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Human Activities Leading To Desertification

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ABSTRACT: Desertification is generally viewed as an advanced stage of land degradation. The UN has defined desertification as a “diminution or destruction of the biological potential of the land which can lead ultimately to desert-like conditions.” Desertification can occur when extended periods of drought in arid, semi-arid, or dry sub-humid areas — known as drylands — sap the land’s productivity until it becomes “dead” soil. In addition, human activities often contribute to the process. While people have managed fragile drylands successfully for millennia in many parts of the world, pressure upon the land is much greater today as roughly 2 billion people inhabit drylands around the world.

KEYWORDS: desertification, deforestation, human activities, land degradation, management, erosion, global population

I. INTRODUCTION

Human activities that contribute to desertification include the expansion and intensive use of agricultural lands, poor irrigation practices, deforestation, and overgrazing. These unsustainable land uses place enormous pressure on the land by altering its soil chemistry and hydrology. Eventually, overexploited drylands suffer from erosion, soil salinization, loss of productivity, and decreased resilience to climatic variations. Land management plays a particularly large role in highly populated regions of less developed countries, where population growth is placing increased pressures on marginal lands. Global warming due to the atmospheric buildup of carbon dioxide and other gases emitted by fossil fuel combustion threatens to complicate this picture in the future. A rise in global temperatures is likely to accelerate the process of desertification as evaporation rates increase.[1,2] While these various causal factors have been identified, the actual process of desertification remains poorly understood. For instance, it is difficult to pinpoint when drought, which is driven by temporary changes in atmospheric circulation patterns, may become a long-term, permanent condition. Some meteorologists and soil scientists measure the impacts and length of a drought to determine if it is an example of desertification. Droughts can persist for months or years, but eventually subside; lands undergoing desertification never recover past productivity. In the United States, for example, 65 percent of the country was affected by drought in the 1930s, but the Great Basin eventually recovered, and modern occurrences of drought usually affect no more than 10 percent of the land.

As social and political forces intensify the pressures on the land that lead to desertification, land degradation itself can lead to further disruption of societal and political stability. The loss of fertile soil, water, and other resources, both for subsistence and for commercial use, leaves many people in dryland areas without the means to support themselves and their children. These displaced populations often migrate to urban areas or to other countries, adding to population pressures and sometimes increasing the likelihood of social and political conflict. According to the Natural Heritage Institute, [3,4] many of the illegal immigrants who enter the United States from Mexico each year are fleeing the country’s severely degraded lands, which make up 60 percent of the country’s territory. Worldwide, the International Committee of the Red Cross estimates that 25 million of the world’s refugees — 58 percent — are fleeing degraded lands. With exponential growth in human population and consequential destruction of natural vegetation and habitats of other living beings for urbanization, industrialization in both developed and developing countries, there is large scale deforestation in tropical and subtropical countries in the world.

Deforestation simply refers to cutting down of trees and the destruction of natural vegetation in an aggressive way. Factors Responsible for Deforestation:-

The following factors are responsible for deforestation –

- Rapid growth of population in the developing countries.

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- Extension of agriculture and grazing land.
- Increasing demand for lumber, timber, paper, pulp, fuel-wood, and charcoal and other forest produce.
- Industrialization, urbanization, and consumerism in the developed and developing countries.
- Demand of raw material for forest-based and agro-based industries.
- Demand of land for infrastructure such as roads, highways, railways, irrigation, electricity, telecommunication services, and civic facilities.
- Construction of multi-purpose dams all over the world.
- Practice of shifting cultivation in the humid-tropical regions of the world.
- Change in food habits – a visible shift from vegetarian food to non-vegetarian food.
- High rate of poverty in the third world countries; it is said that poverty directly or indirectly lead to deforestation.
- Both natural and man-made forest fire.
- Delayed administrative decision and dilatory implementation of forest laws in developing countries.[5,6]

Desertification is defined by the UN Convention to Combat Desertification (CCD) 1995 as land degradation in arid, semi-arid, and dry-sub-humid areas resulting from various factors including climate variation and human activities. The problem of desertification is common to the susceptible dry-lands, with land degradation such as soil erosion, internal soil changes, depletion of groundwater reserves, and irreversible changes to vegetation communities. The term desertification was coined by the French botanist, Aubreville, in 1949 to describe land degradation. Desertification is more anthropogenic (man-made) than it is natural. It is well-acknowledged that the principal agent of land degradation is human activities. The tropical and sub-tropical lands are more prone to desertification. An estimate made by the United Nations (UN), about 40 percent of the African continent's non-desert land is in danger of experiencing desertification. About 33 percent of Asia's land and about 20 percent of Latin America land area are equally threatened with desertification. Countries with extensive and severe desertification are Jordan, Lebanon, Somalia, Ethiopia, Southern Sudan, Chad, Mali, Mauritania, and Western Sahara.[7,8]

II. DISCUSSION

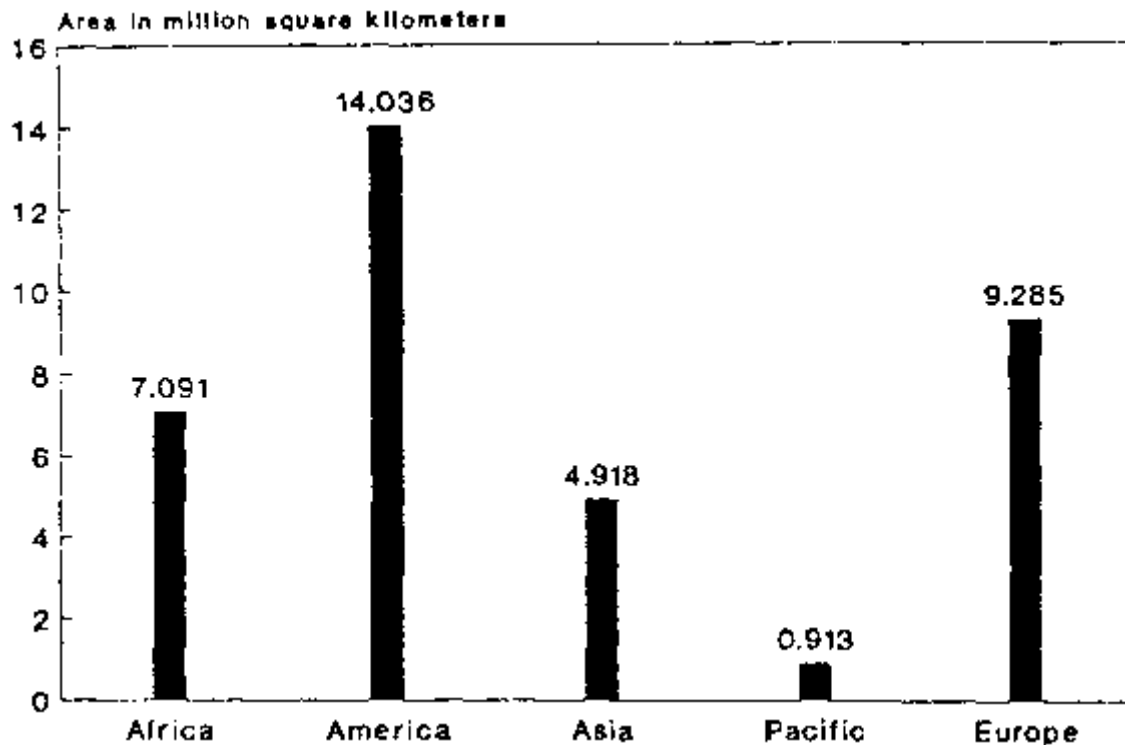
The forests that occupy more than a quarter of the world's land area are of three broad types - tropical moist and dry, temperate, and degraded. The rapid loss of tropical forests, due to competing land uses and forms of exploitation that often prove to be unsustainable, is a major contemporary environmental issue. The main concern globally is with tropical forests that are disappearing at a rate that threatens the economic and ecological functions that they perform. Deforestation in developing countries is more recent, with tropical forests having declined by nearly one-fifth so far in this century. Areas of forests and woodlands at the end of 1980 as assessed by the Food and Agriculture Organization of the UN (FAO) are shown. Deforestation is a much-used, ill-defined, and imprecise term that tends to imply quantitative loss of woody vegetation. There can also be qualitative changes in forests, from, say, species-diverse tropical forests to single-species eucalyptus or pine plantations, or to less species-rich secondary (regrowth) forests. Each year, around 4 million hectares (ha) of virgin tropical forests are converted into secondary forests (Barrow, 1991). However there is little distinction in most of the literature between vegetation loss that will "heal" and that which will not.[9,10]

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Fig. 1. Area of forests and woodlands by continent, end 1980 (km million)



According to the 1989 World Development Report (World Bank 1989), the 14 developing countries in South America, Africa, and South-East Asia where more than 250,000 ha of tropical forests are destroyed annually represent a wide range of third world development problems. They defy easy stereotypes: populations ranged from 11 million in Ecuador to 853 million in India; the percentage of the total population living in rural areas ranged from 15 per cent in Argentina to 82 per cent in Thailand; per capita GNP ranged from US\$170 in Zaire to over US\$2,600 in Argentina; total debt owed to foreign institutions varied from US\$9 billion by Zaire to over US\$110 billion by Brazil; and this debt as a percentage of total GNP ranged from 31 per cent in Peru to 140 per cent in Zaire (Wood, 1990). More recent statistics on deforestation suggest that, for tropical forests, the overall annual rate in the 1980s was 0.9 per cent. This is also the rate in Latin America, with Asia's rate somewhat higher (1.2 per cent) and Africa's somewhat lower (0.8 per cent) (World Bank, 1992). However, current rates of deforestation do not provide an indication of the current conditions of forests on these continents because historically damage may already have taken place at a very high level in the past, leaving highly devastated areas wherein scope for further damage is low. Severe human pressures on forests in many tropical developing countries, especially those resulting from a need to provide for the welfare of numerous poor rural dwellers, will continue to threaten the existence of these resources. In parallel, forests continue to be lost in many developed countries owing to over-harvesting, inadequate regeneration, clearance for agriculture and urbanization, and air pollution. The major causes of deforestation are discussed below. Forest degradation and loss from the spontaneous expansion of people's activities into forest lands is notoriously difficult to quantify. Shifting agriculture is the primary cause of deforestation, accounting for about 45 per cent of the 7.5 million ha losses in tropical forests in 1976-1980. In 1980 it accounted for 35 per cent of deforestation in Latin America, 70 per cent in Africa, and 49 per cent in South-East Asia (notably Sri Lanka, Thailand, north-east India, Laos, Malaysia, and the Philippines) (Tolba et al., 1992).[11]

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Fig. 2. Area of forests and woodlands in the top 10 countries in the Asia and Pacific region, 1983 (million hectares)

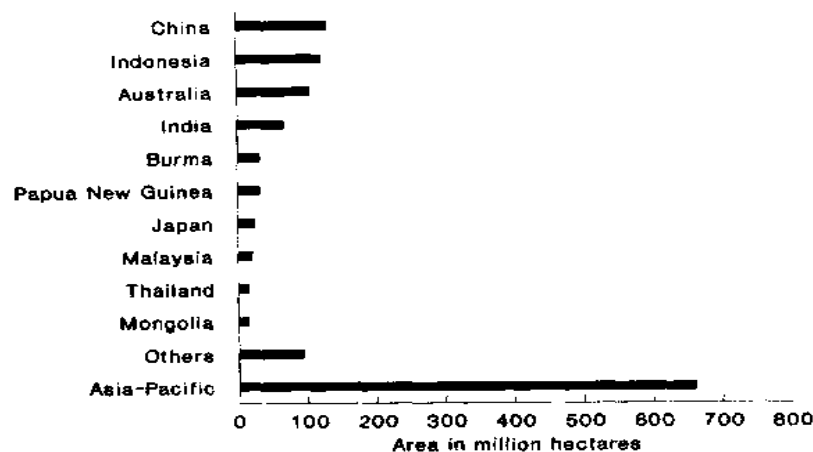
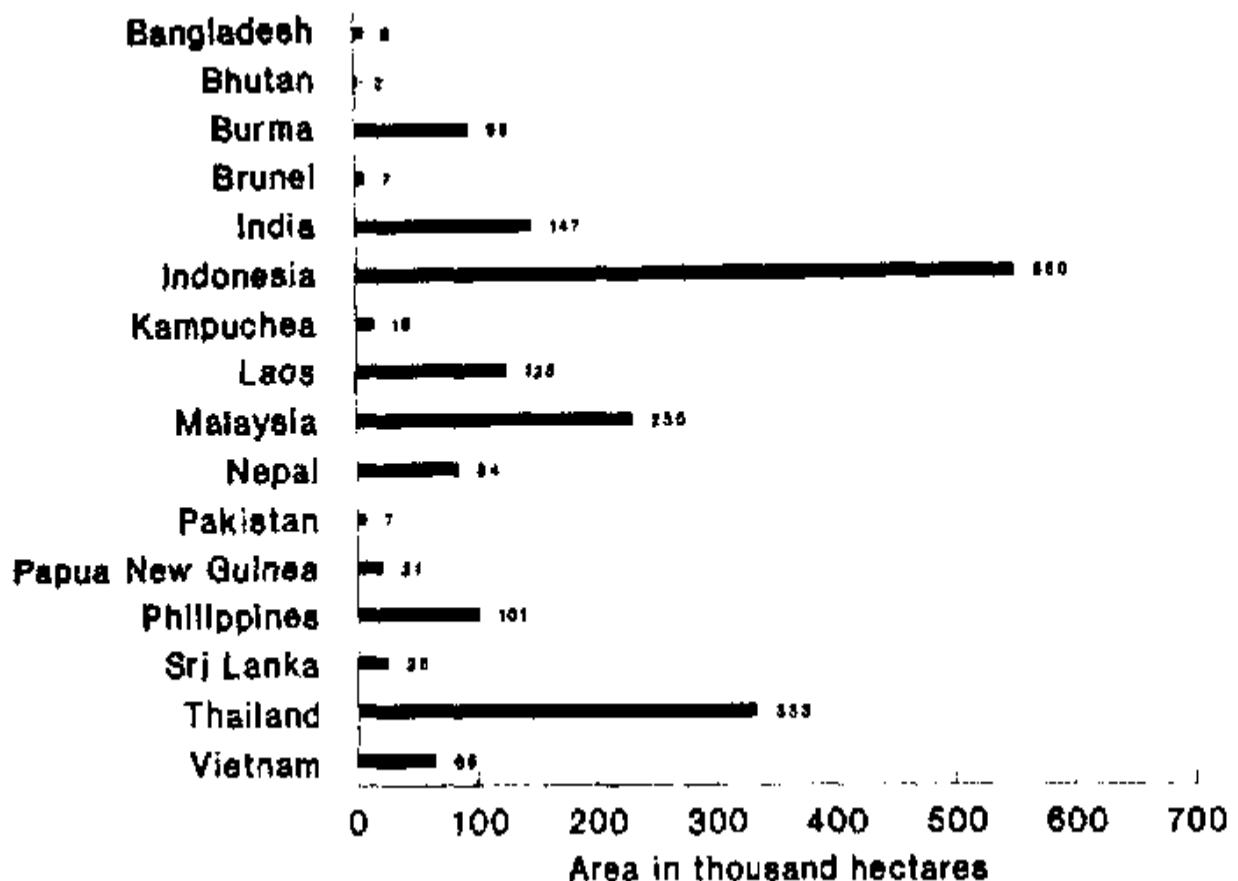


Fig.3. Annual deforestation by country in the Asia and Pacific region, 1976-1980 ('000 hectares)



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Grazing and ranching

Domestic animals in tropical woodlands and forests reduce regeneration through grazing, browsing, and trampling. India alone has about 15 per cent of the world's cattle, 46 per cent of its buffaloes, and 17 per cent of its goats. The spread of irrigated and cultivated land in India has forced livestock owners into forest areas, where 90 million of the estimated 400 million cattle now reside, whereas the carrying capacity is estimated at only 31 million (Government of India, 1987).

Fuelwood and charcoal

Exploitation for fuelwood and charcoal is mainly a problem of tropical and subtropical woodlands, although there are examples of closed forests being severely affected (notably in India, Sri Lanka, and Thailand).[12]

Timber exploitation

On a global scale, increasing demand for industrial roundwood accounts for marginally less exploitation than fuelwood, although it remained high at around 1.7 billion m in 1989 (Barrow, 1991).

Plantations

A smaller, but none the less significant, reason for the removal of natural forests is the planting of tropical tree crops such as rubber, oil palm, and eucalyptus, more so because the rate of plantation establishment is less than rates of deforestation.

Atmospheric pollution

The overall stress of pollution brings about nutrient deficiencies thereby rendering the vegetation vulnerable to droughts, insects, and pests. The growth, development, and decline of forests have always reflected the integrated effects of many variables. Acid rain has now been added to this list. It may not be possible to establish definite proof of the link between acid precipitation and damage to vegetation. The body of circumstantial evidence is large, however, and supports the view that the terrestrial environment is under some threat from acid rain. In addition to the above, the expansion of communication, the construction of large dams, the failure to assist the poor, and climatic anomalies of fire and drought only aggravate this problem further.[13,14]

III. RESULTS

The development of desert-like conditions where none existed previously has been described in many ways. Definitions of desertification are usually broad, including losses of vegetative cover and plant diversity that are attributable in some part to human activity as well as the element of irreversibility. These definitions are not confined to advancing frontiers of sand that engulf pastures and agricultural land, as often shown visually in the media. Various indicators of this phenomenon are listed in table 6.1 (Barrow, 1991).

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Table 1. Indicators of desertification

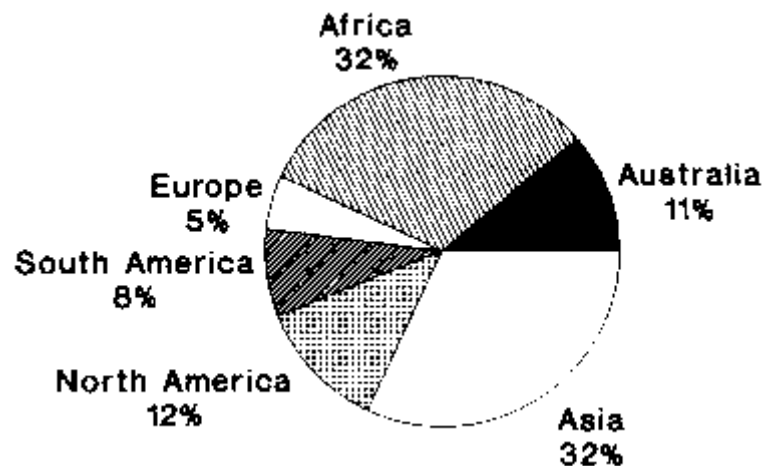
Physical indicators	Decrease in soil depth
	Decrease in soil organic matter
	Decrease in soil fertility
	Soil crust formation/compaction
	Appearance/increase in frequency/severity of dust sandstorms/dune formation and movement
	Salinization/alkalinization
	Decline in quality and quantity of ground and surface water
	Increased seasonality of springs and small streams
	Alteration in relative reflectance of land (albedo change)
Biological indicators	
Vegetation	Decrease in cover
	Decrease in above-ground biomass
	Decrease in yield
	Alteration of key species distribution and frequency
	Failure of species successfully to reproduce
Animal	Alteration in key species distribution and frequency
	Change in population of domestic animals
	Change in herd composition
	Decline in livestock production
	Decline in livestock yield
Social/economic indicators	Change in land use/water use
	Change in settlement pattern (e.g. abandonment of villages)
	Change in population (biological) parameters (demographic evidence, migration statistics, public health information)
	Change in social process indicators - increased conflict between groups/tribes, marginalization, migration, decrease in incomes and assets, change in relative dependence on cash crops/subsistence crops

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Fig. 4. World arid lands by continent (Source: UNEP, 1991)



The nature and scope of the problem

The UNCED defined desertification as land degradation in the arid, semi-arid, and sub-humid areas resulting from various factors, including climatic variations and human activities. These areas are subject to serious physical constraints linked to inadequate water resources, low plant formation productivity, and general vulnerability of biological systems and functions. Whereas on an individual basis animal and plant species are each a model of adjustment and resistance, ecological associates and formations are easily disturbed by the pressures exerted by rapidly growing populations and their livestock. Desertification has become a longstanding and increasingly severe problem in many parts of the world, and in developing countries in particular. According to a UNEP (1984) estimate, 35 per cent of the earth's land surface (4.5 billion ha) - an area approximately the size of North and South America combined - and the livelihoods of the 850 million people who inhabit that land are under threat from desertification. Currently, each year some 21 million ha are reduced to a state of near or complete uselessness. Projections to the year 2000 indicate that loss on this scale will continue if nations fail to step up remedial action (World Bank, 1992). The distribution of the world's arid lands by continent is shown .[15,16]

Trends in desertification

Global statistics on trends in desertification are scanty. However, estimates of trends are possible for areas where detailed assessments

Table 2. Some examples of desertification trends

Kenya	At Lake Baringo, an area of 360,000 ha, the annual rate of land degradation desertification between 1950 and 1981 was 0.4%. At Marsabit, an area of 1.4 million ha, it was 1.3% for the period 1956-1972.
Mali	In the three localities of Nara, Mordiah, and Yonfolia, with a total area of some 195,000 ha, the average annual rate of loss during the past 30-35 years has been of the order of 0.1%.
Tunisia	The annual rate of desertification during the past century was of the order of 10% and about 1 million ha were lost to the desert between 1880 and the present.

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China	The present average annual rate of desertification/land degradation for the country is of the order of 0.6%, while in such places as Boakong County, north of Beijing in Hebei Province, it rises to 1.3%, and to 1.6% in Fenging County.
USSR	The annual desertification/sand encroachment rate in certain districts of Kalmykia, north-west of the Caspian Sea, was recently estimated at a level as high as 10%, while in other localities it was 1.5-5.4%. The desert growth around the drying-out Aral Sea was estimated at about 100,000 ha per year during the past 25 years, which gives an annual average desertification rate of 4%.
Syria	An annual rate of land degradation of 0.25% was found in the 500,000 ha area of the Anti-Lebanon Range north of Damascus for the period 1958-1982.
Yemen	The country's average annual rate of abandonment of cultivated land owing to soil degradation increased from 0.6% in 1970-1980 to about 7% in 1980-1984.
Sahara	An analysis using a satellite-derived vegetation index shows steady expansion of the Sahara between 1980 and 1984 (an increase of approximately 1,350,000 km) followed by a partial recovery up to 1990 (Tucker et al., 1991).

The causes and the process

Much damage has been inflicted on the economic activities in the arid regions, leading to a great deal of hardship for the majority of the people there. Very few parts of the arid zone have been spared. What accounts for this unhappy situation? The answer is twofold. Firstly, human pressure in the dry zones has grown enormously in recent decades owing to an increase in population. The needs for food, water, fuel, raw materials, and other natural resources have grown accordingly, exceeding the carrying capacity of the land in most cases. Secondly, many recent years have seen protracted drought, sometimes lasting for over 20 years. Under natural conditions, such failures of expected rainfall would have had little effect, but coupled with the human pressures they have produced disastrous results. Soil erosion caused naturally by prolonged droughts and by various activities that abuse and over-exploit the natural resources are, in essence, responsible for the advance of deserts. Advancing deserts provide negative feedbacks to the root causes, thereby accelerating the process of desertification further. Whatever the causes, the processes of degradation or desertification involve damage to the vegetation cover.

The implications of deforestation and desertification

The environmental hazards of desertification and deforestation, though distinct, provide mutual feedbacks and are far from being independent of each other. They consequently have similar implications and solutions. Desertification and deforestation involve a drastic change in microclimates. For instance, if shrubs and trees are felled, the noonday sun will fall directly on hitherto shaded soil; the soil will become warmer and drier, and organisms living on or in the soil will move away to avoid the new harshness. The organic litter on the surface - dead leaves and branches, for example - will be quickly oxidized, the carbon dioxide being carried away. So too will be the small store of humus in the soil. All these changes in microclimate also bring about ecological changes. The ecosystem is being altered, in most cases adversely. Hence, these processes result not only in a loss of biological productivity but also in the degradation of surface microclimates. Phenomena such as global warming and the greenhouse effect, which have their origin in deforestation and desertification, among many other causes, are more serious, global in scope, and therefore potentially more threatening.[17,18] Deforestation and desertification adversely affect agricultural productivity, the health of humans as well as of livestock, and economic activities such as eco-tourism. Hence, they have serious socio-economic implications too. In Asia, some 30 million people living in the coldest zones of the Himalayas were unable to ensure their energy supply in 1980, according to estimates for that year, despite overutilization of all the wood available. Approximately 710 million people were in a situation of decidedly inadequate fuelwood supplies, mainly in the highly populated zones of the Ganges and Indus plains and in the lowlands and islands of South-East Asia. It is estimated that

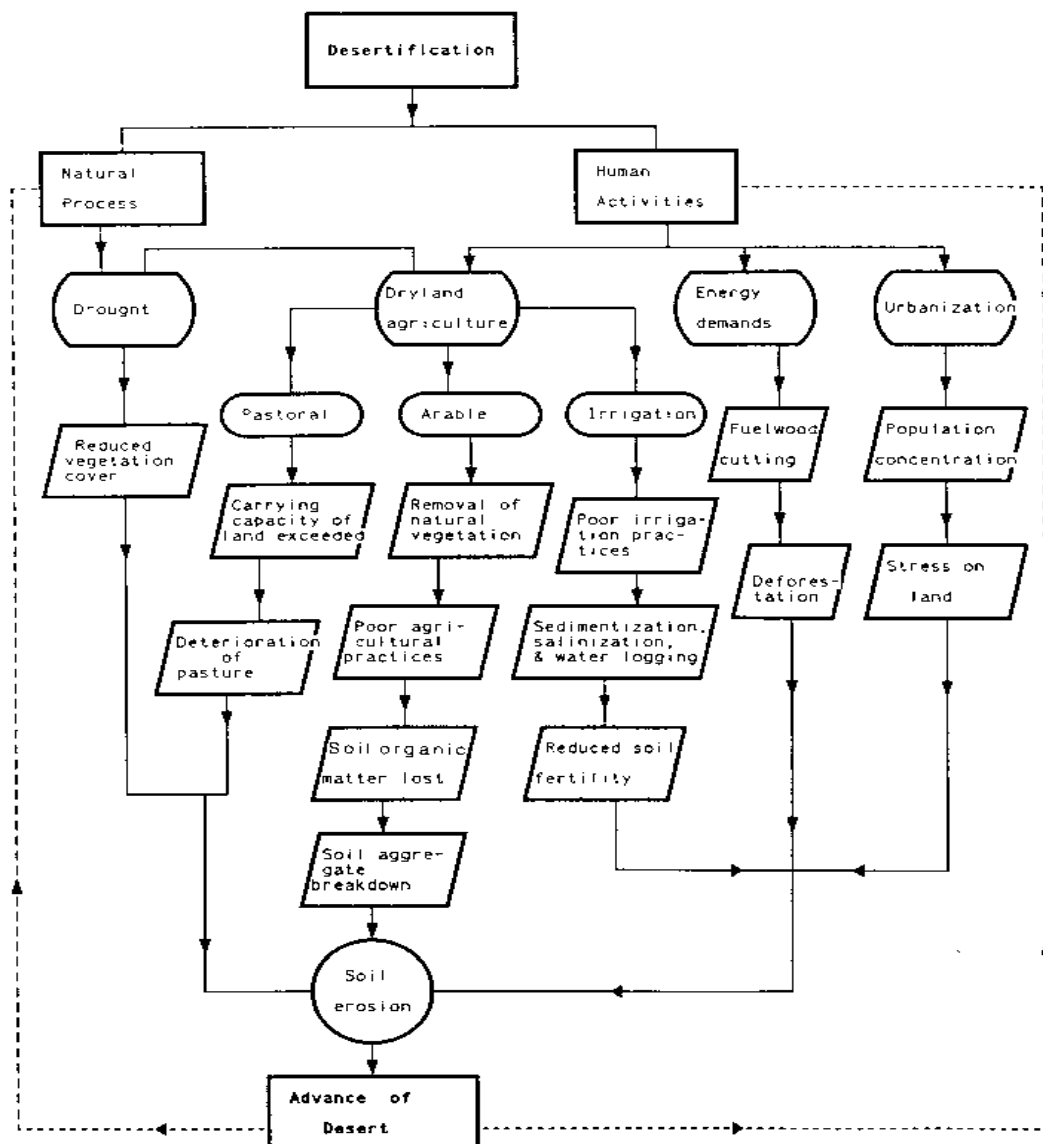
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by the year 2000, if present trends continue, 1.4 billion people in this region will be living in zones where fuelwood supplies are completely inadequate to cover their minimum energy needs (World Bank, 1992).

Fig. 5. The causes and development of desertification



Another indirect implication of these two hazards is that the resources needed to combat them are going to be very large. In 1982, it was estimated that between then and A.D. 2000, US\$1.8 billion per year would be required to combat desertification (Tolba, 1987). Ahmad and Kassas (1987) estimated that a 20-year worldwide programme to arrest desertification would cost (at 1987 prices) roughly US\$4.5 billion a year, US\$2.4 billion of that needed in developing countries. Such sums are well beyond 1987 levels of donor assistance to the third world for everything.

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Citizen action to counter deforestation and desertification

The Chipko Movement in India, which began in 1972, is a people's ecology movement professing non-violence and non-cooperation. It has been significant in protecting forest and woodland on the Indian subcontinent. Also in India, a centuries-old practice is being rediscovered, adapted, and promoted. Deeply rooted, hedge-forming vetiver grass, planted in contour strips across hill slopes, slows water run-off dramatically, reduces erosion, and increases the moisture available for crop growth. Since 1987 a quiet revolution has been taking place, and today 90 per cent of soil conservation efforts in India are based on such biological systems. In the Philippines, non-governmental organizations (NGOs) and the Catholic Church have been active in supporting and promoting citizen groups seeking to protect existing trees and to plant new forests. In the Sahel, simple technologies involving the construction of rock bunds along contour lines for soil and moisture conservation have succeeded where sophisticated measures once failed. Bunded fields yield an average of 10 per cent more produce than traditional fields in a normal year, and in the drier years almost 50 per cent more.[19]

The role of forestry in combating desertification

The problem of developing arid lands and improving the well-being of the people living on them is one of both magnitude and complexity magnitude in terms of the large area involved and complexity in that their development cannot be dissociated from their ecological, social, and economic characteristics. Forestry has a major role to play in such a development strategy:

- one of its fundamental roles is the maintenance of the soil and water base for food production, through shelterbelts, windbreaks, and scattered trees, and through soil enrichment;
- it contributes to livestock production through silvipastoral systems, particularly the creation of fodder reserves or banks in the form of fodder trees or shrubs, to cushion the calamities of drought;
- it produces fuelwood, charcoal, and other forest products through village and farm woodlots;
- it contributes to rural employment and development through cottage industries based on raw materials derived from wild plants and animals and the development of wildlife-based tourism;
- it provides food from wildlife as well as from plants in the form of fruits, leaves, roots, and fungi.

Scenario of deforestation and desertification in India

During the British rule, the area under reserved forests was progressively increased at the cost of the areas set aside to meet the needs of village populations. Increasing population pressure, shrinking areas of land accessible to meet the domestic requirements of agriculture and animal husbandry, and, above all, the creation of open access meant continuing degradation of these areas. Simultaneously, in the reserve forests, the whole emphasis was on a few commercially valuable species such as Teak. The trend everywhere was to harvest the more accessible larger timber that had commercial value, with little thought for long-term sustainability. Making biomass available to influential groups in society (merchants, contractors, etc.) at highly subsidized prices was carried to its extreme after independence when the forest-based industry, originated under the British rule, really took off (Gadgil, 1989). The latest statistics related to forest cover in India show that 19.44 per cent of the total geographical area (639,182 km) is covered by forests (Government of India, 1991). The estimated annual rate of deforestation during 1981-1985 was 147,000 ha and the area annually deforested as a percentage of the total forest area in the country was 0.25 per cent (Maheshwari, 1989). The arid zone of India covers about 12 per cent of the geographical area including (31.9 billion km) of hot desert

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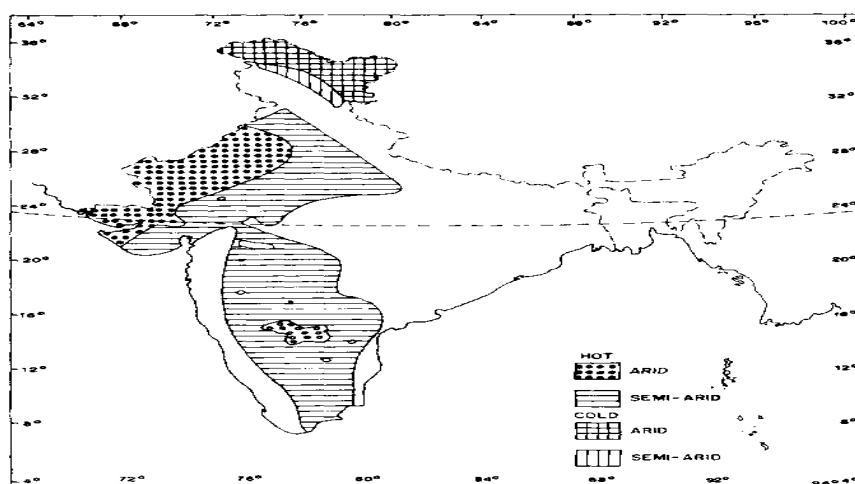
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located in parts of Rajasthan (61 per cent), Punjab and Haryana (9 per cent), and Andhra Pradesh and Karnataka (10 per cent). The cold arid tracts are located in the north-west Himalayas, namely Ladakh, Kashmir, and Lahaul Spiti (Himachal Pradesh). The Indian arid zone is by far the most populated arid zone in the world. The programme for combating desertification in India was started in 1977-1978 and is being implemented in 18 affected districts of Rajasthan, Gujarat, Haryana, Jammu & Kashmir, and Himachal Pradesh. During recent years there has been growing recognition of the failure of traditional forest management systems in India. The social forestry programme of the State Forest Departments and various community and agro-forestry projects, funded internally as well as internationally, are actively countering deforestation. Looking at the potential of participatory forest management, the Tata Energy Research Institute (TERN) is implementing the Joint Forest Management Programme (JFMP) in the State of Haryana in collaboration with the Haryana Forest Department (HFD) and with the active participation of the local communities. After completing the first three-year phase successfully, implementation of the second phase has now begun. TERI's primary objectives in implementing this programme are:

- to facilitate the development of participatory forest management systems for adoption by the HFD;
- to orient the forestry staff and local communities to bring in attitudinal changes regarding JFMP through regular meetings, workshops, training, and extension activities;
- to assist in research on the institutional, economic, social, and ecological aspects of joint forestry management;
- to disseminate information concerning the effects of joint forestry management on ecological regeneration, economic productivity, and environmental security.[19]

Fig. 6. Map showing arid and semi-arid zones of India



Various strategies and incentive mechanisms adopted for implementing the programme are:

- the provision of various non-timber forest products to local communities at concessionary rates;
- the organization of meetings, field training and workshops emphasizing micro-planning and women's participation to sensitize, motivate, and orient the target groups;

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- regular documentation, and dissemination of publicity and extension material.

So far, 38 Hill Resource Management Societies have been formed in villages adjoining the forests in Haryana Shiwaliks (lower Himalayas). The target group comprises marginal farmers and traditional graziers. Since 1990, there has been a remarkable change in the livestock pattern (the numbers have gone down whereas quality has improved), shifting the emphasis from open grazing to stall feeding. Agricultural yields have increased up to fourfold owing to the provision of irrigation water through the construction of water-harvesting structures. There has been significant increase in the yield of commercial as well as fodder grasses as a result of social fencing offered by the local communities in return.[18,19]

Measures undertaken to counter the problems of deforestation and desertification

The FAO and United Nations Development Programme (UNDP) have been mapping and monitoring deforestation and desertification, especially since 1979. The Geographical Information System (GIS) is being used to map and monitor the amount and degree of damage caused by these hazards and extensive databases are being established. In 1977, the United Nations Conference on Desertification (UNCOD) adopted a Plan of Action to Combat Desertification (PACD), which was endorsed by the UN General Assembly in the same year. The worldwide programme was aimed at stopping the process of desertification and at rehabilitating affected land. In 1985, the World Resources Institute, the World Bank, and the UNDP published a Tropical Forestry Action Plan (TFAP). This had taken several years to prepare through the combined efforts of governments, forestry agencies, UN agencies, and NGOs. These plans, however, stated only what should be done, but not how it could be achieved, and efforts undertaken so far have not been adequate to cope with the magnitude of the problem. So the damage continues. The general conclusion is that the plans failed to generate enough political support, although the proposals were probably quite sound. Despite the limited success of PACD, several countries have adapted their national plans to come within the scope of PACD implementation. Particularly significant measures have been undertaken in the countries of the Sudano-Sahelian belt of Africa, and in India, China, Iran, and the former USSR. In both developed and developing countries much could be achieved through a change in attitudes toward forests - from one of seeing the potential for exploitation to one of seeing the need and desirability to conserve and make exploitation more rational and sustained and less wasteful. Various multinational development agencies and philanthropic foundations (e.g. the FAO, the World Bank, the Ford Foundation) are now supporting efforts to encourage management by smaller groups more closely associated with particular forest tracts, and to give them responsibility for forests in good condition, as well as for degraded land. For example, the Joint Forest Management Programme in India, implemented in 12 states since 1990, is being funded by such organizations and aims at evolving and establishing systems of sustainable forest management jointly by the government and the local people.[16,17]

Possible solutions

In face of the above hazards, with all the social, economic, political, and environmental problems that they imply, it is inevitable that two questions have received increased attention in recent years: Can the damage be prevented? Can the damage that has already occurred be reversed? The answer to both is a qualified yes. Preventive measures for combating drought and halting the spread of the deserts, as highlighted by the UNCED in Agenda 21, include:

- strengthening the knowledge base and developing information and monitoring systems for regions prone to desertification and drought, including the economic and social aspects of the fragile ecosystems;
- combating land degradation through, inter alia, intensified soil conservation, afforestation, and reforestation activities;
- developing and strengthening integrated development programmes for the eradication of poverty and the promotion of alternative livelihood systems in areas prone to desertification;

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- developing comprehensive anti-desertification programmes and integrating them into national development plans and national environmental planning;
- developing comprehensive drought-preparedness and drought-relief schemes, including self-help arrangements for drought-prone areas and the design of programmes to cope with environmental refugees;
- encouraging and promoting popular participation and environmental education, focusing on desertification control and management of the effects of drought (UNCED, 1992).

The overriding need of the next few decades is to evolve strategies that inextricably tie conservation and development together. Policies for resource management will have to include the following essential components:

- a recognition of the true value of natural resources, because they ultimately are in finite supply;
- institutional responsibility for resource management hand in hand with a matching accountability for results;
- better knowledge of the extent, quality, and potential of the resource base while accelerating the diffusion of existing technology that can expand output in environmentally sound ways.

In developing countries, where the actions of local people are the root cause of deforestation, the various alternatives that offer some hope for slowing tropical deforestation, and at the same time are cheap and fast enough to be worthy of consideration, are: conservation to help natural forests regenerate, better management of forests, better fire control measures, reforestation and afforestation, fuelwood/energy plantations and woodlots, agro-forestry, farm and village woodlots, cash-crop tree farming, and, last but not least, non-conventional methods of forest management. The causal chain of land degradation and possible interventions at various stages to reverse the process are illustrated in figure 6.8. As is evident in this figure, the development of science and technology occupies a prominent position in the possible interventions. Land-use planning, dryland cropping strategies, appropriate forest management technologies optimizing their resource potential, the standardization of harvesting techniques for non-timber forest products, fuelwood-supply plantations, and renewable energy technologies are some of the potential areas for research that need more probing.[15,16]

The following are a few suggestions appropriate for immediate action to fight against deforestation and desertification in a reasonably long-term perspective:

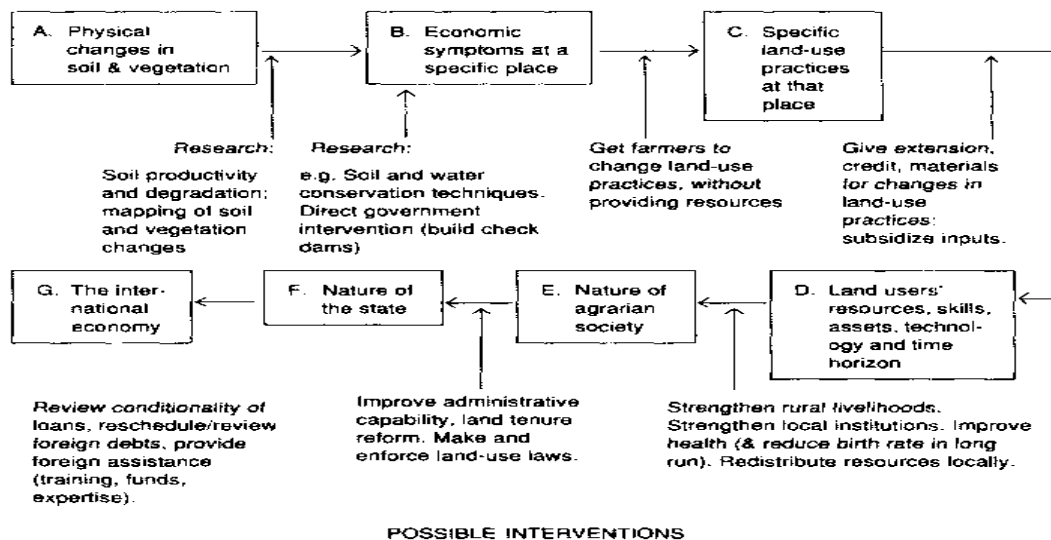
- strengthen the planning and organization of ecological, silvicultural, and socio-economic research;
- strengthen research on particular subjects (such as certain social and cultural aspects of rural life, natural resource accounting, etc.) that appear to be weak at present in view of development and resource conservation objectives;
- strengthen research on non-traditional methods in forestry, e.g. community forestry programmes emphasizing people's participation like the JFMP, the use of biotechnology in the breeding of tree species for desired characteristics;
- decentralize research work according to ecological and socioeconomic conditions;
- determine and carry out a systematic programme for the advanced training of research workers and research administrators.

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Fig. 7. Interventions refuted to the causation of land degradation (Source: Winpenny, 1990)



To assume that massive aid inflows through the multilateral development banks and bilateral agencies for international development can solve the developing countries' problems is to ignore decades of documentation demonstrating that such aid has compounded environmental degradation. The history of development assistance suggests that its success depends on getting it to the right people. NGOs such as TERI, which are actively involved in a participatory approach at the grass roots, research on biomass, and biotechnology could all play a vital role in developing and implementing the above strategy. The urgency of the problem is accentuated by the fact that the pressure on natural resources is fast getting out of hand owing to unprecedented population growth and increasing densities. The time for action is running out as the environmental damage rendered by deforestation and desertification expands, threatening new areas and new societies, while countermeasures tend to be long term and time consuming. The cost of countermeasures is escalating from year to year because the area affected is growing, the degree of damage is growing, and world prices of rehabilitative measures are rising. Off-site (and social) costs too continue to increase. Other environmental and economic problems are likely to become serious, tending to distract the attention of international funding agencies to other issues (e.g. sealevel rise). However, if the process of desertification and deforestation is not arrested soon, the world shortage of food will increase dramatically. Past experiences show that the success of programmes to combat desertification and deforestation will depend on the institutional arrangements, the dissemination of information, the creation of awareness, the development of assessment methodology, and adaptive research. Funding and implementing agencies, both national and international, must give priority to programmes for combating desertification and countering deforestation, both nationally and internationally. The necessary assistance - in cash as well as in kind - will have to be provided to developing countries affected by these hazards. Any countermeasures will have to be fully integrated into programmes of socio-economic development, instead of being considered only as rehabilitation measures, and the affected populations will have to be fully involved in the planning and implementation of these programmes.[19]

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