

Desertification Control Bulletin

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In the Sahel, overexploitation of inherently fragile resources and prolonged dry years since the 1960s have resulted in vast areas of desertified land. Photo: UNESCO/FAPIS project

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A New Assessment of the World Status of Desertification

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Introduction

A new assessment of the world status of desertification was undertaken by the United Nations Environment Programme (UNEP) in 1990-1991. The aim was to provide reliable and consistent data on the present situation and recent changes in the world's drylands for the United Nations Conference on Environment and Development (UNCED), or *Earth Summit*, to be held from 1-12 June 1992 in Brazil.

Two previous global assessments of the status of desertification had already been carried out: the first in 1976-1977 for the United Nations Conference on Desertification (UNCOD, 1977); and the second in 1983-1984 for UNEP Governing

Council's 12th Session which evaluated progress in the implementation of the United Nations Plan of Action to Combat Desertification (PACD). The PACD was adopted in 1977 by UNCOD and endorsed by the UN General Assembly.

Results of Past Assessments

It was accepted by UNCOD (1977) that *desertification is the diminution or destruction of the biological potential of land, and can lead ultimately to desert-like conditions*. At the time of UNCOD it was found that, within the drylands, the area affected at least moderately by desertification comprised some 3.97 billion ha, or 75.1% of total drylands, excluding hyper-arid deserts, and that the process seriously threatened the well-being and future of peoples in more than 100 countries in different parts of the world. Population in areas that had recently undergone severe desertification and directly affected was estimated at 78.5 million. Annual loss of productive capacity of land due to desertification (income foregone) was globally estimated at US \$26 billion. A twenty-year world-wide programme to arrest further desertification required funding of about US \$4.5 billion annually or US \$90 billion in total.

The 1984 assessment confirmed the scale and urgency of the desertification problem as presented to UNCOD and addressed by the PACD. Desertification had

continued to spread and intensify despite efforts undertaken since 1977 which were too modest to be effective. Land continued to be irretrievably lost through desertification or degraded to desert-like conditions at a rate of 6 million ha annually; land reduced to zero or negative net economic productivity was showing an increase of up to 21 million ha annually. Areas affected by at least moderate desertification comprised 3,100 million ha of rangelands (80% of their total area in drylands), 335 million ha of rainfed croplands (60% of their total area in drylands), and 40 million ha of irrigated croplands (30% of their total area in drylands) - in all, up to 3,475 million ha (or 70% of total area of drylands). Rural populations in areas severely affected by desertification numbered 135 million.

Recently, desertification has become one of the most serious environmental and socio-economic problems of the world, as was stressed in the report of the United Nations Commission on Environment and Development (*Our Common Future*, 1988).

The Concept of Desertification

At the start of this new assessment it was recognized that the existing definition of desertification as adopted by UNCOD in 1977 was not sufficiently operative and grossly inadequate for purposes of quantitative assessment. Two studies were commissioned

order to qualify for outside assistance, the recipient countries should have, or be willing to develop, a sound overall policy structure, including a range of critical macro-economic policies, regulations and institutional arrangements as appropriate to individual country needs; and the projects and programmes to be financed should be cost-effective in as much as only operations that maximize results at low cost and require minimal external assistance to achieve desired results should be included.

The total amount of funding required for anti-desertification programmes is large and various estimates have been identified in recent years. It is clear from current trends that adequate funds are not likely to come from voluntary contributions. It is necessary to consider alternative financial mechanisms at the national, regional and global levels. These would include economic instruments for use locally and globally.

Economic Instruments

In recent years some progress has been achieved, notably in the industrialized countries, with the introduction of a whole range of economic instruments including user's fees, environmental taxes of various types, tradeable emission permits, tradeable resource permits, deposit-refund systems, etc. Compared to the *command and control* approaches to environmental maintenance, the use of such economic instruments permits greater flexibility, higher yields and could result in important benefits to society.

First, in the case of anti-desertification activities, the economic instruments described above could produce a level of total funding which is much higher than that which is currently available to meet the needs of desertification-prone countries.

Secondly, these economic instruments affect market signals. One of the main causes of degradation of land resource systems all over the world (not only in the developing countries) is that the market place is constantly sending out wrong signals as to the real scarcity and value to society of these resources. User's fees (for example, for irrigation and water, use of rangelands, etc) are much more efficient (in the economic sense) because they serve to concentrate resource uses to those users who are the most efficient in treating and developing the resource. Because the fees

are related to the level of use there is also a continuous search for better and more innovative technology in order to reduce costs.

The primary objective of implementing economic instruments is to raise adequate funding for environmental (preferably international) concerns, but there are also important corrective elements involved. In the present state of the art, it is not clear how far the developing countries, and particularly the least-developed countries which are also the desertification-prone countries, will be able to levy user's fees and charges. Such charges would have to be levied in industrial countries and those countries then must decide what percentage would be used for national environmental maintenance problems and what percentage for international concerns such as desertification. In so far as the developing countries are concerned, wherever applied, these economic instruments could contribute to improving or correcting the present situation where the exceptionally low charges for the use of resources (frequently below the marginal cost of supply) are distorting energy prices, water prices, fertilizer and pesticide prices, etc. They could also produce beneficial results in regulating grazing levels in rangelands and fishing in coastal waters, as well as serve as re-cycling incentives.

Needless to say, careful attention must be paid in levying user's fees to the interests of low income groups.

Sources of Funds

In a series of resolutions during 1978-1990, the UN General Assembly addressed the problems relating to financing the UN Plan of Action to Combat Desertification. In response to these resolutions several mechanisms for mobilizing additional resources for this purpose were tested, including the Special Account and Consultative Group on Desertification Control (DESCON); and several studies on likely sources and mechanisms of funding were carried out. So far, no viable mechanism exists for mobilizing the resources required for a world-wide programme of action to combat desertification. One reason for this failure was perhaps related to conceiving such a programme as strictly an *environment* programme.

Programmes for combating desertification, as conceived in this paper, comprise three elements: conservation (preventive measures that maintain productivity of land),

reclamation (regaining land that was once productive) and development of dryland resources. As such these are programmes of sustained development of drylands and within this framework environment and development issues are inseparably knit. So any programme for combating desertification should receive its due share of support from world funds and financial mechanisms for supporting already-established development and environmental programmes (eg, UNDP, UNEP, Global Environment Facility, etc), or programmes that may be established as a consequence of the forthcoming 1992 United Nations Conference on Environment and Development.

Desertification is a truly global issue with field manifestations at the national level. Corrective action remains the prime responsibility of national governments. Each government in the dryland territories should set the combating of desertification problems (within its broader context as outlined in this paper) among its priority actions, adopt policies that ensure that it is accorded its due priority, and establish national mechanisms for monitoring, assessment, planning for action and programming for implementation of national endeavours to combat desertification. These measures should become an integral part of action towards national development and appropriate resources for implementation should thus be made available. In this way, national Plans of Action to Combat Desertification will have their due priority in appropriation of national resources and in planning bilateral aid programmes.

The economics of implementing programmes to combat desertification (and the sustainable development of dryland resources) have their own features: long gestation periods, low rates of return in the short term and the need to build up a necessary infrastructure (transport, energy, communication, settlements and services, etc). As such these programmes may require a special mechanism for mobilizing resources and should not have to compete for resources shared with other objectives. The series of studies requested by the UN General Assembly (Ahmad and Kassas, 1987) survey a number of likely sources of funds for the general purposes of development and protection of the environment in which desertification programmes may have a share. This series also provides a detailed

poor and marginalised populations with limited access to political power, governments in developing countries have tended to magnify the costs of anti-desertification projects and to under-value their benefits and so these projects have been given low priority. Cash-flow problems at local level have further meant that many governments have been reluctant to initiate long-gestation, anti-desertification projects which may, at the same time, be of high risk and uncertainty. But because the ultimate impact of desertification may transcend national boundaries and have a regional or even global impact, and because of the failure of most national economies to meet expenditures to deal with management of drylands, international assistance is justified and should be forthcoming.

This assistance seems particularly needed in two broad areas: transfer of technology and financing of programmes for sustainable development of dryland resources. There is clearly a need for the global community to reconcile two conflicting claims: the desire for economic growth for a rapidly escalating population, including the legitimate aspirations of developing countries to provide for the basic human needs of their populations, and the equally strong desire to restore delicate planetary balances and environmental quality by repairing the damage already afflicted on the natural resource base. The reconciliation essentially depends upon international cooperation based on a sense of a global interdependence and partnership.

Technological Transfer

This is a very broad field: overall, technology means tools and equipment, materials (pesticides, fertilizers, hormones, etc), methods of farming and husbandry, methods of management of farm operations, methods of marketing, etc. There is already available a considerable body of scientific information and technological knowledge that could be applied in various ventures of dryland development. The fact that it is not always applied is primarily due to the inability of local people effectively to assimilate the available knowledge and adapt it to their own situations. This applies to several innovative methods of irrigation and means for enhancing efficiency of water use, fertilizers, soil conditioners and ameliorators, methods for soil conservation, planting

shelter belts, sand stabilization, etc. The need here is to help countries to develop their indigenous science and technology capabilities, including training of technicians and other personnel.

Technological transformation in agriculture, transportation, energy, housing, etc, and the introduction of more benign technologies in dryland resource management may require economic incentives which may need external assistance. Assistance may also be needed in incorporating environmental costs in dryland use programmes.

There is a third group of privately-owned technologies, including bio-engineered organisms, improved crop and fodder plants, improved livestock animals, innovative organisms to be used as bio-fertilizers or pest biocontrols, etc. The international community should look carefully at the opportunities and challenges that agricultural studies are revealing about the prospects of far-reaching improvements to resource management that could be undertaken in developing countries with external assistance.

Lack of indigenous capabilities is not the only major hurdle to technological transformation and its transfer. The other major barrier is the lack of funds to overcome proprietary rights, royalty payments and the like. In the past, international support for the development and transfer of new technologies through research and development funding achieved substantive results in medicines, computers, etc. A similar effort is needed, on a much larger scale, to maintain the productivity and resilience of land resource systems.

One way to resolve some of these problems is through collective self reliance - ie, the establishment of regional mechanisms that can mobilize the resources of several countries. Cooperating countries may be able to gain access to technologies that would be otherwise difficult to obtain, as well as improved means for sustained use of dryland resources. The African Ministerial Conference on Environment (AMCEN, Cairo, 1985) designed a number of African networks of science and technology for purposes of assisting member countries. These networks are now operative with the assistance of UN bodies.

Under the aegis of the Consultative Group on International Agricultural Research, the international donor community established a world-wide network of

international centres of agriculture research. These centres have contributed to the advance of agriculture world-wide and have provided technical services to many countries. This success story of collaborative and fruitful action may inspire the world community to establish a similar world-wide network of international centres of advanced science and technology in fields related to dryland development and control of desertification.

Cost of Corrective Measures

The process of desertification leads to a net reduction (or loss) of biological and economic productivity of land resource systems and thus of their market value. In examining the impact of desertification at national, regional and global level, an economic analysis is helpful in clarifying certain overriding considerations which should govern the availability of external resources.

First, the heavy damage inflicted by desertification at local and national level cannot be adequately redressed without international assistance.

Second, the impact is such that the desertification-prone country cannot be asked to bear the full cost of redress, especially since the balance of benefits is not only with the country concerned but with the international community. The cost-benefit ratio may be changed and the project made viable if the international community makes a substantial contribution to the cost of the project programme.

This could be achieved in part by, thirdly, identifying a substantial advantage to the international community of implementing anti-desertification programmes - eg, global food security.

Fourth, management of desertified lands could be improved and lead to better yields if the project or programme is subject to cost changes or other modifications to permit replicability, greater cost effectiveness and enhanced application.

Fifth, outside assistance should be geared towards training nationals of other countries in ways to lessen the impact of desertification, which will also help lead to a lessening of the global effects of desertification (eg, climate fluctuations and the threat to soils in neighbouring countries).

Apart from these considerations, and in

- * *Cooperative feed warehouses.* Total capacity of these warehouses was 180,000 metric tons.
- * *National Feed Revolving Fund (NFRF).* This is the credit mechanism for supporting the whole operation. The fund received initial support from the government and some international sources: *(It has now (1978) grown to around US \$4.5 million, mostly revolving in support of various activities... NFRF makes available to members of project cooperatives short-term loans for feed purchases and long-term loans for the construction of feed warehouses... World Bank Loan Agreement with the Syrian government where US \$11.5 million loan and collected interest rates, would go back to the NFRF for the following year's operation. (Draz, 1978)*
- * *Government centres.* The government established a network of eight experimental, training and demonstration centres of range management and sheep husbandry on 120,000 ha of rangeland. Experiments included range improvement (schemes such as reseeding and plantation of palatable shrubs); training of staff; extension services; and programmes for selecting and breeding sheep stock.
- * *Restoration of water cisterns.* Cisterns are underground chambers, dating from Roman times, which were designed to collect and store run-off water. Most of the Syrian cisterns had silted up during centuries of neglect; 2,000 were cleared and restored.

With this packet of measures the Syrian steppe rangelands, their livestock and their pastoralist communities are better able to withstand spells of drought. The essence of management here is insurance against natural hazard.

Common Elements

The issues involved in these two cases are different: in the USA, the aim was to reclaim devastated territories and re-establish a system of sustainable development for land and water resources; in Syria, the aim was to provide a system of insurance that would enable the people, their live-

stock and their land to withstand the hazards of drought and/or rainfall failure.

However, although the aims were different, three equally important elements were common to both solutions:

- * application of new/appropriate technologies,
- * availability of additional funds,
- * societal and managerial re-structuring.

Two factors ensured success to the two endeavours: political will as shown by both governments and positive public participation by the communities concerned. Wide-ranging and effective extension services are essential for the latter.

An Economic Analysis: general considerations

Whether considered in their local (national) dimension or in their world-wide extent, the drylands (territories in the arid, semi-arid and dry-subhumid regions of the world) present a number of general features:

- * they comprise more than 40% of the land surface of our planet;
- * they comprise areas that are extremely arid (little or no rainfall) and broader areas with low (insufficient for permanent farming) rainfall which is often un-reliable;
- * they have considerable resources of oil, minerals, etc;
- * their climate is dry, sunny and warm;
- * extensive drylands are coastal lands;
- * they have land space available for non-agricultural uses (settlements, industrial centres and energy parks, etc).

Sustainable development of the resources of the drylands needs to encompass three considerations:

- * conservation of productive land (farmlands, pasturelands, etc) in order to prevent its ecological deterioration. This may also include mechanisms for insurance against recurrent drought;
- * reclamation of desertified territories, ie, lands that were once productive but have now become non-productive;
- * development of *all* dryland resources for agricultural and non-agricultural uses.

Sustainable development that integrates

these three considerations will also set the drylands and their inhabitants on a par with other, more fortunate, parts of the country. Development of the drier parts of USA during recent decades (eg, the State of Arizona) proved that there are many lessons to be learned, particularly with regard to non-agricultural use of land resources.

Land use world-wide comprises two principal categories: agricultural use and non-agricultural use. The latter seems economically remunerative: urban, industrial, recreation, resorts, oil and mining centres, etc. But agricultural use has become less and less economically viable. We may note that in the fertile lands of Western Europe, where highly productive technologies and management are used, agriculture has remained dependent on economic subsidies throughout recent decades.

Agricultural uses of land, including programmes of desertification control and reclamation of desertified land, cannot be expected to be economically remunerative in the short term. But in terms of stability and security for the immediately-affected population, and the effects on regional security, world climate and biodiversity, the social dividends resulting from agricultural land use are surely positive.

However, actions to combat desertification and to develop dryland resources are still considered part of national responsibilities, even though governments in developing countries prone to desertification do not seem capable of giving dryland programmes high priority in development expenditure budgets. The reasons behind this are complex. Desertification reflects not only the inherent fragility of particular land resource systems but is also indicative of the pressures generated by growing populations, the increasing need for food and agricultural produce, economic growth, demands of trade and external debt, macro economic policies to support State objectives and the myriad of other by-products generated by the development process. Although domestic and external financing is made available for development, the same attention and urgency is not paid to the *effects* of development.

The escalating pressures of high population growth rates and increasing needs of individuals put pressure on land and government resources. Since the people most affected by desertification are typically the



Developing countries need external assistance if local populations are to assimilate available technology and apply it to their own situations. Photo: UNEP/Tibor Farkas

materials (UNESCO, 1960). Loss of populations of these plants and their wild relatives would represent loss of valuable and irreplaceable genetic materials. The impact of desertification on loss of germplasm resources may be, from an economic point of view, no less severe than the impact of deforestation.

The impact of desertification on climate is varied. First, deserts and desertified territories are sources of atmospheric dust that could act to modify the scattering and absorption of solar radiation in the atmosphere. Its effect on temperature would depend on the altitude at which it is borne. The climatic impact of suspended particulate substances in the atmosphere may be no less than that of many other pollutants (greenhouse gases).

The impact of impoverishment of plant cover on the ground surface energy budget and the adjoining air temperature has been the subject of many studies (Jackson and

Idso, 1975; Balling, 1988, 1991; Schlesinger *et al*, 1990, etc). Two processes are involved: increased surface albedo and reduced removal of soil moisture by evapotranspiration. Balling's (1991) measurements show a perceptible increase in ground surface temperature and in near-surface atmospheric temperature as a consequence of desertification. Regional and global impacts are discussed by Schlesinger *et al* (1990).

The extensive areas of non and low-productive drylands (natural deserts and desertified lands, as well as other drylands, covering around 40% of the world land area) have little part in the global sinks of carbon dioxide. With the exception of hyperarid deserts they represent space available for programmes of afforestation and other forms of plant growth. The greening of these areas would enhance the global sinks for greenhouse gases.

Management of Desertification and Drought

Kassas (1988) describes briefly two case studies from USA and Syria to illustrate the management processes that are likely to succeed in addressing desertification (over-exploitation of the resources of a fragile system) and drought (natural recurrent hazard).

The USA Case Study - a desertification management package

The history of USA arid and semi-arid lands (Logan, 1961; National Science Foundation, 1977; Warrick *et al*, 1975) may be briefly described as follows. In the early 1930s the Great Plains region of western

ecological fragility of the land resource system. This exploitation is in the form of three principal land use operations in drylands: irrigated farming, rainfed agriculture and pastoralism. Other vegetation-related uses include wood cutting, collecting special plants for their medicinal and other uses, etc. To these we may add hunting game animals, etc.

Excessive human pressures on resource ecosystems relate to the:

- * increase in human numbers and escalation of human needs;
- * socio-political processes that bring pressures on rural communities for orienting their production towards national and international markets;
- * socio-economic processes that reduce the market value of rural products and escalate the prices of goods needed by rural people; and
- * processes of national development, especially programmes for farmland expansion for production of cash crops, that exacerbate conflicts over land and water use and often reduce areas available to marginalised communities.

Definitions of Desertification

Odingo (1990) and Rozanov (1990) reviewed various literal definitions of the term *desertification*. A Consultative Meeting on the Assessment of Desertification (UNEP, Nairobi, February 1990) adopted the following definition:

Desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from adverse human impact.

Webb (1987) quotes the following definition of land degradation:

land degradation is a change in the state of the terrestrial component of global ecosystems that threatens human welfare now and/or in the future.

Land degradation/desertification is a broader concept than soil degradation since it deals with the whole ecosystem in which soil is just one of the components. In many instances of desertification (eg, reduction of range productivity due to invasion of thornbush, a widespread form of range degradation in USA, South Africa and Australia), degradation of vegetation may not be associated with soil degradation.

Desertification is often confused with drought. Although they are both prevalent in drylands and appear to cause similar sorts of damage, they are two entirely distinct phenomena. Desertification is a process of ecological degradation of dryland resource systems that is slow and insidious. It is caused by a combination of the inherent ecological fragility of the land and water resources that form the life-support systems of dryland societies, and the subsequent pressure put on these resources through overuse by these societies. Like other forms of degradation, desertification is induced by mismanagement so better control of land and water resources is one of the most effective corrective measures.

Recurrent drought is one of the causes of the inherent fragility of the resource system. But drought is a natural hazard caused by rainfall failure which is itself a characteristic of dryland climate. Incidences of drought are irregular and unpredictable and the damage caused is sudden and often dramatic. This means that drought should be managed like other recurrent hazards of nature - by instituting insurance mechanisms which would enable societies and their resource base to survive spells of drought.

We shall refer to cases of management of drought and of management of desertification to show their differences.

Impacts of Desertification

Like all major ecological changes, desertification may have impacts at three levels: on-site, off-site and global.

On-site impacts relate to changes in:

- * plant growth (reduction of standing biomass, replacement changes, reduction of primary productivity, extermination of certain species or populations, etc);
- * animal life (reduction of populations of wild animals including soil fauna, degradation of livestock, etc); and
- * surface deposits (soil erosion, loss of organic matter, salinization, crusting, etc).

These changes often cause changes to the microclimate and add to the dust load of the atmosphere.

Societies dependent on land productivity are hard-hit as their life-support sys-

tem deteriorates. They may, under fortunate conditions, change to some other life-support system - as did the coastal land pastoralists in Somalia who became fishermen, or the nomads of Eastern Sudan who settled in the Khashm-el-Girba irrigation scheme. But it is far more likely that they will move to new territories or to relief camps.

Off-site impacts are many and varied, including:

- * Surface deposits that are transported through water and wind erosion and pile sediments on downstream sites of productive lands, roads, railways and water reservoirs;
- * Suspended particulates (dust) that affect the health of livestock and people and reduce visibility; and
- * Salinized surfaces of deserted irrigated fields become sources of salt particles and may be wind-carried to other productive farmlands.

Dregne (1991) quotes one study on wind erosion in the State of New Mexico (USA) that concluded: *off-site costs were about 45 times greater than on-site costs.*

Another off-site impact is the forced movement of people who have to leave the land because their life-support system has deteriorated. These *environmental refugees* bring menacing pressures to their host-sites. This is currently one of the very serious environmental hazards on the African continent and is one of the causes of political strife.

On a global scale the impacts of desertification relate to its effects on world food-producing capacity, world bio-diversity and world climate. The loss or reduction in productivity of extensive areas would entail reduction in the world's food-producing potential and create food deficits in menaced regions with subsequent impacts on world food reserves and food trade.

Desertification entails the destruction of vegetation and diminution of many plants and animal populations. It is an effective cause of loss of species. Many crops (wheat, barley, sorghum, millet, etc) and fodder species that form the backbone of world agriculture and pasture husbandry, have their origins in arid and semi-arid territories (Vavilov, 1949; Barigozzi, 1986). Hundreds of wild plant species native to arid lands are sources of valuable medicinal

Ecological Analysis: The Processes and Results of Desertification

As with other forms of habitat degradation, desertification may be studied and monitored as a process of ecological retrogression with a sequence of phases, or be described and recorded as the cumulative result (manifestation) of the process. Whether we consider the process or its manifestation, the most pertinent symptoms relate to reduction of economic productivity and hence depreciation of the market-value of land. Manifestations include:

- * reduction or failure of yield in irrigated or rainfed farmland;
- * reduction of biomass produced by rangeland and consequent depletion of feed material available to livestock;
- * reduction of available wood biomass, and consequent extension of the distance to be travelled to obtain fuelwood;
- * reduction of available water due to subsidence of river flow or groundwater resources;
- * encroachment of sand bodies that may overwhelm productive land, settlements or infrastructures;
- * disruption to society due to deterioration of life-support systems and the society's consequent need for outside help (relief aid) or for its people to seek haven elsewhere (environmental refugees).

The symptoms of this ecological degradation are varied. Deterioration of irrigated farmland is often related to the build-up of the water table near the soil surface (waterlogging), primarily due to an imbalance between irrigation and drainage systems. Salinization, which builds layers of salt-rich crusts at soil sub-surface or surface, may result from waterlogging, low-quality irrigation water or intrusion of subsurface saltwater. Other chemical changes, such as alkalinization, may follow. Deterioration of rainfed farmland is often manifested as soil erosion, loss of organic matter and nutrients, compaction and crust formation, and extensive invasion of weeds including noxious parasites, etc.

Symptoms of degradation of rangelands



In the USSR Middle Asia region around 2 million hectares of irrigated land has been affected by salinization and another 9.5 million hectares has been salinized as a result of the drop in sea level. Photo: WHO/Novosti

include: reduction of bioproductivity, invasion of (ie, replacement by) non-palatable species including succulents and thorn-bushes, soil erosion, poorer livestock, etc.

Similar degradation may occur in all climatic zones of the world but the result is not the same for every zone. In the drylands the final stage is a desert-like landscape; in regions of wetter climate the ecological degradation of, for example, oak forests in southern Europe, may result in scrublands of the *maquis* and *garrigue* types; in tropical woodlands ecological degradation may end in a savanna-like grassland. We noted

in the aforementioned survey of land degradation in Australia that land degradation in non-arid areas was mostly manifested as soil erosion, whereas in arid areas degradation affected vegetation with or without soil erosion.

Causes

The causes of these various forms of ecological degradation relate to a combination of excessive human exploitation that oversteps the natural carrying capacity of the land resource system and the inherent

	million ha
degradation of vegetation	
by overgrazing	66.4
degradation of vegetation	
by undergrazing	0.4
partial desertification	
around wells	10.2
wind erosion	5.9
salinization of irrigated lands	2.1
technogenic desertification	11.6
salinization caused by	
sea level drop	9.5
water erosion	1.2
Total	107.3

The area affected represents about 60% of the territories surveyed; almost all the remaining 40% is true desert.

China

Extensive studies on desertification were carried out in China (Zhu Zhenda *et al.*, 1988). A desertification map of China at a scale of 1:4 million is being published and several experimental maps (larger scale) are available. According to these studies, 334,000 km² are already desertified. Shifting sand is a prominent issue: 42.2% of desertified land is classified as sandy steppe and 52.3% as re-activated sand dunes and shifting sands.

The Chinese studies classify the causes of desertification as follows:

over-cultivation of	
marginal steppe land	25.4%
collection of fuelwood	31.8%
sand dune encroachment	5.3%
misuse of water resources,	
destruction of vegetation,	
technical problems	37.5%

India

ICAR/CAZRI (1988) assesses that out of a total area of 231,000 km² of Western Rajasthan:

desertified area	9,290 km ²	4.35%
at high risk	135,292 km ²	63.26%
at medium risk	67,400 km ²	31.51%
at slight risk	1,900 km ²	0.80%

Singh (1989) estimates that out of the total area of India (328.6 million ha), about 53% of land is subject to various forms of land degradation:



In Sudan nearly 97 million hectares of rangelands have been affected by desertification. Photo: UNEP/Dan Stiles

	million ha
areas subject to water erosion	111.3
areas subject to wind erosion	38.7
areas degraded	
through:	
waterlogging	6.0
alkalinization	2.5
salinization	5.5
ravines & gullies	3.97
shifting cultivation	4.36
ravine processes	
& torrent	2.73
Total area (53%)	175.06

Africa

The desertification menace to the continent of Africa is well known. The prolonged drought that brought catastrophic losses of land and livestock resources during 1968-1986 induced the UN General Assembly, the UN system of agencies and programmes and the international community to mobilize considerable resources of relief and assistance to aid the bedeviled continent.

National surveys show widespread land degradation. In Sudan, desertification affects 1.6 million ha of irrigated farmlands (94.1% of total), 8.8 million ha of rainfed croplands (82.2% of total), and nearly 97 million ha of rangelands. In the northern and north-eastern regions of Nigeria, 12.5 million ha are subject to ecological degradation. A recent study in six countries of Southern Africa (Darkoh, 1989) showed a highly significant increase in desertification since 1977 in Lesotho. The increase in

Botswana, Madagascar, Tanzania, Zambia and Zimbabwe was less severe, but it was noted.

Australia

Surveys of land degradation in Australia (Wood, 1983; Chartres, 1987) divide the continent into a non-arid part (annual rainfall more than 500 mm) and an arid part (annual rainfall less than 500 mm). In the non-arid part (total area 1.8 million km²), 757,000 km² (42%) show degradation due to:

	km ²
water soil erosion	577,000
wind soil erosion	55,000
vegetation degradation	92,000
salinization of soil	19,000
other forms	14,000

55% of the non-arid lands show no recognizable degradation.

In the arid part (total area 3.35 million km²) 55% show degradation (desertification) manifested as:

	km ²
vegetation degradation	
(little soil erosion)	950,000
vegetation degradation	
(some soil erosion)	467,000
vegetation degradation	
(substantial	
or severe soil erosion)	432,000
salinization	1,000