

Land Use and Abuse in the East African Region

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The Region's most pressing environmental problems involve deforestation and massive soil erosion in upland areas. As a result, millions of tons of soil is washed into rivers and streams where it expands river beds, clogs deltas, kills off coral reefs and damages beaches. Subsistence agriculture and fuelwood gathering are largely to blame. But coupled to this is the almost complete absence of real physical and environmental planning. If the Region's resource base is not to be entirely eroded, large-scale projects must be launched soon.

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The countries of East Africa and the Western Indian Ocean suffer from the most difficult syndrome of under-development—the predominance of subsistence agriculture and slow and unsteady industrialization. Valuable marine resources in the Region are threatened by the aggregate effects of decentralized agricultural and pastoral activities including brush forest clearing. The effects of massive upland soil loss are felt in coastal river plains and at the mouths of major rivers. In certain areas, unplanned coastal development has also created specific environmental problems. Economic values of coastal resources have not been fully realized through special development programs. Improved land-use planning and terrestrial resource management are needed throughout the region to help protect its marine resources and to optimize coastal development.

THE CONTINENT AND MADAGASCAR

Since the populations of East Africa and Madagascar are for the most part concentrated in the relatively productive highlands and river valleys, the greatest environmental impacts from human activities, especially subsistence agriculture and livestock raising, result from the cumulative effects of improper land use in the interior. Due to the number of major rivers draining the highlands, strong seasonal rains in the interior, and large catchment areas, the effects of upland activities are transmitted to the coast where they are magnified in flood plains and at river mouths. Certain activities in the coastal zone itself, however, especially urban development, also have important effects on natural resources.

Inland Activities

Economic and resource planners have begun to stress the tremendous implications for national development of large-scale soil loss resulting from burgeoning popula-

tions, accompanied by continued reliance on traditional methods of cultivation, livestock raising, and fuelwood collection (1). In Madagascar, for example, officials have declared soil erosion to be the key problem facing the nation: Soil loss averages 25–40 metric tons per hectare per year nationwide and reaches as much as 300 metric tons/ha/year in the highlands. Fully 65 percent of the country's entire land area is believed to be dangerously denuded of vegetation—primarily as a result of destructive agricultural practices (see article by Randrianarijaona).

Subsistence Agriculture

Shifting cultivation continues to exploit new areas for agricultural production. Because of rapidly increasing rural populations, fallow periods have been diminished and increasingly marginal lands have been brought under cultivation. In Kenya, for example, with an annual population growth rate of almost 4 percent—and 90 percent of the entire population engaged in subsistence agriculture—cultivated areas have been extended into regions of marginal rainfall and dry-season pasturage (2). In Mozambique, high population growth has combined with unfavorable soil and rainfall conditions to destabilize soils over large areas. Poor technical advice and support has led to inappropriate crop selections (such as maize instead of traditional cassava) and unsuitable resettlement schemes.

In Madagascar, some 200 000 hectares are converted annually by tavy, or slash-and-burn agriculture. The problem is especially severe in the eastern highlands where steep slopes, the fragility of the rainforest, and an ever-expanding population contribute to an accelerating deterioration of the resource base (3). Throughout East Africa, the problem of converting marginal lands to agriculture is compounded by the brushfires, called *quemara* in Mozambique, which are widely used to facilitate clearing.

Deforestation

Large amounts of forest resources, including degraded forest and scrub, are harvested for domestic fuelwood and charcoal. This harvest, organized both on a subsistence and commercial basis, is little controlled through quotas or permits. In Kenya, for example, total forest resources harvested for domestic purposes are estimated at 15 million cubic meters (m³), 90 percent of the total annual consumption. Of this, only some 200 000 m³ is obtained from the Forestry Department (4). The result is only too evident: only some 2.5 percent of the country is still forested (5). The FAO has estimated fuelwood collection in the other countries as follows: Madagascar, 5.1 million m³; Mozambique, 9.9 million m³; and Tanzania, 39 million m³ (6–9). Deforestation has also decreased the availability and increased the price of domestic fuels for urban dwellers. In Kenya, the charcoal sources for Nairobi have moved to the slopes of Mt Kenya, over 200 km away. In Somalia, the fuelwood sources for Mogadishu are fully 500 km to the south.

Livestock Raising

Throughout East Africa and Madagascar there are almost as many cattle as people. The FAO in 1978 estimated the following cattle stocks: Kenya, 9.8 million head; Madagascar, 9.0 million; Mozambique, 1.3 million; Somalia, 4.0 million; and Tanzania, 15.2 million (6–10). Overgrazing has caused soil destabilization over wide areas, and serious erosion has resulted, especially in areas of high wind and rainfall, on slopes, and along the banks of rivers where animals congregate for watering. The effects of grazing are magnified by the practice of burning pastures to clear undergrowth and produce edible shoots for forage. In Madagascar, officials estimate that fully 1 million hectares of vegetative cover was lost in 1979 alone to such brushfires, but claim that this has been reduced to a rate of 100 000 hectares/year since 1980 as



Coastal bluffs south of Mogadishu, in Somalia, were desertified as a result of seasonal overgrazing. In all some 5000 km² of shifting dunes were created, of which only about 50 km² have been restabilized through the systematic replanting of prickly pear cactus by volunteers. Photo: J Kundaell.

a result of new government initiatives. In Somalia—where there is, in principle, a system of classified reserves regulating the time and extent of grazing—large-scale destabilization has occurred nevertheless, especially along the coast. Coastal bluffs south of Mogadishu were desertified as a result of seasonal overgrazing during a drought beginning in 1978, and shifting coastal dunes were created by strong monsoonal winds. These dunes are threatening coastal roads and power lines and could encroach on the country's premier agricultural area—the fertile inter-riverine plain of the Juba and Shebelle Rivers. Some 5000 km² of shifting dunes have been created, of which about 50 km² have been restabilized—but lost as pasturage—through labor-intensive, systematic replanting of dune vegetation, such as prickly pear cactus.

Rural Settlement Patterns

National population growth combined with traditional lifestyles would itself place great stress on forests and soils. Political and social developments in certain countries have also influenced the patterns of rural settlement so that even greater strains could result. In Mozambique and Tanzania, and to a certain extent in Madagascar, villagization campaigns have been organized to improve rural life. In most cases this has involved the regrouping of local populations, but sometimes major resettlements of rural and even urban populations have occurred.

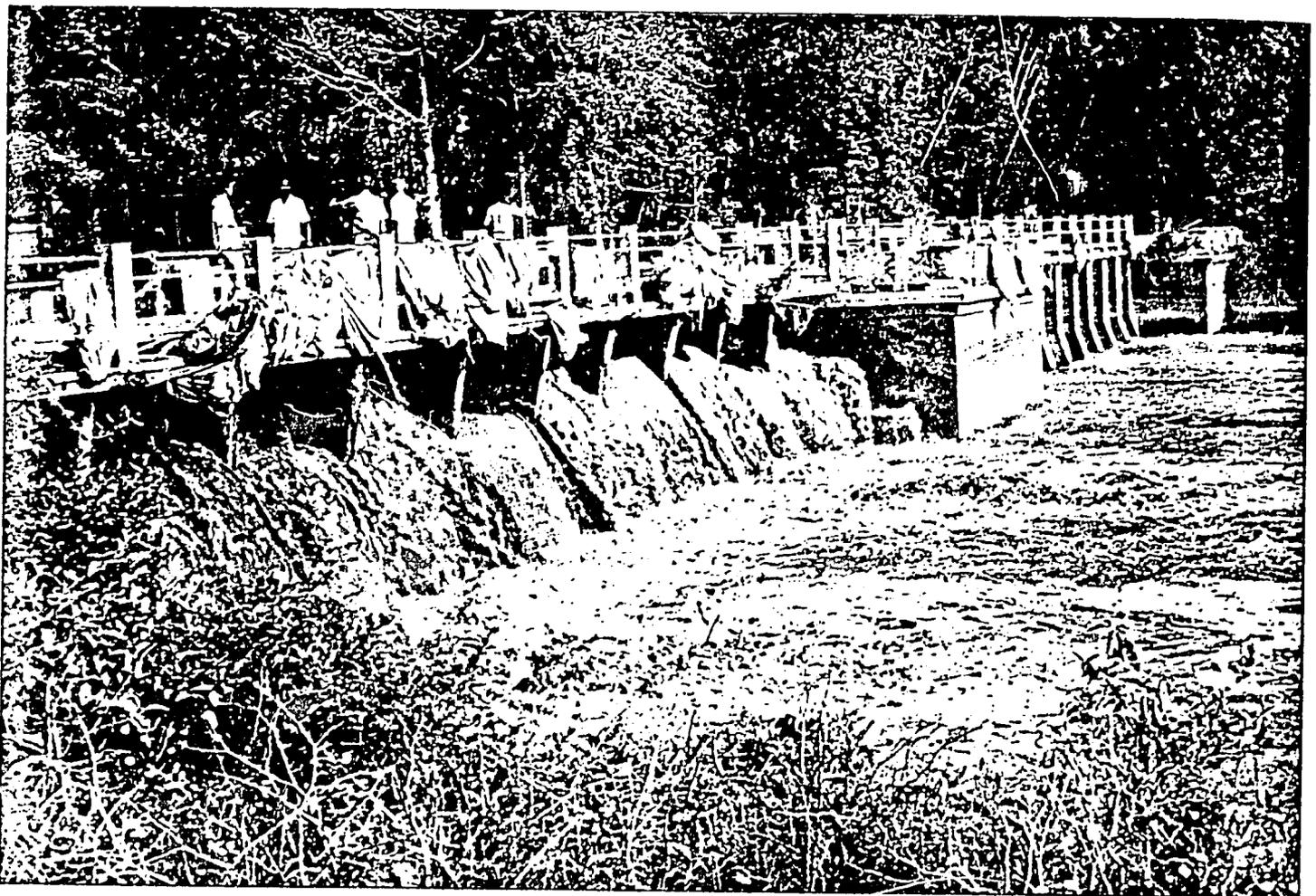
Concentration of rural populations into village centers can result in the over-cultivation of nearby lands, often without regard for agricultural suitability. In the vicinity of the village center, cultivation is intensified; new areas are rapidly brought under cultivation and the crop cycle is often shortened. But in many cases, adequate technical assistance, infrastructure, equipment, and supplies are not available to support such intensified activity. Indeed, selection of the village site itself may have been inadequately studied or subject to political factors. In addition to the agricultural limitations of cropland, natural areas adjacent to villages may become degraded as a result of overgrazing or intensive harvesting.

In Mozambique, villagization has a strong grassroots basis dating from FRELIMO's efforts, during the liberation struggle, to reorganize the rural population. Central authorities now permit the creation of new villages and provide support for them. But a marked absence of technical resources coupled to local "politics" has led to many inappropriate decisions about siting, agricultural methods, and crop selection. Foreign advisors are very concerned about these developments in all parts of the country—especially in provinces like Inhambane and Manica, where the villagization movement is advanced—and about government plans to resettle peasants into new, marginal agricultural areas like Tete.

In Tanzania, the formation of *ujamaa*

(familyhood) villages has been pushed by the central government. The Prime Minister's office plans and approves new villages while physical planning and services are provided by the Lands (*Ardhi*) Ministry. *Ujamaa* villages are comparable in size and population with villages in Mozambique, but in Tanzania, they are specifically defined as to lie within a 5 km radius (7 km to the limit of pastures) and accommodate 240–300 families, or some 2000–5000 people in all. There are many stories of inappropriate siting decisions and government failure to provide adequate infrastructure such as potable water and sanitation. Apparently, there have been forced resettlements, including a large number of urban squatters evicted from Dar es Salaam. An especially unfortunate situation is the loss of agricultural production in the traditional rice-growing areas of the Rufiji flood plain due to the relocation of peasants to permanent village sites on the sides of the valley, which are remote and cut off from the former agricultural region (11). These factors, combined with an absence of technical and material support, have had a counterproductive effect: there has been a substantial out-migration to the slums in the capital.

In Madagascar, calls for radical transformation of rural life led to the formation of *fokonolona's*, based on the traditional village community of the dominant Merina tribe. Some 10 000 such villages were created between 1973 and 1975 and continue to exist (at least in principle) (9). Forma-



The silt-choked Shebelle River in Somalia transports thousands of tons of soil to the coast, where it severely affects coral reefs and beaches, smothering marine ecosystems. Photo: J Kundaell.

tion of villages in Madagascar has not entailed a major change in rural life, since rural collectivization is a two-step process. The first stage involves land reform, carried out by the state through the expropriation and redistribution of all private tracts over 600 hectares in area. The second stage, collectivization of agricultural production and trade, (if it in fact occurs at all) would result only from a distinct and separate movement by the local population.

SOIL EROSION AND SILTATION

Problems in River Valleys and the Coastal Zone

Much of the soil lost in the uplands enters the major rivers and produces a range of effects along their courses and at their mouths. Little information is available on total riverine sediments reaching the coast, but some $4.81 \times 10^6 \text{ m}^3$ of terrigenous sediment is thought to reach the Western Indian Ocean annually (12). Sedimentary discharge through Stegler's Gorge on the Rufiji River (the site of a future dam) alone was estimated at 15-25 million metric tons per year (13). Massive sedimentation from upland soil loss could irreversibly alter the coastal and marine ecosystems of East Africa (see Figure 1).

Expansion of Deltas, Estuaries and Mud Banks

Riverine sediments contribute to the formation of wetland flood plains, deltas,

and offshore mud banks. All three are important areas of freshwater, estuarine, and marine biological productivity. In the Region, the major estuarine areas and mud banks form the basis of a productive shrimp fishery, especially on the Sofala Bank off the mouth of the Zambezi River; on the shallow, muddy shelf areas off west/northwest Madagascar; in the Mafia Channel at the mouth of the Rufiji River (little exploited); and elsewhere, such as Maputo Bay in Mozambique and along the northern Kenyan coast. Significantly increased sedimentation could, however, have adverse consequences for fisheries. Turbidity caused by sedimentation could reduce light penetration in near-shore areas, inhibiting phytoplankton production. Similarly, accumulation of sediments on the continental shelf could cause benthic turbidity and the formation of disruptive "sand waves". Some parts of the Bight of Sofala are reported to have become a "dead sea", carpeted with large amounts of unconsolidated sediment (14). Huge volumes of sediment reaching the coastal plain and deltas could actually lower these areas through "down-pressing", resulting in a rise in the local sea level and extensive coastal erosion; this phenomenon is thought to have occurred already in the Zambezi delta (14).

Loss of Beaches and Reefs

Riverine sediment depositions can have significant effects on the characteristics, form, and quality of the coastline. Sedi-

mentation from the Sabaki River, for example, has seriously affected the beaches at Malindi, a major Kenyan tourist center. Sand and water quality has markedly declined and there has been considerable beach accretion—reportedly as much as 500 meters over the last 10-15 years, with a noticeable acceleration during the last decade. As a result, fewer tourists visit the area and hotel occupancy has dropped.

Beaches and reefs at Nossi-Bé, a tourist center in northwest Madagascar, have been similarly affected. In some areas coral reefs are being smothered in sediment.

Riverine and Coastal Flooding

Increased siltation along river courses, often combined with greater storm-water "pulses" resulting from deforestation, causes increased flooding in valleys, river plains, and estuaries. Floods of this nature along the Rufiji River were first recorded in the late 1940's (11). Flooding can affect estuarine productivity by exposing aquatic organisms to rapid changes in salinity. Due to the limited utilization of coastal areas, including flood plains, little attention has been directed to the problems caused by floods. In the densely populated (about 700,000) highland plain around Antananarive on Madagascar, deforested hillsides and rivers choked by silt cause flooding. Soil losses of 240 metric tons per hectare per year have been recorded in the surrounding uplands. The Malagasy government is seeking assistance from the World Bank to help resolve this problem.

Effects of Hydropower Development Projects

East Africa, especially Madagascar, has some of the world's greatest potential hydropower resources in the many major rivers that drain large, rainy, upland catchments (see Figure 1). High siltation threatens the viability of these projects; their development, moreover, could adversely affect coastal marine resources.

Throughout the Region a number of large hydropower projects are completed, underway, or planned. These include the huge Cabora Bassa Dam on the Zambezi in Mozambique, now reaching its second stage of construction; the Bardera Dam on the Juba River in Somalia, under construction; several smaller-scale projects already completed or planned on Kenyan rivers, especially the Tana; and others.

Large dams reduce the amount of sediment reaching downstream, constricting flood plains. Depending on the extent of utilization and management of water flow, dams can affect the flooding cycle and diminish estuarine productivity.

Fishery officials in Mozambique are concerned about the effect of further damming on the Zambezi delta, the primary nursery for the large shrimp stocks caught in the Bight of Sofala. Saline influence now reaches 80 km up the river, and increased salinity was noticed in agricultural areas after previous damming. Aerial surveys and ground observations indicate the re-establishment of salt-tolerant vegetation in inner delta areas. Lower water levels have also been noticed in the delta,

but to date no effect on the fishery has been ascertained.

Consultant studies on the proposed Stiegler's Gorge project indicate that salinity in the Rufiji delta—which currently intrudes 5–40 km depending on conditions—would not increase, since operation of the dam would probably result in a more uniform and higher-than-median water flow. However, the delta would ultimately recede by as much as one meter per year, due to reduced sedimentation (15). Officials believe that there would not be major loss of estuarine productivity, due to the ability of marine organisms to migrate within the delta to optimal saline conditions.

The Bardera project would probably greatly reduce the water flow as well as siltation at the mouth of the Juba River, due to its connection to large-scale irrigation works for 220 000 hectares—ten times the total in Somalia today. A UNEP consultant has been provided to work on the environmental effects of the dam, including downstream impacts.

Of the several estuaries in Kenya, probably only those on the Tana and Sabaki Rivers will be significantly affected by damming. Although the effects noted are possible here, it has been reported that fisheries in the area actually improved after damming of the Tana. Damming of the Sabaki could help ameliorate, but could not undo, the siltation of the coastline and reefs at Malindi.

The effects of hydropower projects on marine resources call for assessment of the problems of salinity intrusion, delta contraction, and altered flooding regimes. For the most part, these problems are secondary to the major economic and social benefits of properly designed hydro projects. Responsive management of the projects could, however, help to alleviate the problem of altered flood regimes and also help to minimize saline intrusion into agricultural areas along major rivers.

reached except through mixed programs of popular education and mobilization together with technical improvements in infrastructure and services; this approach is being tried in Maputo (see articles by Osore and Madeley *et al.*).

A number of secondary urban centers are also located in the coastal zone, usually in connection with major ports. As port cities, they are often the location of important transportation-related industries such as oil refining, cement production, and commodity processing, which result in special pollution problems. These well-established cities are usually served by basic infrastructure (including sewers), but it is invariably very limited and outmoded. Meanwhile, populations are growing rapidly if not at the pace of the primary centers. The chief needs, therefore, are upgrading and expansion of infrastructure; physical planning to reduce conflicts among residential construction, recreational activities, and industrial operations; and prevention of undue strains on coastal and marine resources, degradation of environmental health, and loss of amenities.

PHYSICAL AND DEVELOPMENT PLANNING FOR THE ISLANDS

Because of the small size of the islands—the Comoros, Mauritius, and Seychelles—their natural resources are particularly susceptible to the effects of human activities. Scarcity of land and restrictive topography have resulted in significant conversion of natural areas to agricultural or urban uses, or for the siting of industrial or tourist facilities. User conflicts—conflict among human activities or pre-emption of one sector by another—also inevitably arise, especially through loss of potential agricultural areas to residential or other development. Some of the key problems in resource management for the islands, illustrated by examples, follow.

Sand, Gravel, and Coral Extraction

The continuing extraction of beach sand in the Comoros for making cement has severely degraded the quality of beaches and lagoons, largely reducing them to mudflats fed by terrigenous sediments from eroded hillsides. Coral shares a similar fate and is systematically collected for building purposes, leading to widespread loss of reefs. This dual loss exposes the coastline to increased erosion—in some places affecting roads and other facilities. This situation in the Comoros is the result of traditional preferences in building materials, absence of cash to buy materials from foreign sources, and a large population. Alternative construction materials must be found and the government is at work on the problem.

Sand extraction from beaches has occurred at various places in Seychelles, but has now largely been brought under control through a licensing system; the government actually collects the sand in certain areas such as at the mouths of streams and vends it to the licensees.

In Mauritius, sand extraction is fairly regularized and sand is mined from pits shoreward of the immediate coast and the

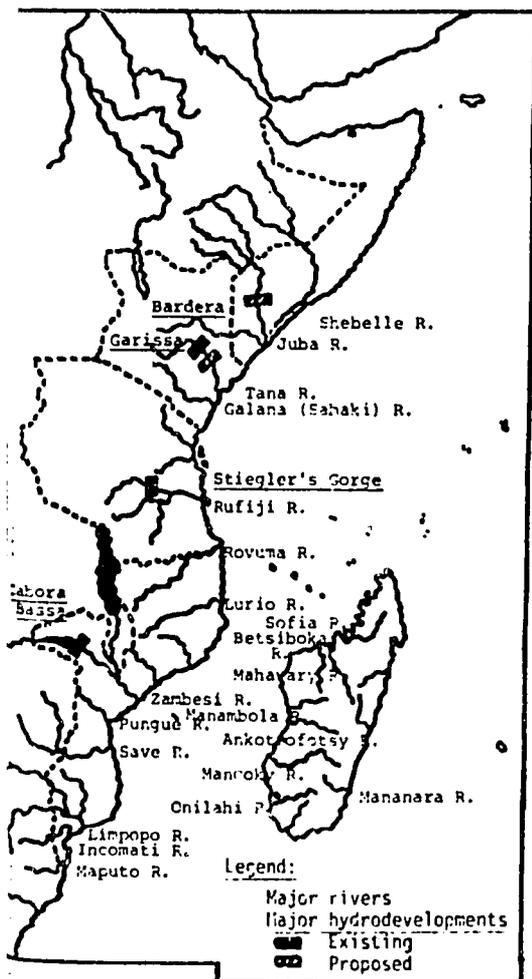


Figure 1. Major rivers and hydropower projects in East African Region.

DEVELOPMENT IN THE COASTAL ZONE

Although some industrial and other facilities (mostly tourist) are located in the coastal zone, residential development and subsistence activities along the coast are causing the most serious problems. In certain areas, especially southern Mozambique (14) and southern Somalia, livestock raising and other human activities near the coast have destabilized coastal bluffs and dunes. But it is municipal development, and associated environmental health problems, that pose the most important issues for land-use planners. Three primary urban centers are located on the East African coast—Dar es Salaam, Maputo, and Mogadishu; the first two have witnessed extremely rapid and unplanned growth of residential areas. These large unplanned additions have strained amenities and resources; degraded environmental health; and made rational planning very difficult. The large amounts of untreated human and domestic waste have generated high biological pollution loads in coastal waters. Given the magnitude of the waste problem, it is hard to see how solutions can be

On the Comoros Islands, coral is routinely extracted for building purposes, leading to the widespread degradation and destruction of reefs. Photo: D Finn.



area then recovered and planted. But these supplies cannot continue to meet demand, and there is a search for offshore sources.

Agriculture and Silviculture in High-Slope Areas

The most serious soil erosion on the islands occurs in connection with agriculture and silviculture in high-relief areas. Little of this form of erosion has occurred in Mauritius, although a switch to mixed cropping could lead to much greater erosion (16). In Seychelles, numerous "cuts" are visible on hillsides, resulting from problematic agricultural but especially silvicultural development: localized erosion results and the scars tend to disfigure the scenic, steep, vegetated hillsides.

The most severe problems occur in the Comoros, especially the rugged and densely-populated island of Anjouan. Soil erosion in the Comoros is a threat to the continued viability of agriculture there: it has already led to local water shortages, as upland forests and soils no longer retain adequate water to feed streams on a continuous basis; and to damaging siltation of lagoons and reefs, lowering fishery productivity (17). Especially on Anjouan and Moheli, plantations historically took over the most favorable agricultural areas, including the coastal plain and inland plateaus (18). This has driven large numbers of subsistence farmers up hillsides—literally to the tops of the mountains—to plant their crops consisting primarily of

rain-fed rice, cassava, and bananas. Little terracing is used. Paradoxically, the plantation crops are mostly perennials that could be successfully cultivated in more marginal areas, and could actually stabilize the soil (18). Some form of government intervention seems to be called for to allocate agricultural resources more rationally, as well as to improve subsistence farming methods (17, 18).

Residential and Other Development

Islands subject to the rapid growth of residential areas, such as Mauritius and Seychelles, are often confronted with the choice of directing development to hillsides where development could be costly and environmentally precarious or allowing development to spread, or "sprawl", into flatter areas that may include prime agricultural territory.

In Seychelles, considerable residential construction has occurred on hillsides and more can be expected as the government moves to tighten up protection of agricultural resources.

In Mauritius, where three-quarters of export earnings have been contributed by sugar, agricultural land preservation is one of the primary objectives of the national physical plan (19). Even so, a large percentage of the island's population lives in Port Louis, the inland town of Curepipe, and the area in between. Planners hope to create development centers in other areas, less suitable for agriculture, but this will increase transportation difficulties for urban workers.

Dredging and Reclamation Projects

A lack of suitable natural harbors has led to major dredging and reclamation projects, the most major being the creation of a new port area in Victoria, on Mahé, Seychelles, just prior to independence. In the future there may be additional reclamation, possibly including the construction of a new coastal road which may or may not be elevated on causeways (20). In Port Louis, Mauritius, there was a reclamation for mosquito control in the 1950's which later became a commercial zone. Parts of the port are also situated on reclaimed land, including a new bulk loading facility, and there are plans to reclaim another area for port uses. There have been no major projects of this sort in the Comoros, but some attention is being given to dredging and expanding the small port at Mutsumudu, Anjouan (17).

Deforestation

Forested areas are especially valuable on the islands because they serve as watersheds and help prevent soil erosion. The chief causes of deforestation are slash-and-burn agriculture (in the Comoros only) and fuelwood collection (Comoros and Mauritius). The rural residents of Seychelles rely primarily on kerosene stoves. But hillside vegetation has been destroyed in certain areas, for example on the island of Praslin, where feuding landholders put the torch to each other's land. On Mauritius, the population is beginning to rely on fuelwood once again as a result of high oil prices; about five times as much wood is

actually removed from the public lands as would be allowed under existing permits.

In the Comoros, forest loss has been characterized as a "crisis situation" (17). Forested areas are being felled for construction materials, industrial uses (including firing retorts on the fragrance plantations), and for domestic use (fuelwood). The only remaining large stands are on the upper slopes of Mt. Karthala, the shield volcano that dominates the island of Grand Comore.

Physical and Development Planning

Because of their limited resources, rugged conditions, and competing demands, the governments of the smaller island states have special needs for effective formulation and implementation of planning controls and development programs. Good physical planning can help avoid user conflicts by referring various classes of activities to suitable areas; prevent hazards by limiting development in hazard-prone areas such as stream beds and coastal flood plains; ensure that utilization of the shorefront is not pre-empted by non-water dependent uses, such as general industrial facilities; protect access to the shoreline for residents and visitors; conserve natural areas; and preserve esthetics and amenities by preventing poor or unsafe residential construction and bad waste management. The viability of tourist facilities is especially dependent on the physical and social characteristics of their immediate surroundings.

In both Mauritius and Seychelles, there are effective systems of land use control through permit issuance, but general plans are vague (as in many other places), and are also not regularly updated (19, 21). Generally, such land use decisions really reflect economic development alternatives because they significantly affect the direction of economic growth. The limited land resources of the islands, and especially the danger of pre-emption of primary agricultural land, require stronger procedures for its allocation. Given the political and social importance of land suitability classification, a high-level decision-making body, perhaps an autonomous lands commission, should be involved. Effective general development planning is also needed to ensure that the absence of sound economic options does not cause lands to be converted to less than optimal uses.

CONCLUSIONS

The environmental problems of East Africa result to a considerable degree from geographical factors, but unplanned helter-skelter development makes a bad situation worse. While there are a few small areas where there is a higher level of socioeconomic development and correspondingly more effective governmental services, for the most part the Region suffers serious and intractable environmental problems. Even where governmental systems function reasonably well, the level of development continues to be threatened by global economic conditions and, from time to time, political instability. But it is in the interior of the littoral states of the continent and Madagascar that the strug-

gle to maintain a viable resource base must be waged. If soil destabilization and forest loss continue at present levels the material basis upon which the large highland populations depend will begin to erode and socioeconomic conditions will decline dramatically. It is unlikely that any massive infusion of outside development capital, or technological inputs, will be able to reverse the degradation of the human environment. If these disturbing trends continue, then the coastlines of the Western Indian Ocean states could be altered on a massive scale. Entire beaches and reefs will be degraded, and disappear. Rather than threatening the deltas, the dams and irrigation systems that are built will themselves be menaced by siltation. There will be greater flooding in river plains. Coastal forests will be further diminished, and coastal dunes and bluffs further destabilized. Fisheries will be enhanced in some areas, and decline in others. Coastal dynamics will change, jeopardizing some areas with erosion while causing siltation elsewhere.

This is not a pretty picture. It will be extremely difficult for the Region's governments to confront such large-scale and diffuse problems. Comprehensive environmental regulations must be devised and enforced. Concomitant with effective legislation must come alternative fuel sources and better agricultural techniques through technical assistance and support. A major financial and organizational commitment will be required to avert disaster. Every effort must be made in the future to mobilize the population to prevent soil loss and to provide them with support to make the inevitable transition to intensive agricultural techniques and renewable energy sources.

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22. The research for this article was performed in connection with UNEP's exploratory mission to the region in October-December, 1981 and subsequent UNEP-sponsored activities. Where no other reference is provided, information contained herein is based on general sources, discussions in the field, and personal observations; also references have been limited to reasonably obtainable materials. No part of the research or conclusions therefrom are related in any way to the author's current professional responsibilities. Further details on the subject of this article may be found in *Marine and Coastal Area Development in the East African Region*, UNEP Regional Seas Reports and Studies No. 6 (final, 1983).

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