, cloves, perfume essences, copra, coconuts, bananas and other fruit, cassava (tapioca)		41	-1	Severe deforestation, biodiversity loss, coastal degradation, inadequate waste management, high impact natural disasters (cyclones, flooding, sea surges, volcanoes/ earthquakes	**Exports Imports**
Dem. Rep. Congo	Mining, mineral processing, consumer products (including textiles, footwear, cigarettes, processed foods and beverages), cement, diamonds	Coffee, sugar, palm oil, rubber, tea, quinine, cassava (tapioca), palm oil, bananas, root crops, corn, fruits; wood products	Cobalt, copper, cadmium, petroleum, industrial and gem diamonds, gold, silver, zinc, manganese, tin, germanium, uranium, radium, bauxite, iron ore, coal, hydropower, timber	59	-1	Poaching threatens wildlife populations; water pollution; deforestation; refugees who arrived in mid-1994 were responsible for significant deforestation, soil erosion, and wildlife poaching in the eastern part of the country	**Exports** Diamonds, copper, coffee, cobalt, crude oil **Imports** Foodstuffs, mining and other machinery, transport equipment, fuels
	Limited to a few small-scale enterprises,	Fruits, vegetables; goats, sheep, camels	Geothermal areas	3	-	Inadequate supplies of potable water; desertification	**Exports** Re-exports, hides and skins, coffee

[3] Mapquest.com download 2005; World Bank (2005) downloaded Country Briefs, and Country at a Glance Tables; IOC (2005) Documentation for African Environmental Outlook II, UNEP forthcoming.

ESA Countries	Principal industries[3]	Principal agricultural products	Natural resources	GDP from Agriculture %	Current account balance % GDP	Current environmental issues	Principal exports and imports
Djibouti	such as dairy products and mineral-water bottling						(in transit) **Imports** Foods, beverages, transport equipment, chemicals, petroleum products
Eritrea	Food processing, beverages, clothing and textiles	Sorghum, lentils, vegetables, corn, cotton, tobacco, coffee, sisal; livestock, goats; fish	Gold, potash, zinc, copper, salt, possibly oil and natural gas, fish	14	-13	Deforestation; desertification; soil erosion; overgrazing; loss of infrastructure from civil warfare	**Exports** Livestock, sorghum, textiles, food, small manufactures **Imports** Processed goods, machinery, petroleum products
Ethiopia	Food processing, beverages, textiles, chemicals, metals processing, cement	Cereals, pulses, coffee, oilseed, sugarcane, potatoes; hides, cattle, sheep, goats	Small reserves of gold, platinum, copper, potash, natural gas, hydropower	42	-5	Deforestation; overgrazing; soil erosion; desertification	**Exports** Coffee, gold, leather products, oilseeds **Imports** Food and live animals, petroleum and petroleum products, chemicals, machinery, motor vehicles
Kenya	Small-scale consumer goods (plastic, furniture, batteries, textiles, soap, cigarettes, flour), agricultural products processing; oil refining, cement; tourism	Coffee, tea, corn, wheat, sugarcane, fruit, vegetables; dairy products, beef, pork, poultry, eggs	Gold, limestone, soda ash, salt barites, rubies, fluorspar, garnets, wildlife, hydropower	16	0	Water pollution from urban and industrial wastes; degradation of water quality from increased use of pesticides and fertilizers; deforestation; soil erosion; desertification; poaching	**Exports** Tea, coffee, horticultural products, petroleum products **Imports** Machinery and transportation equipment, petroleum products, iron and steel
Madagascar	Meat processing, soap, breweries, tanneries, sugar, textiles, glassware,	Coffee, vanilla, sugarcane, cloves, cocoa, rice, cassava (tapioca), beans, bananas, apples, peaches, nectarines, mangoes, oranges,	Graphite, chromate, coal, bauxite, salt, quartz, tar sands, semiprecious stones, mica, fish,	29	-6	Drought, deforestation, high impact natural disasters (cyclones, flooding and famine), under- developed irrigation, illegal logging, degraded	**Exports** Timber and other wood products, fruit, coffee, vanilla, manufactures **Imports**

ESA Countries	Principal industries[3]	Principal agricultural products	Natural resources	GDP from Agriculture %	Current account balance % GDP	Current environmental issues	Principal exports and imports
	cement, automobile assembly plant, paper, paper board petroleum, tourism	coconuts, peanuts; livestock products	hydropower			coastline from land based pollution.	Food, fuel, energy, capital goods
Malawi	Tobacco, tea, sugar, sawmill products, cement, consumer goods	Tobacco, sugarcane, cotton, tea, corn, potatoes, cassava (tapioca), sorghum, pulses; cattle, goats	Limestone, arable land, hydropower, unexploited deposits of uranium, coal, and bauxite	38	-17	Deforestation; land degradation; water pollution from agricultural runoff, sewage, industrial wastes; siltation of spawning grounds endangers fish populations	**Exports** Tobacco, tea, sugar, cotton, coffee, peanuts, wood products **Imports** food, petroleum products, semimanufactures, consumer goods, transportation equipment
Mauritius	Food processing (fish canning and sugar milling), textiles, clothing; chemicals, metal products, transport equipment, non-electrical machinery; brewing, tourism.	Sugarcane, tea, corn, potatoes, bananas, coconuts, pulses; cattle, goats; fish, poultry, other fruit (mangoes, litchis, papayas, pineapples, oranges, lemons) and other market gardening products.	Arable land, fish, sandy beaches	6	3	Deforestation, land degradation, unsightly urbanisation, traffic congestion and pollution, coastal and marine pollution, loss of biodiversity; loss of wetlands, sea-grasses, mangroves; water scarcity, cyclone risks, loss of non-use aesthetic value of natural scenery.	**Exports** Sugar, textiles, clothing, financial services **Imports** Food, fuel, energy, capital goods, vehicles
Rwanda	Cement, agricultural products, small-scale beverages, soap, furniture, shoes, plastic goods, textiles, cigarettes	Coffee, tea, pyrethrum (insecticide made from chrysanthemums), bananas, beans, sorghum, potatoes; livestock	Gold, cassiterite (tin ore), wolframite (tungsten ore), methane, hydropower, arable land	44	-4		**Exports** Coffee, tea, hides, tin ore **Imports** Foodstuffs, machinery and equipment, steel, petroleum products, cement and construction material
Seychelles	Fishing; tourism; processing of coconuts and vanilla, coir	Coconuts, cinnamon, vanilla, sweet potatoes, cassava (tapioca),	Fish, copra, cinnamon trees, sandy beaches and outer islands	3	-5	Coastal degradation from Tsunami damage 2004, coral bleaching from El Nino 1998, torrential	**Exports** Canned fish, coir products, shark fins,

ESA Countries	Principal industries[3]	Principal agricultural products	Natural resources	GDP from Agriculture %	Current account balance % GDP	Current environmental issues	Principal exports and imports
	(coconut fibre) rope, boat building, printing, furniture; beverages	bananas; broiler chickens; tuna fish	and forest areas for tourism.			rain and flooding, loss of biodiversity from alien species, land reclamation, fires urbanisation and traffic congestion.	manufactured goods **Imports** Food, fuel, energy, capital goods
Somalia	Airlines, Telecommunications, tourism, fisheries	Livestock, fish	Uranium, iron, ore, tin, gypsum, bauxite, copper, salt			Famine, deforestation, overgrazing, soil, erosion, desertification	Livestock, fruits, hides, fish
Sudan	Cotton ginning, textiles, cement, edible oils, sugar, soap distilling, shoes, petroleum refining.	Cotton, groundnuts (peanuts), sorghum, millet, wheat, gum arabic, sesame; sheep.	Petroleum; small reserves of iron ore, copper, chromium ore, zinc, tungsten, mica, silver, gold, hydropower.	8	-6	Inadequate supplies of potable water; wildlife populations threatened by excessive hunting; soil erosion; desertification.	**Exports** Cotton, sesame, livestock, groundnuts, oil, gum arabic **Imports** Foodstuffs, petroleum products, manufactured goods, machinery and transport equipment, medicines and chemicals, textiles.
Swaziland	Asbestos, coal, soft drinks	Sugar cane, citrus fruits, wood pulp	Asbestos, coal, clay, hydropower, forests, gold, diamonds, quarry stones	12.6	-2.3	Water scarcity, depletion of bio diversity, over hunting, overgrazing, soil degradation and erosion	Soft drinks, cotton, wood pulp, sugar
Tanzania	Tourism, sugar cane products, beer, tobacco, sisal, gold, diamond mining, oil refining, shoes, textiles, wood products, fertilizer, salt	Coffee, sisal, tea, cotton, pyrethrum (from chrysamthemums), fruits, vegetables, cattle, sheep, goats	Gold, hydropower, tin, phosphates, iron ore, coal, diamonds, gem stones, natural gas, nickel	45		Lake Victoria environmental management, water and sanitation provision, soil degradation and desertification, loss of oral reefs	Coffee, cotton manufactures, cashew nuts, tobacco, cisal
Uganda	Sugar, brewing, tobacco, cotton textiles, cement	Coffee, tea, cotton, tobacco, cassava (tapioca), potatoes, corn, millet, pulses; beef, goat meat, milk, poultry	Copper, cobalt, hydropower, limestone, salt, arable land	32	-14	Draining of wetlands for agricultural use; deforestation; overgrazing; soil erosion; poaching is widespread	**Exports** Coffee, cotton, fish and fish products, tea; electrical products, iron and steel **Imports** Vehicles, petroleum, medical

ESA Countries	Principal industries[3]	Principal agricultural products	Natural resources	GDP from Agriculture %	Current account balance % GDP	Current environmental issues	Principal exports and imports
							supplies; cereals
Zambia	Copper mining and processing, construction, foodstuffs, beverages, chemicals, textiles, fertilizer	Corn, sorghum, rice, peanuts, sunflower seed, tobacco, cotton, sugarcane, cassava (tapioca); cattle, goats, pigs, poultry, beef, pork, poultry, milk, eggs, hides; coffee	Copper, cobalt, zinc, lead, coal, emeralds, gold, silver, uranium, hydropower	19	-15	Air pollution and resulting acid rain in the mineral extraction and refining region; poaching seriously threatens rhinoceros and elephant populations; deforestation; soil erosion; desertification; drought, lack of adequate water treatment presents human health risks	**Exports** Copper, cobalt, electricity, tobacco, manufactures. **Imports** Machinery, transportation equipment, foodstuffs, fuels, petroleum products, electricity, fertilizer.
Zimbabwe	Mining (coal, gold, copper, nickel, tin, clay, numerous metallic and non-metallic ores, steel, wood, cement, chemicals, fertilizer, clothing and footwear, foodstuffs, beverages.	Corn, cotton, tobacco, wheat, coffee, sugarcane, peanuts; cattle, sheep, goats, pigs	Coal, chromium ore, asbestos, gold, nickel, copper, iron ore, vanadium, lithium, tin, platinum group metals	17	-20	Deforestation; soil erosion; land degradation; air and water pollution; the black rhinoceros herd - once the largest concentration of the species in the world - has been significantly reduced by poaching	**Exports** tobacco, gold, ferroalloys , cotton. manufactures **Imports** Food, fuel, energy, machinery and transport equipment, other manufactures , chemicals.

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2.5.2 The IGAD Environment Outlook Report

(Quick Summary)

The IGAD Environment Outlook (IEO) highlights the potential of the region's natural resource base to support the development agenda of NEPAD, sustain human development, serve as a monitoring and evaluation tool for the implementation of the programmes and activities contained in the Action Plan of the Environment Initiative of NEPAD as well as the various targets of the Millennium Development Goals (MDGs). It has the following four sections:

Section 1: Environment for development

The founding fathers of IGAD were motivated by a vision where the people of this sub- region would have developed a regional identity and would be living in peace and a clean environment having alleviated poverty through appropriate and effective economic, food security and environmental programmes. By linking the various local, national and sub-regional aspirations for sustainable development, the strategy focus of IGAD clearly articulates this philosophy. This is also the key message emanating from this section of the IGAD Environment Outlook:

"People and livelihoods are at the centre of concern for sustainable development. Human beings are entitled to a healthy and productive life in harmony with nature".

Section one provides the setting for the entire report. It consists of chapter 1 and is divided into two parts. The first part starts with an overview of the state of human development in the IGAD region by focusing on the large population as a resource for development. It goes on to highlight the concept and range of livelihoods in the region. The different livelihood options range from complete dependence on the resources (subsistence or business) to total dependence on wage earning, trade or industries. The role of culture in colouring the nature of exploitation and the asset value assigned to these natural resources is acknowledged.

A fundamental principle for sustainable development is that of human well being. That is the health, wealth and quality of life of people, is part of, and linked to the diversity, productivity and quality of the ecosystem. However, the diversity, productivity and quality are linked to how the environmental resources are managed. As acknowledged in Agenda 21, the integration of environment and development concerns and greater attention to them will lead to the fulfilment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future.

The second part of the chapter provides an overview of key sustainable development initiatives influencing the environmental agenda in the IGAD sub-region. It analyses how these are operating at the sub-regional, national and local levels and endeavours to show the linkages between the concept of sustainable livelihoods, and the importance of the environmental initiatives in supporting them, highlighting how these opportunities can be utilized to put the countries firmly on the path to sustainable development. The analysis concludes by highlighting the different approaches IGAD is employing to harness the identified environmental opportunities for development.

Section 2: the state of the environment

Following on from the review of the environment and development, attention is now turned to the environment context that underlies policy and forms the background for progress. The sub-region has a wealth of natural resources with the potential to drive economic growth and social development. In this

section (chapters 2-8), an integrated assessment on the state of these resources, based on the opportunities framework, is undertaken. The analysis is presented along seven themes. Each theme has an innate asset value from which opportunities can be identified (see table below) in support of livelihoods for poverty alleviation and economic growth. These opportunities are important to human well-being in terms of food security, health, safe water, clean energy and safe housing. Where data is available, valuation of the resource is indicated to emphasise the need for safeguards against unsustainable exploitation. Each chapter concludes by highlighting some of the strategies that are being pursued to realise the potential.

Asset value and key opportunities by environmental themes

Theme	Asset value	Opportunity
Atmosphere	Potential for new and renewable sources of energy, as a driver for economic development, and modification of ecosystems	Renewable energy resources Rainwater harvesting Potential to support science and technology
Biodiversity	Extensive reserve of biological resources	Ecosystem services Biological products Tourism and ecotourism Trade, bioprospecting and biotechnology
Coastal and marine	Existence of extensive and diverse coastal and marine resources and a long coastline with a large Exclusive Economic Zone	Biodiversity for food security and livelihoods Tourism development Mining and energy potential International maritime industry and coastal development Provision of marine ecosystem services
Forests	Forest and woodland resources for use as energy, food, timber and non-timber products and potential for wealth	Energy provision Timber and non-timber products Provision of ecological services
Freshwater and wetlands	The extensive surface and groundwater resources and the ecosystem services and resources for human use	Water for multiple uses Enhansing sub-regional cooperation Wetlands: A socio-economic and ecological asset
Agricultural land and food security	Land as a factor of production and wealth	Land for agriculture and agricultural expansion Trade, markets and food security Science and technology Unexploited mineral potential Tourism Integrated land use planning IGAD agriculture and environment programme
Human settlements	Existence of shelter with human resources for human welfare and services, space, labour, markets, and infrastructure	Opportunity for planned settlement Social, economic and cultural exchange Centres for easy communication and joint use of infrastructure Urban agriculture Opportunities for reuse and recycling

Source: UNEP 2004

The overall strategy of IGAD is based on the realisation of the close interdependency of the issues of policy, agriculture and environment, and peace and stability for economic growth and development. Chapter 9, therefore, focuses on the interlinkages and interdependencies that have been identified in the

thematic chapters. A discussion of the interlinkages between major environmental challenges and policy implications is done and case studies highlight success stories and lessons to be learned.

Section 3: Emerging and re-emerging issues and their impact on environment, peace and regional integration

Emerging and re-emerging issues may be completely 'new' environmental phenomena or 'old issues' being looked at in a different light. Section 3 will highlight the key emerging and re-emerging issues that may represent new challenges on achieving sustainable environment management, durable peace and regional integration in the IGAD sub-region. It will serve as a monitoring tool, to keep track of environmental problems (or solutions) that can suddenly become important, and bring them to the attention of policy makers. In this context, the five emerging issues currently relevant to this sub-region: include environment for peace and security (chapter 10); invasive alien species and genetically modified organisms (GMOs) (chapter 11); and HIV/AIDS, malaria, tuberculosis and bird flu (chapter 12). These are all issues that could potentially cause disaster and bring untold human suffering, or which if adequately harnessed have the potential to contribute to sustainable development within the sub-region. Understanding the issues surrounding them is therefore the first step in defining appropriate strategies to ensure adequate early warning, response and management plans.

There is growing recognition that peace is a prerequisite for human development and effective environmental management both of which are critical to the attainment of National Sustainable Development Strategies, the MDGs and NEPAD. Principle 25 of the 1992 Rio Declaration asserts that '*Peace, development and environmental protection are interdependent and indivisible*'. In other words, the idea of peace forms an integral part of the idea of sustainable development and vice versa. In 2005, Kofi Annan, UN Secretary General warned that all efforts to promote security, development and human rights and to pursue sustainable development will be in vain if environmental degradation and natural resources depletion continue unabated (UN 2005).

In trying to promote peace and regional integration, it is also meaningful to reflect on current ideas of security which see development, freedom and peace-building as essential elements of a multi-dimensional approach to Africa's problems (CHS 2003). Termed in the literature as human security, it integrates elements captured by the sustainable development concept, at the centre of which is the delicate balance between human security and the environment (CHS 2003). The environment is thus a source of natural resources or assets for the economy and a basis for regional integration. And, as will be seen, many of the primary causes of conflict are closely related to the unsustainable use of natural resources. Examples of current trends which present challenges to the achievement of both peace and sustainability include pressures caused by population growth, access to fresh water and pasture, food security, widespread poverty, increasing social inequality and the mounting numbers of refugees and displaced people. Some of these have been discussed in sections 1 and 2. Section 3 will thus concentrate on other emerging and re-emerging threats to the IGAD sub-region.

The key message being the need to deal with the emerging and re-emerging challenges that have thus far constrained the sub-region's ability to use the existing environmental assets to achieve sustainable peace, development and regional integration. IGAD has committed itself to maintaining a proactive approach towards relevant emerging issues both of regional and international nature and to increasing its involvement in the issues of good governance and human rights in the sub-region and considering their linkages to peace, security and sustainable development (IGAD 2003).

Section 4: A vision for the future

This concluding section of the report gives a vision for the future. It consists of two chapters – chapter 13 dealing with scenarios and chapter 14 with policy recommendations.

The analysis in the previous chapters indicates that the environment in the IGAD sub-region is under threat from a variety of forces. It also shows that there are opportunities that can be seized to create a sustainable environment for our current and future needs.

Scenario analysis offers a means of exploring how the future may play out. It draws on science, history, current conditions and imagination to articulate alternative pathways of development and the environment (Raskin *et.al.* 2002). Chapter 13 will explore a variety of ways in which the environment can be managed, recognising that policy and decision-makers have to walk a balance between trying to create and maintain a sustainable environment, whist at the same time recognising the need to develop the economic and societal resources. It aims to help policy makers test their current assumptions and actions and adjust their course to more positively shape the future. Each alternative presented will have different implications for the social, ecological and economic well-being of the sub-region. This will, in effect, provide a set of policy choices or development pathways that decision makers can select from as showing greatest promise for sustainable development. The time frame is 2005-2025.

The last chapter of this report, Chapter 14 on policy recommendations, considers different means to strengthen implementation and policy in light of the state of the environment and emerging issues highlighted. It captures issues identified in the preceding chapters and specifies possible actions at different levels. By attaching responsibilities and time lines, it presents an implementation plan as a guide for policy makers.

2.5.3 Environmental Performance Index for ESA IO Countries

The Environmental performance Index from Yale and Columbia Universities in the USA Covers six policy categories of environmental performance:

- Environmental health
- Air Quality
- Water resources
- Biodiversity and habitat
- Productive natural resources
- Sustainable Development

The system covers 133 countries and provides a country ranking and an index score 1-100 (100 = high performance) In addition country profile tables are provided and raw data for each country with target values many of which are related to MDGs.

13 of the 19 ESA countries are covered in the EPI system. The countries not included are:

- Comoros
- Djibouti
- Eritrea
- Mauritius
- Seychelles and
- Somalia

Together these missing countries represent 4% of the total ESA population.

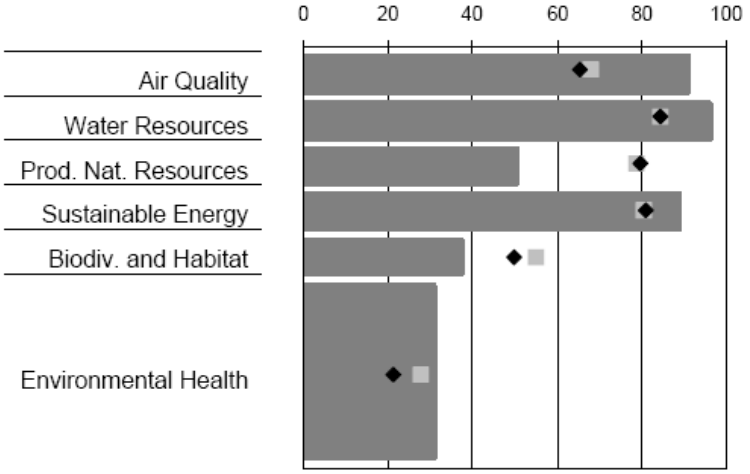
Burundi

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $600

Income Decile 10 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	108
Score:	51.6
Income Group Avg.	46.7
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	90.9	65.6	67.8
Water Resources	96.1	84.6	84.3
Prod. Nat. Resources	50.0	79.5	78.9
Sustainable Energy	88.8	81.1	80.3
Biodiv. and Habitat	37.2	49.8	54.9
Environmental Health	30.6	21.3	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	35.6	*0*	81.7
OZONE	Regional Ozone (ppb)	14.7	*15*	100.0
NLOAD	Nitrogen Loading (mg/L)	410.3	*1*	92.2
OVRSUB	Water Consumption (%)	0.0	*0*	100.0
OVRFSH	Overfishing (scale 1-7)	..	*1*	..
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	87.2	*3*	0.0
PWI	Wilderness Protection (%)	17.9	*90*	19.9
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.6	*1*	58.6
INDOOR	Indoor Air Pollution (%)	100.0	*0*	0.0100.0
WATSUP	Drinking Water (%)	79.0	*100*	62.1
ACSAT	Adequate Sanitation (%)	36.0	*100*	22.2
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	24.1	*0*	6.9
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	1,650.3	*1,650*	100.0
RENPC	Renewable Energy (%)	18.6	*100*	18.6
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	69.7	*0*	93.9

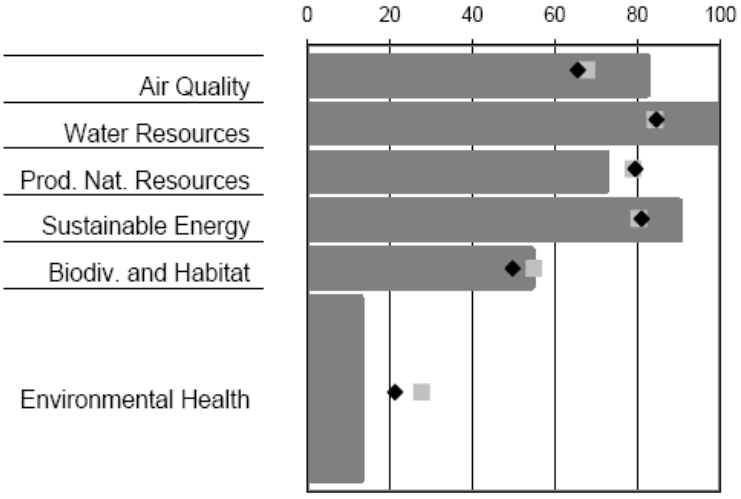
Dem. Rep. Congo

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $700

Income Decile 10 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	119
Score:	46.3
Income Group Avg.	46.7
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	82.3	65.6	67.8
Water Resources	99.7	84.6	84.3
Prod. Nat. Resources	72.2	79.5	78.9
Sustainable Energy	90.1	81.1	80.3
Biodiv. and Habitat	54.3	49.8	54.9
Environmental Health	12.8	21.3	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates ($\mu g/m^3$)	51.0	*0*	70.9
OZONE	Regional Ozone (ppb)	17.7	*15*	93.8
NLOAD	Nitrogen Loading (mg/L)	35.1	*1*	99.4
OVRSUB	Water Consumption (%)	0.0	*0*	100.0
OVRFSH	Overfishing (scale 1-7)	6	*1*	16.7
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	0.4	*3*	100.0
PWI	Wilderness Protection (%)	15.8	*90*	17.5
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.7	*1*	66.0
INDOOR	Indoor Air Pollution (%)	100.0	*0*	0.0100.0
WATSUP	Drinking Water (%)	46.0	*100*	2.5
ACSAT	Adequate Sanitation (%)	29.0	*100*	13.7
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	28.4	*0*	0.0
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	2,139.0	*1,650*	98.0
RENPC	Renewable Energy (%)	76.6	*100*	76.6
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	161.6	*0*	85.9

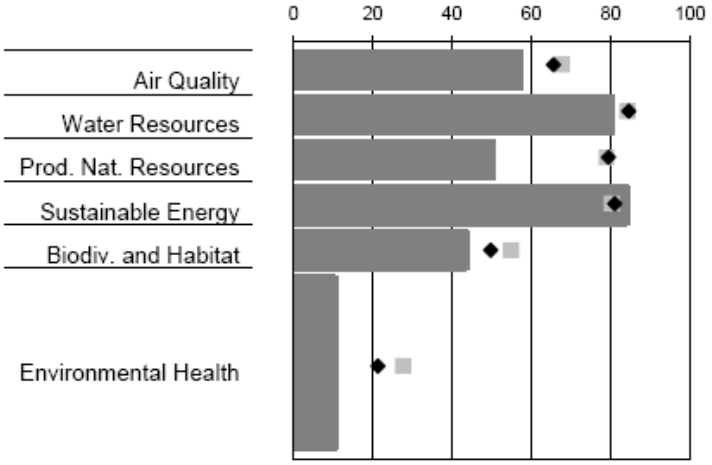
Ethiopia

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $800

Income Decile 10 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	129
Score:	36.7
Income Group Avg.	46.7
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	57.0	65.6	67.8
Water Resources	80.2	84.6	84.3
Prod. Nat. Resources	50.0	79.5	78.9
Sustainable Energy	84.1	81.1	80.3
Biodiv. and Habitat	43.5	49.8	54.9
Environmental Health	10.4	21.3	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	88.0	*0*	44.5
OZONE	Regional Ozone (ppb)	27.9	*15*	69.6
NLOAD	Nitrogen Loading (mg/L)	335.3	*1*	93.7
OVRSUB	Water Consumption (%)	18.2	*0*	66.8
OVRFSH	Overfishing (scale 1-7)	..	*1*	..
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	36.9	*3*	0.0
PWI	Wilderness Protection (%)	13.4	*90*	14.9
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.9	*1*	85.8
INDOOR	Indoor Air Pollution (%)	97.0	*0*	3.097.0
WATSUP	Drinking Water (%)	22.0	*100*	0.0
ACSAT	Adequate Sanitation (%)	6.0	*100*	0.0
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	21.2	*0*	18.3
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	1,587.7	*1,650*	100.0
RENPC	Renewable Energy (%)	26.8	*100*	26.8
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	204.4	*0*	82.1

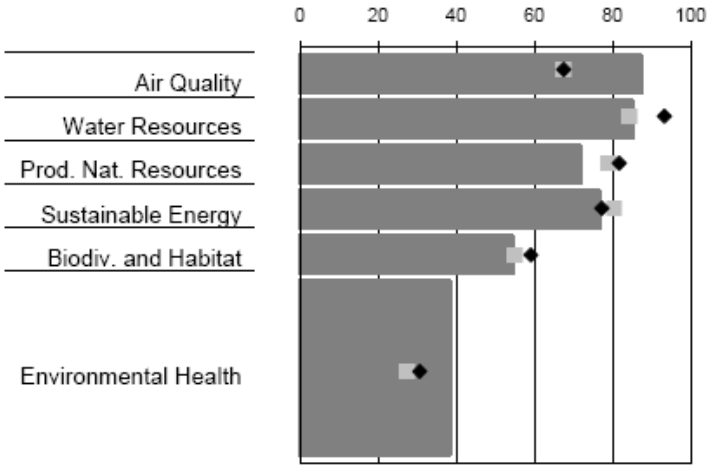
Kenya

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $1,100

Income Decile 9 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	93
Score:	56.4
Income Group Avg.	53.2
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	87.0	67.6	67.8
Water Resources	84.8	93.5	84.3
Prod. Nat. Resources	71.4	81.6	78.9
Sustainable Energy	76.5	77.5	80.3
Biodiv. and Habitat	54.1	59.2	54.9
Environmental Health	38.0	30.5	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	44.0	*0*	75.8
OZONE	Regional Ozone (ppb)	15.8	*15*	98.2
NLOAD	Nitrogen Loading (mg/L)	269.4	*1*	94.9
OVRSUB	Water Consumption (%)	13.9	*0*	74.7
OVRFSH	Overfishing (scale 1-7)	6	*1*	16.7
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	3.7	*3*	97.4
PWI	Wilderness Protection (%)	16.6	*90*	18.5
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.7	*1*	69.9
INDOOR	Indoor Air Pollution (%)	85.0	*0*	15.085.0
WATSUP	Drinking Water (%)	62.0	*100*	31.4
ACSAT	Adequate Sanitation (%)	48.0	*100*	36.8
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	13.9	*0*	46.5
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	4,641.7	*1,650*	87.5
RENPC	Renewable Energy (%)	26.2	*100*	26.2
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	258.3	*0*	77.4

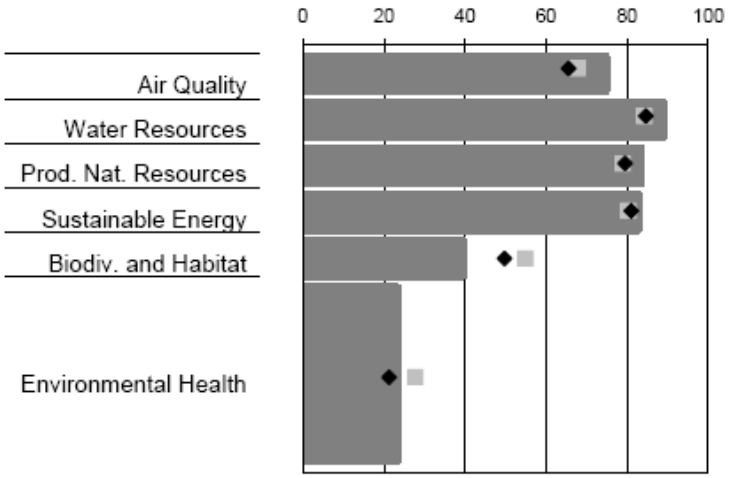
Madagascar

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $800

Income Decile 10 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	116
Score:	48.5
Income Group Avg.	46.7
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	74.7	65.6	67.8
Water Resources	88.8	84.6	84.3
Prod. Nat. Resources	83.3	79.5	78.9
Sustainable Energy	82.7	81.1	80.3
Biodiv. and Habitat	39.5	49.8	54.9
Environmental Health	23.3	21.3	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	46.7	*0*	73.9
OZONE	Regional Ozone (ppb)	25.4	*15*	75.5
NLOAD	Nitrogen Loading (mg/L)	31.3	*1*	99.4
OVRSUB	Water Consumption (%)	11.9	*0*	78.3
OVRFSH	Overfishing (scale 1-7)	4	*1*	50.0
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	0.8	*3*	100.0
PWI	Wilderness Protection (%)	4.7	*90*	5.2
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.4	*1*	43.9
INDOOR	Indoor Air Pollution (%)	99.0	*0*	1.099.0
WATSUP	Drinking Water (%)	45.0	*100*	0.7
ACSAT	Adequate Sanitation (%)	33.0	*100*	18.5
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	14.8	*0*	43.0
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	2,712.8	*1,650*	95.6
RENPC	Renewable Energy (%)	15.1	*100*	15.1
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	162.3	*0*	85.8

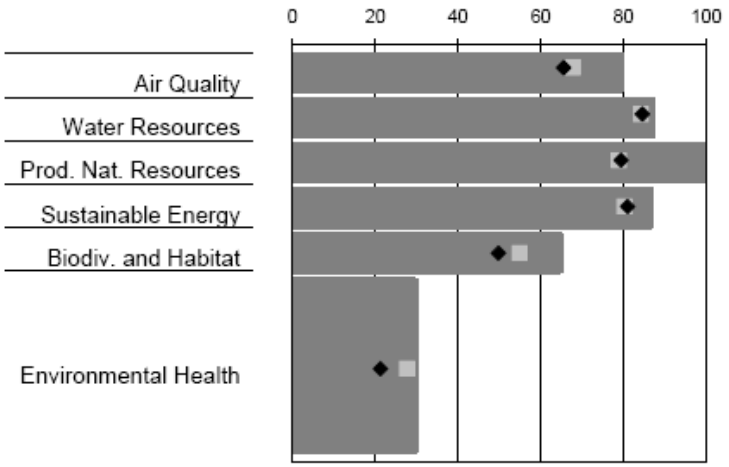
Malawi

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $600

Income Decile 10 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	91
Score:	56.5
Income Group Avg.	46.7
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	79.2	65.6	67.8
Water Resources	86.9	84.6	84.3
Prod. Nat. Resources	100.0	79.5	78.9
Sustainable Energy	86.5	81.1	80.3
Biodiv. and Habitat	64.6	49.8	54.9
Environmental Health	29.6	21.3	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	46.4	*0*	74.1
OZONE	Regional Ozone (ppb)	21.7	*15*	84.3
NLOAD	Nitrogen Loading (mg/L)	41.7	*1*	99.2
OVRSUB	Water Consumption (%)	13.9	*0*	74.6
OVRFSH	Overfishing (scale 1-7)	..	*1*	..
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	2.1	*3*	100.0
PWI	Wilderness Protection (%)	47.7	*90*	53.0
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.6	*1*	60.8
INDOOR	Indoor Air Pollution (%)	99.0	*0*	1.099.0
WATSUP	Drinking Water (%)	67.0	*100*	40.4
ACSAT	Adequate Sanitation (%)	46.0	*100*	34.3
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	21.9	*0*	15.5
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	3,688.8	*1,650*	91.5
RENPC	Renewable Energy (%)	52.9	*100*	52.9
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	120.9	*0*	89.4

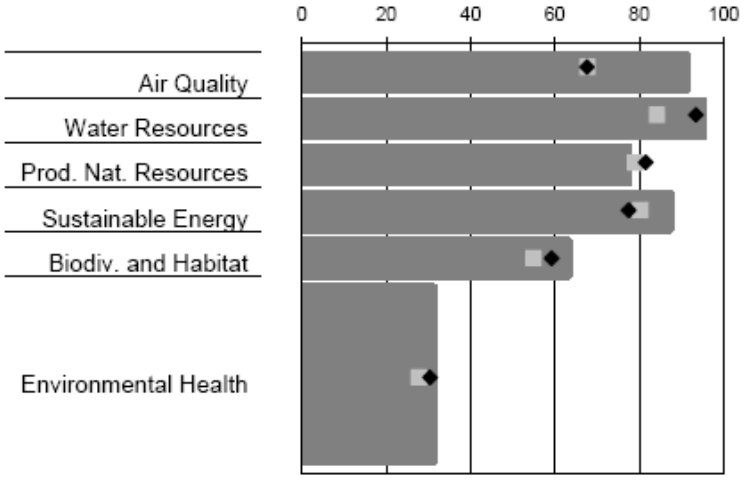
Rwanda

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $1,300

Income Decile 9 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	89
Score:	57.0
Income Group Avg.	53.2
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	91.1	67.6	67.8
Water Resources	95.0	93.5	84.3
Prod. Nat. Resources	77.3	81.6	78.9
Sustainable Energy	87.3	77.5	80.3
Biodiv. and Habitat	63.2	59.2	54.9
Environmental Health	31.1	30.5	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	35.1	*0*	82.1
OZONE	Regional Ozone (ppb)	14.1	*15*	100.0
NLOAD	Nitrogen Loading (mg/L)	524.7	*1*	90.1
OVRSUB	Water Consumption (%)	0.0	*0*	100.0
OVRFSH	Overfishing (scale 1-7)	..	*1*	..
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	16.2	*3*	54.7
PWI	Wilderness Protection (%)	21.8	*90*	24.2
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	1.0	*1*	100.0
INDOOR	Indoor Air Pollution (%)	100.0	*0*	0.0100.0
WATSUP	Drinking Water (%)	73.0	*100*	51.3
ACSAT	Adequate Sanitation (%)	41.0	*100*	28.3
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	22.3	*0*	14.2
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	1,298.3	*1,650*	100.0
RENPC	Renewable Energy (%)	7.1	*100*	7.1
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	75.7	*0*	93.4

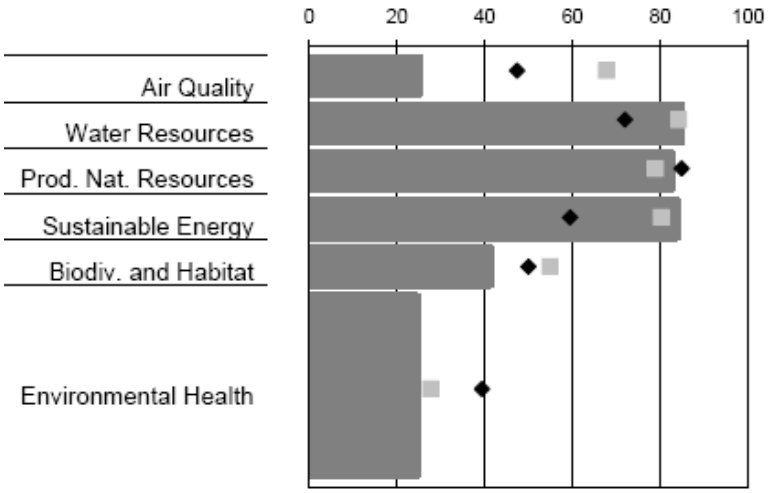
Sudan

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $1,900

Income Decile 8 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	124
Score:	44.0
Income Group Avg.	51.1
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	24.9	47.4	67.8
Water Resources	84.8	72.0	84.3
Prod. Nat. Resources	82.5	84.9	78.9
Sustainable Energy	83.8	59.5	80.3
Biodiv. and Habitat	41.3	50.0	54.9
Environmental Health	24.5	39.4	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	246.4	*0*	0.0
OZONE	Regional Ozone (ppb)	36.3	*15*	49.9
NLOAD	Nitrogen Loading (mg/L)	576.0	*1*	89.1
OVRSUB	Water Consumption (%)	10.7	*0*	80.5
OVRFSH	Overfishing (scale 1-7)	4	*1*	50.0
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	3.7	*3*	97.6
PWI	Wilderness Protection (%)	5.4	*90*	6.0
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.5	*1*	48.4
INDOOR	Indoor Air Pollution (%)	100.0	*0*	0.0100.0
WATSUP	Drinking Water (%)	69.0	*100*	44.0
ACSAT	Adequate Sanitation (%)	34.0	*100*	19.8
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	13.2	*0*	49.2
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	2,156.1	*1,650*	97.9
RENPC	Renewable Energy (%)	9.8	*100*	9.8
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	147.6	*0*	87.1

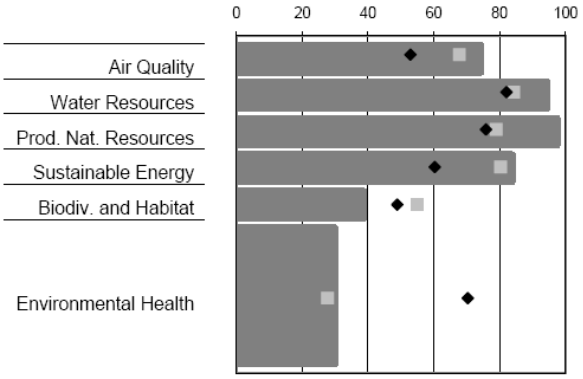
Swaziland

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $5,100

Income Decile 5 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	101
Score:	53.9
Income Group Avg.	67.2
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	74.3	52.9	67.8
Water Resources	94.4	82.1	84.3
Prod. Nat. Resources	97.5	75.8	78.9
Sustainable Energy	83.9	60.3	80.3
Biodiv. and Habitat	38.8	48.9	54.9
Environmental Health	29.9	70.4	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	39.6	*0*	79.0
OZONE	Regional Ozone (ppb)	28.0	*15*	69.5
NLOAD	Nitrogen Loading (mg/L)	206.5	*1*	96.1
OVRSUB	Water Consumption (%)	4.0	*0*	92.7
OVRFSH	Overfishing (scale 1-7)	..	*1*	..
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	4.5	*3*	95.0
PWI	Wilderness Protection (%)	0.7	*90*	0.8
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.5	*1*	46.2
INDOOR	Indoor Air Pollution (%)	88.0	*0*	12.088.0
WATSUP	Drinking Water (%)	52.0	*100*	13.4
ACSAT	Adequate Sanitation (%)	52.0	*100*	41.6
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	19.9	*0*	23.3
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	3,948.2	*1,650*	90.4
RENPC	Renewable Energy (%)	9.2	*100*	9.2
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	64.8	*0*	94.3

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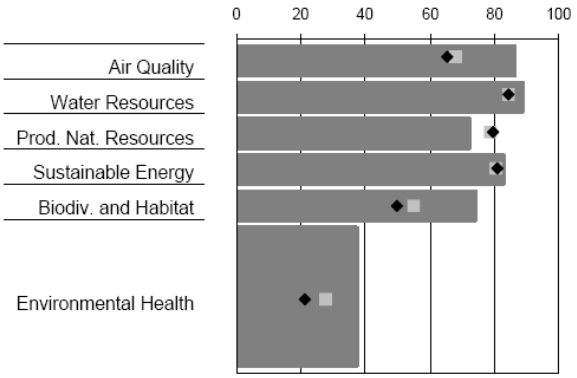
Tanzania

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $700

Income Decile 10 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	83
Score:	59.0
Income Group Avg.	46.7
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	86.2	65.6	67.8
Water Resources	88.6	84.6	84.3
Prod. Nat. Resources	72.2	79.5	78.9
Sustainable Energy	82.9	81.1	80.3
Biodiv. and Habitat	74.1	49.8	54.9
Environmental Health	37.3	21.3	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	37.3	*0*	80.6
OZONE	Regional Ozone (ppb)	18.5	*15*	91.9
NLOAD	Nitrogen Loading (mg/L)	160.2	*1*	97.0
OVRSUB	Water Consumption (%)	10.8	*0*	80.2
OVRFSH	Overfishing (scale 1-7)	6	*1*	16.7
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	1.4	*3*	100.0
PWI	Wilderness Protection (%)	34.4	*90*	38.2
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	1.0	*1*	99.4
INDOOR	Indoor Air Pollution (%)	96.0	*0*	4.096.0
WATSUP	Drinking Water (%)	73.0	*100*	51.3
ACSAT	Adequate Sanitation (%)	46.0	*100*	34.3
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	17.3	*0*	33.4
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	3,492.5	*1,650*	92.3
RENPC	Renewable Energy (%)	37.9	*100*	37.9
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	181.9	*0*	84.1

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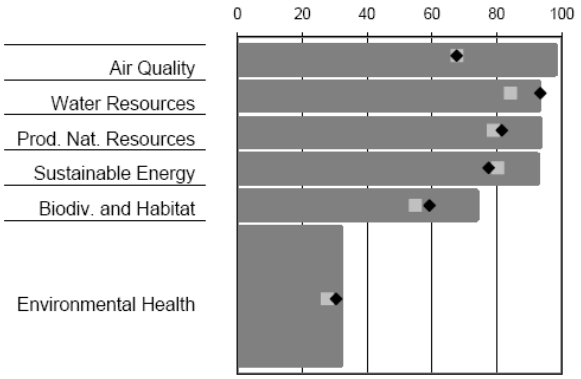
Uganda

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $1,500

Income Decile 9 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	78
Score:	60.8
Income Group Avg.	53.2
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	98.0	67.6	67.8
Water Resources	92.7	93.5	84.3
Prod. Nat. Resources	93.0	81.6	78.9
Sustainable Energy	92.4	77.5	80.3
Biodiv. and Habitat	73.6	59.2	54.9
Environmental Health	31.7	30.5	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	15.7	*0*	95.9
OZONE	Regional Ozone (ppb)	14.2	*15*	100.0
NLOAD	Nitrogen Loading (mg/L)	636.3	*1*	87.9
OVRSUB	Water Consumption (%)	1.4	*0*	97.5
OVRFSH	Overfishing (scale 1-7)	..	*1*	..
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	7.1	*3*	86.1
PWI	Wilderness Protection (%)	52.0	*90*	57.7
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.8	*1*	80.9
INDOOR	Indoor Air Pollution (%)	97.0	*0*	3.097.0
WATSUP	Drinking Water (%)	56.0	*100*	20.6
ACSAT	Adequate Sanitation (%)	41.0	*100*	28.3
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	16.4	*0*	36.6
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	1,009.7	*1,650*	100.0
RENPC	Renewable Energy (%)	46.9	*100*	46.9
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	52.8	*0*	95.4

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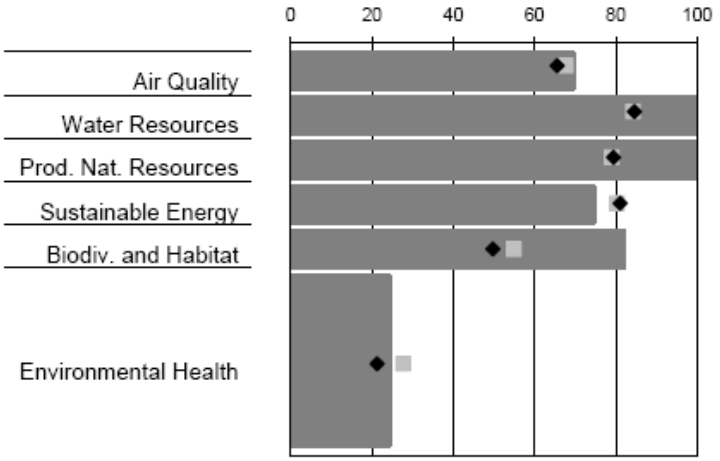
Zambia

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $900

Income Decile 10 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	98
Score:	54.4
Income Group Avg.	46.7
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	69.1	65.6	67.8
Water Resources	99.6	84.6	84.3
Prod. Nat. Resources	100.0	79.5	78.9
Sustainable Energy	74.2	81.1	80.3
Biodiv. and Habitat	81.6	49.8	54.9
Environmental Health	24.0	21.3	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates ($\mu g/m^3$)	72.7	*0*	55.4
OZONE	Regional Ozone (ppb)	22.3	*15*	82.9
NLOAD	Nitrogen Loading (mg/L)	33.7	*1*	99.4
OVRSUB	Water Consumption (%)	0.1	*0*	99.8
OVRFSH	Overfishing (scale 1-7)	..	*1*	..
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	0.6	*3*	100.0
PWI	Wilderness Protection (%)	48.0	*90*	53.3
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	1.0	*1*	100.0
INDOOR	Indoor Air Pollution (%)	87.0	*0*	13,087.0
WATSUP	Drinking Water (%)	55.0	*100*	18.8
ACSAT	Adequate Sanitation (%)	45.0	*100*	33.1
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	22.8	*0*	11.9
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	11,906.2	*1,650*	57.1
RENPC	Renewable Energy (%)	78.5	*100*	78.5
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	124.7	*0*	89.1

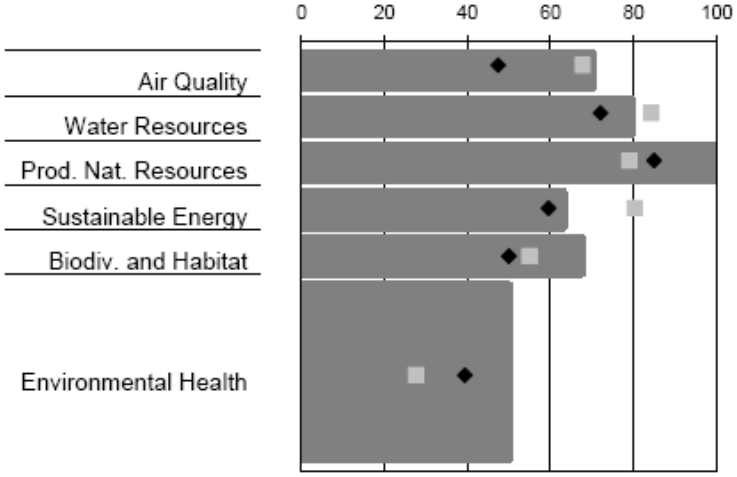
Zimbabwe

SUB-SAHARAN AFRICA
GDP/capita 2004 est. (PPP) $1,900

Income Decile 8 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	74
Score:	63.0
Income Group Avg.	51.1
Geographic Group Avg.	50.5

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	70.0	47.4	67.8
Water Resources	79.5	72.0	84.3
Prod. Nat. Resources	100.0	84.9	78.9
Sustainable Energy	63.0	59.5	80.3
Biodiv. and Habitat	67.6	50.0	54.9
Environmental Health	49.9	39.4	27.7

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	61.4	*0*	63.4
OZONE	Regional Ozone (ppb)	24.9	*15*	76.6
NLOAD	Nitrogen Loading (mg/L)	195.1	*1*	96.3
OVRSUB	Water Consumption (%)	20.4	*0*	62.7
OVRFSH	Overfishing (scale 1-7)	..	*1*	..
AGSUB	Agricultural Subsidies (%)	0.0	*0*	100.0
HARVEST	Timber Harvest Rate (%)	1.2	*3*	100.0
PWI	Wilderness Protection (%)	39.4	*90*	43.8
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.8	*1*	79.8
INDOOR	Indoor Air Pollution (%)	67.0	*0*	33.067.0
WATSUP	Drinking Water (%)	83.0	*100*	69.3
ACSAT	Adequate Sanitation (%)	57.0	*100*	47.7
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	15.2	*0*	41.4
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	6,126.2	*1,650*	81.3
RENPC	Renewable Energy (%)	23.7	*100*	23.7
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	515.9	*0*	54.9

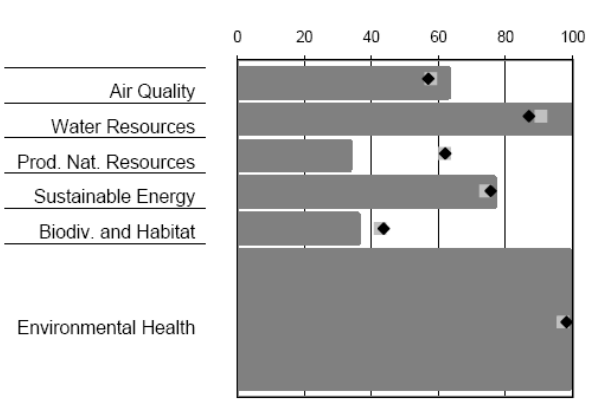
Norway

EUROPEAN UNION +
GDP/capita 2004 est. (PPP) $40,000

Income Decile 1 (1=high, 10=low)

Pilot 2006 EPI	
Rank:	18
Score:	80.2
Income Group Avg.	81.6
Geographic Group Avg.	81.3

Policy Categories



	Country	Income Group	Geographic Group
Air Quality	62.8	57.0	57.7
Water Resources	100.0	87.0	90.6
Prod. Nat. Resources	33.3	62.0	61.9
Sustainable Energy	76.5	75.5	74.1
Biodiv. and Habitat	35.8	43.7	42.6
Environmental Health	98.8	98.2	97.2

Indicator Data

		Value	Target	Standardized Proximity to Target (100=target met)
PM10	Urban Particulates (µg/m^3)	20.7	*0*	92.4
OZONE	Regional Ozone (ppb)	43.4	*15*	33.2
NLOAD	Nitrogen Loading (mg/L)	6.2	*1*	99.9
OVRSUB	Water Consumption (%)	0.0	*0*	100.0
OVRFSH	Overfishing (scale 1-7)	7	*1*	0.0
AGSUB	Agricultural Subsidies (%)	40.1	*0*	0.0
HARVEST	Timber Harvest Rate (%)	1.1	*3*	100.0
PWI	Wilderness Protection (%)	7.2	*90*	8.0
PACOV	Ecoregion Protection (scale 0-1, 1=10% each biome protected)	0.3	*1*	28.0
INDOOR	Indoor Air Pollution (%)	0.0	*0*	100.00.0
WATSUP	Drinking Water (%)	100.0	*100*	100.0
ACSAT	Adequate Sanitation (%)	100.0	*100*	100.0
1TO4MORT	Child Mortality (deaths/1000 population 1-4)	0.3	*0*	98.9
ENEFF	Energy Efficiency (Terajoules / million GDP PPP)	10,688.9	*1,650*	62.2
RENPC	Renewable Energy (%)	60.4	*100*	60.4
CO2GDP	CO_2 per GDP (Tonnes / GDP PPP)	77.1	*0*	93.3

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Table 3: EPI Indicators, Targets, and Weighting

Objective	Policy Category	Indicator*	Data Source*	Target	Target Source	Weight within Category	Weight within EPI
Environmental Health		Urban Particulates	World Bank, WHO	10 µg/m^3	Expert judgment [a]	.13	.50
		Indoor Air Pollution	WHO	0% of house-holds using solid fuels	Expert judgment [b]	.22	
		Drinking Water	WHO-UNICEF Joint Monitoring Program	100% access	MDG 7, Target 10, Indicator 30	.22	
		Adequate Sanitation	WHO-UNICEF Joint Monitoring Program	100% access	MDG 7, Target 10, Indicator 31	.22	
		Child Mortality	UN Population Division	0 deaths per 1,000 pop aged 1-4	MDG 4, Target 5, Indicator 13	.21	
Ecosystem Vitality and Natural Resource Management	Air Quality	Urban Particulates	World Bank, WHO	10 µg/m^3	Expert judgment [a]	.50	.10
		Regional Ozone	MOZART model	15 ppb	Expert judgment [c]	.50	
	Water Resources	Nitrogen Loading	UNH Water Systems Analysis Group	1 mg/liter	GEMS/Water expert group	.50	.10
		Water Consumption	UNH Water Systems Analysis Group	0% oversub-scription	By definition	.50	
	Biodiversity and Habitat	Wilderness Protection	CIESIN, Wildlife Conservation Society	90% of wild areas protected	Linked to MDG 7, Target 9	.39	.10
		Ecoregion Protection	CIESIN	10% for all biomes	Convention on Biological Diversity	.39	
		Timber Harvest Rate	FAO	3%	Expert judgment [d]	.15	
		Water Consumption	UNH Water Systems Analysis Group	0% oversub-scription	By definition	.07	
	Productive Natural Resources	Timber Harvest Rate	FAO	3%	Expert judgment [d]	.33	.10
		Overfishing	South Pacific Applied Geosciences Commission	No overfishing	By definition	.33	
		Agricultural Subsidies	WTO, USDA-ERS	0%	GATT and WTO agreements	.33	
	Sustainable Energy	Energy Efficiency	Energy Information Administration	1,650 Terajoules per million $ GDP	Linked to MDG 7, Target 9, Indicator 27	.43	.10
		Renewable Energy	Energy Information Administration	100%	Johannesburg Plan of Implementation	.10	
		CO_2 per GDP	Carbon Dioxide Information Analysis Center	0 net emissions	Expert judgment [e]	.47	

* *Note: Full indicator names, definitions, and data sources are provided in Appendix H.*
[a] *Determined in consultation with Kiran Pandey from the World Bank and other air pollution experts;*
[b] *Determined in consultation with Kirk Smith and Daniel Kammen at UC Berkeley and the indoor air pollution literature;*
[c] *Determined in consultation with Denise Mauzerall and her air pollution team at Princeton University;*
[d] *Determined in consultation with Lloyd Irland and Chad Oliver from the Yale School of Forestry and Environmental Studies;*
[e] *Strict interpretation of the goal of the 1992 UN Framework Convention on Climate Change.*

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