Part III

Priority issues

Developmental activities in India have been pursued without giving much attention on environmental issues. This has resulted in pressure on its finite natural resources, besides creating impacts on human health and well being. 5 priority issues are discussed in the report. The priority issues identified are 1) land degradation 2) biodiversity 3) air pollution with special reference to vehicular pollution in urban cities 4) management of fresh water and 5) hazardous waste with special reference to municipal solid waste management. These priority issues are analyzed by following the pressure-state-impact-response framework. Conscious efforts need to be made to integrate the environmental planning into development planning to achieve the sustainable development.

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8 Land degradation

Introduction

Of India's total geographical area of 328.73 million hectare (mha), 304.89 mha comprise the reporting area and 264.5 mha only is under use for agriculture, forestry, pasture and other biomass production. Since 1970/71, the net area sown has remained around 140 mha (Ministry of Agriculture and Cooperation 1992) and was 142.22 mha during 1998/99.

India supports approximately 16% of the world's human population and 20% of the world's livestock population on merely 2.5% of the world's geographical area. The steady growth of human as well as livestock population, the widespread incidence of poverty, and the current phase of economic and trade liberalisation, are exerting heavy pressures on India's limited land resources for competing uses in forestry, agriculture, pastures, human settlements and industries. This has led to very significant land degradation. According to the latest estimates (Sehgal and Abrol 1994), about 187.8 mha (57% approximately) out of 328.73 mha of land area has been degraded in one way or the other. It appears therefore, that most of our land is degraded, is undergoing degradation or is at the risk of getting degraded.

Among the different categories, lands under cultivation face the biggest problem followed by grazing land and pastures, forests, barren lands, and unculturable lands in decreasing order.

The negative effects of land degradation are telling very heavily on India's environment and economy, which are causes of grave concern.

Pressure

Land in India suffers from varying degrees and types of degradation stemming mainly from unstable use and inappropriate management practices. Loss of vegetation occurs due to deforestation, cutting beyond the silviculturally permissible limit, unsustainable fuelwood and fodder extraction, shifting cultivation, encroachment into forest lands, forest fires and over grazing all of which subject the land to degradational forces. Other important factors responsible for large-scale degradation are the extension of cultivation to lands of low potential or high natural hazards, non-adoption of adequate soil conservation measures, improper crop rotation, indiscriminate use of agro-chemicals such as fertilisers and pesticides, improper planning and management of irrigation systems and extraction of ground water in excess of the recharge capacity. In addition, there are a few underlying or indirect pressures such as land shortage, short-term or insecure land tenancy, open access resource, economic status and poverty of the agriculture dependent people, which are also instrumental to a significant extent, in the degradation of the land.

Land degradation manifest itself chiefly in the form of water erosion, followed by wind erosion, biophysical, and chemical deterioration.

Direct pressures

- Deforestation is both, a type of degradation by itself, and a cause for other types of degradation, principally, water erosion. Deforestation causes degradation firstly, when the land cleared is steeply sloping, or has shallow or easily erodible soils; and secondly, where the clearance is not followed by good land management (Photo 8.1). Between 1980 and 1990, forests were depleted at the rate of about 0.34 mha annually while, afforestation efforts covered about one mha of area annually during the same period (MoEF 1999). Forests in India have also been shrinking owing to pressures from user groups.

Photo 8.1 Land degradation due to deforestation

- Impoverishment of the natural woody cover of trees and shrubs is a major factor responsible for wind and water erosion, which occurs because the per capita forest land in the country is only 0.08 ha against the requirement of 0.47 ha to meet basic needs, creating excessive pressure on forest lands (Photo 8.2). This gap has resulted in unpermissible levels of timber, firewood, and fodder extraction from the forests. The demand for commercial timber comes from industries including pulp and paper, plywood, packaging, housing, matchwood, sports goods, furniture, agricultural implements and railway-coaches (FSI 1987). The total demand for timber, including small timber, was estimated at 64.4 million cum for 1996 with a growth rate of 5% per annum (FSI 1995).
- Although, officially, extraction from the forests is organised so as to maintain a sustainable yield yet, in practice, the extraction far exceeds the limit resulting in a rapid depletion of forest stock. According to the State of Forest Report (FSI 1987), against the demand of more than 27 million cubic metre, the permissible felling of timber was only 12 million cubic metre creating an excess felling of about 15 million cubic metre over the permissible limit with a consequent loss of vegetative cover so essential for the health of the land.
- Firewood extraction from forests has been far exceeding the silviculturally permissible limit resulting in a rapid depletion of the forests (Photo 8.3). Extraction of wood from forests for fuel is believed to be one of the most important causes of forest

Photo 8.2 Land degradation due to erosion

Photo 8.3 Firewood extraction

degradation in India. Fuelwood consumption was estimated at 260 million cubic metre in 1997 as against the sustainable supply of 52.6 million cubic metre and has grown at a rate of about 2.4% per annum between 1980 and 1994 (Pachauri and Sridharan 1998). This has been happening especially in the semi-arid and arid environments of India where fuelwood shortages are often severe and recurrent.

- A livestock population of 467 million grazes on 11 mha of pastures. This implies an average of 42 animals grazing in a hectare of land against the threshold level of 5 animals per hectare (Sahay 2000). In the absence of adequate grazing land, nearly a third of the fodder requirement is met from forests in the form of grazing and cut fodder for stall-feeding (MoEF 1999). An estimated 100 million cow units graze in forests against a sustainable level of 31 million per annum (Photo 8.4). A sample survey by the FSI estimates that the impact of grazing affects approximately 78% of India's forests. Overgrazing and over extraction of green fodder, both lead to forest and land degradation through a loss of vegetation and physical deterioration in the form of compaction and reduced infiltration, and increase in soil erodibility.

Photo 8.4 Extraction of fodder

- Shifting cultivation is traditionally practised in 13 states of the country and more extensively in the northeastern hill states, Orissa and the Eastern Ghats on an estimated forest area of about 4.35 mha. This contribute significantly towards forest land degradation With the progressive reduction in the land to population ratio, the fallow period between cultivations has fallen from 30 years to about 2 to 3 years. This in turn does not permit the natural processes of recuperation to repair the disturbed ecosystem resulting in erosion and a decline of soil fertility.
- An estimated 0.7 mha of forest lands are encroached upon for agriculture by the people who live in their vicinity, such lands are mostly of a marginal nature, susceptible to degradation.
- The occurrence of frequent forest fires has been a major cause of degradation of forest land in many parts of India. Apart from the destruction of vegetation, high intensity forest fires alter the physico-chemical and biological properties of the surface soil and leave the land prone to erosion and with a lowering of soil quality.
- The extension of cultivation to land of lower potential and fertility, with greater natural degradation hazards such as steep slopes areas of shallow or sandy soils, or with laterite crusts, arid or semi-arid land bordering to deserts, which are called fragile or marginal lands, in many parts of the country has resulted in their degradation.
- The use of agrochemicals has become essential for modern agriculture, but they, together with sewage sludge and composted municipal wastes are used improperly and indiscriminately, leading to the contamination of soil and water with toxic substances and heavy metals. This problem is widespread over the country although there is no exact estimate of the area affected.

- The expansion of canal irrigation has been associated with widespread waterlogging and salinity problems in command areas. Disturbances of the hydrological equilibrium resulting from excessive recharge because of inefficient use of irrigation water, poor land development, seepage from unlined water courses, non-conjunctive use of surface and ground water resources and poor drainage have all resulted in a rise of the water table in most canal command areas. Where the water table approaches the surface, waterlogging occurs associated with salinisation and/or sodification. Such phenomena have occurred on a large scale in several parts of canal command areas such as the Indo-Gangetic plains and the Indira Gandhi Nahar Project. In arid, semi-arid and sub-humid tracts of the country, large areas have been rendered barren due to the development of saline-sodic soils because of unhealthy land management in respect of irrigation, drainage and crop husbandry. An estimated 11 mha of land has thus been affected by varying degrees of salinity and sodicity in different parts of the country.
- An increase in industrialisation, urbanisation and infrastructural development is progressively taking away considerable areas of land from agriculture, forestry, grasslands and pastures, and unused lands with wild vegetation, resulting in environmental disturbances. Regional plans do not build in environmental components to provide zones for the above compatible with surrounding land uses. This process has resulted in the degradation of land directly through changed land use and also through the negative impacts of waste disposal.
- Land degradation is the inevitable result of any form of mining, particularly opencast mining, which thoroughly disturbs the physical, chemical, and biological features of the soil and alters the socioeconomic features of the area (Photos 8.5 and 8.6). Although there are no data available for the area actually affected by mining and quarrying, mining lease area is approximately 0.8 mha, which may be taken as degraded directly due to mining activities in addition to the areas affected indirectly.
- Water erosion across the country is the major cause of topsoil loss (in 132 mha) and terrain deformation (in 16.4 mha). Wind erosion is dominant in the western part of the country causing a loss of top soil and terrain deformation in 13 mha

Photo 8.5 Land degradation due to mining activities

Photo 8.6 Overburden dumps in forests

(Sehgal and Abrol 1994). Land management practices are often not geared to check water erosion on slopes and wind erosion on level lands of dry regions leading to considerable deterioration. Often, it is neither the environment nor the type of land use that necessarily leads to degradation, but the standard of land management.

Indirect or underlying pressures

Together with an increase in population land shortage in India has also increased in the already small per capita agricultural lands. As a result of fragmentation the number of land holdings has increased from 48 million in 1960 to 105 million in 1990 and is still more today. Most holdings (> 75%) are less than 2 ha (small and marginal). While there is virtually no culturable unused land in the country the population to be supported from this finite land resource is growing fast. The direct and indirect causes of land degradation are linked by a chain of cause and effect, or the causal nexus. The external, or driving forces are limited land resources and an increase in rural population. They combine to produce land shortages, resulting in small farms, low production per person and increasing landlessness whose consequence in term, is poverty. Land shortage and poverty, taken together, lead to non-sustainable land management practices, the direct causes of degradation. This has the effect of increasing land shortage, a vicious cycle of cause and effect.

State - Impacts

According to the estimates of actual land-use and vegetation cover by the National Remote Sensing Agency and the Forest Survey of India based on satellite imagery, 80 mha out of 142 mha under cultivation is substantially degraded and about 40 mha out of 75 mha under the forest departments has a canopy cover of less than 40% (Gadgil 1993). Nearly 11 mha of pasturelands is also substantially degraded. Thus, a total of 131 mha, representing about 40% of the country's landmass, has a productivity well below its potential. According to Wastelands Atlas of India 2000 (1:50,000 scale map), the total wastelands area covered in 584 districts is 63.85 million which accounts 20.17% of the total geographical area.

India supports approximately 16% of the world's human and 20% of livestock population on a mere 2.5% of the world's geographical area. The pressure on the country's land resources is obvious. Further, competing uses of land for forestry, agriculture, pastures, human settlements, and industries exert an enormous pressure on the country's finite land resources. This is mainly because the country has not been implementing a well-defined integrated land use policy and land management has largely been unscientific and arbitrary both of which have resulted in the current phase of degradation.

Land degradation in India has been brought about largely through i) displacement of soil materials and their deposition, and, ii) *in situ* degradation. Top soil loss and terrain deformation through water and wind erosion and also overblowing through wind erosion are manifestations of the first category and chemical degradation involving loss of nutrients and/or organic matter, salinisation and pollution, and physical degradation in the form of waterlogging, mass movement, land slides, compaction, crusting and sealing, in the second.

Soil erosion

The fertility status and the productivity of soil as a medium for biomass production depends largely on the top soil which, besides being a producer of biomass, is important for many other well-known important functions.
Soil erosion, by wind or water, affects these functions adversely and has produced considerable negative impacts both on-site as well as off-site. Out of the total estimated degraded

land of the country, about 162.4 mha is due to displacement of soil material by water and wind and 21.7 mha is due to *in situ* processes as salinity and waterlogging. The remaining 4 mha is affected by the depletion of nutrients (CSWCRTI 1994) (Photo 8.7).

Soil erosion by water results largely in the loss of top soil and terrain deformation, being a function of geological formation, rainfall, susceptibility to erosion, length and steepness of slope, cultural practices, vegetative cover, and conservation measures being followed. Soil erosion accounts for 87% of the total degraded land in India. Erosion due to water is greater in regions, which receive heavy rainfall over short periods than in places with low-intensity rainfall.

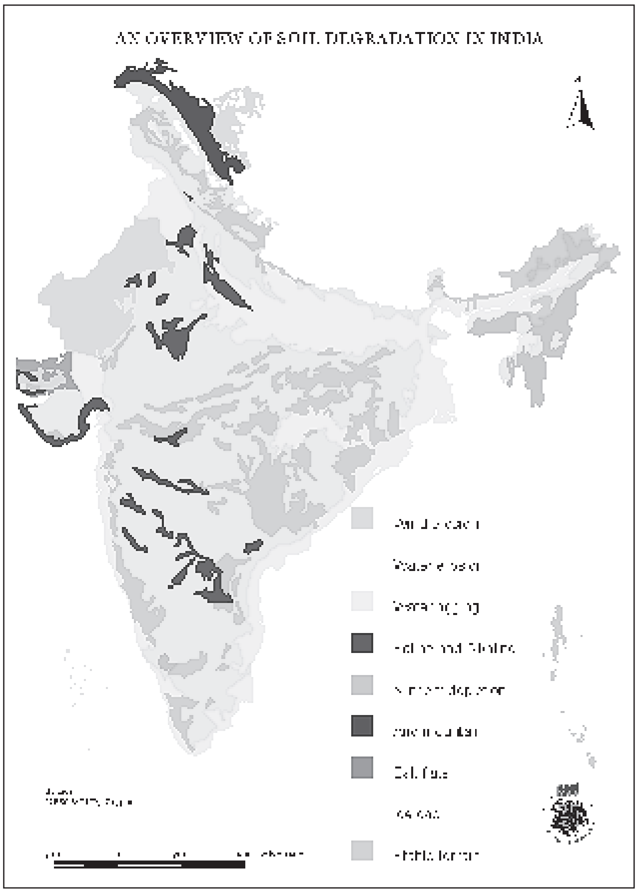
Non-adoption of proper soil and water conservation measures, improper crop rotation and extension of cultivation onto lands of low potential or high natural hazards, are some of important reasons contributing to soil erosion in lands under cultivation. Similarly, loss of vegetation due to deforestation, over cutting beyond silviculturally permissible limit, unsustainable fuel and fodder extraction, shifting cultivation, encroachment into forest land, forest fire and over grazing are mainly responsible for the degradation of forest lands (some estimates are given in the section on pressures). Obviously the governance is not properly geared to regulate and control the factors mentioned above and adequate enforcement is conspicuous by its absence (Photo 8.8).

Narayana and Ram Babu (1983) analysed the existing data on soil loss and concluded, as a first approximation, that soil was being eroded at an annual average rate of 16.35 tonnes per hectare, yielding a figure of 5.3 billion tonnes a year for the entire country Of that, nearly 29% is permanently lost to the sea; about 10% is deposited in reservoirs (thereby decreasing their storage capacity by 2% annually); and the remaining 61% is merely displaced.

Gurmel Singh, Ram Babu, Narain, and others (1990) estimated that the annual erosion rate ranges from less than 5 tonnes/ha for dense forests, snow-clad cold deserts, and arid regions of western Rajasthan to more than 80 tonnes/ha in the Shiwalik hills. The single largest category is moderate erosion (5 to 10 tonnes/ha annually). The annual loss of soil amounts to nearly 5 billion tonnes, of

Photo 8.7 Soil erosion

Photo 8.8 Forest degradation and soil erosion in West Khasi hills, Meghalaya
Source MoEF Annual report, 1997-98



Map 8.1 An overview of soil degradation in India

Table 8.1 Soil erosion

Type of degradation	*Sehgal and Abrol (1994)*
Water erosion	148.9
Wind erosion	13.5
Total	162.4
Saline and alkali soils	10.1
Water-logging	11.6
Decline in soil fertility	3.7
Total	187.8

which 3.2 billion tonnes (64%) is contributed by highly eroded to very severely eroded areas, such as the Shiwalik hills, the Western Ghats, black and red soil areas, the north-eastern states and other ravinous tracts.

The loss of natural vegetative cover resulting from felling, excessive grazing, extension of agriculture to marginal areas, and the depletion of organic matter because of unsuitable cropping patterns, has been the major cause of accelerated wind erosion due to human activities. Structureless sandy soils, low in organic matter and water holding capacity, are vulnerable to strong desiccating winds. Wind erosion is a serious problem in arid and semi-arid regions and coastal areas, where soils are sandy, and in the cold desert regions of Leh in the extreme north of India. The threshold velocity for initiating wind erosion has been estimated at 10 km/hour.

The arid and semi-arid regions of the north-west cover 28 600 square kilometres, of which the sand dunes and sandy plains of western Rajasthan, Haryana, Punjab, and Gujarat account for 66% (Gupta 1990). Severe wind erosion is observed mostly in the extreme western sectors of the country. It is reported that the removal and deposition of sand during a 100-day period from April to June ranges between 1449 and 5560 tonnes/ha (Gurmel Singh, Ram Babu, Narain, and others 1990). The latest estimates show that area affected by wind erosion is 13.5 mha (4.1% of the total geographical area). The loss of topsoil accounts for 1.9% of the total area under soil degradation; terrain deformation for 1.2%; and shifting of sand dunes another 0.5% (Sehgat and Abrol 1994).

On-site impacts of erosion

In more than three-quarters of the area that suffers from soil erosion, productivity is lowered by 5% to more than 50% because the loss of productivity is directly linked to its severity. Different crops vary in their response to soil erosion - groundnut suffers the most and cotton the least. The difference in response is largely due to the differences in the rooting patterns of individual crops. Productivity loss is also influenced by the depth of soil - the shallower the soil, the greater the loss. According to a World Bank study (Brandon, Hommann, and Kishor 1995) the annual loss in production of major crops due to soil erosion in India has been estimated to be 13.5 million tonnes by Bansil (1990) and 7.2 million tonnes by UNDP, FAO and UNEP (1993). The loss in production of eleven major crops amounted to 1.7% of the total production of these crops in 1992/93 (UNDP, FAO, and UNEP 1993), and 4.1% of the total production in 1985/86 (Bansil 1990).

However, the current (one-year only) influence of past soil degradation actually undervalues the total loss resulting from the degradation. Erosion-induced productivity losses are not confined to a terminal year, but accumulate throughout most or all of the intervening period.

Loss of nutrients and/or organic matter

The loss of topsoil due to erosion depletes the productive substrate since a major portion of the essential plant nutrients are present there. Soils over much of the sub-continent are also highly deficient in Soil Organic Matter (SOM) with an associated proneness to degradation.

The National Bureau of Soil Survey and Land Use Planning (Sehgal and Abrol 1994) data show that nearly 3.7 million ha suffer from nutrient loss and/or depletion of organic matter. The problem is widespread in the cultivated areas of the subtropical belt, including areas under shifting cultivation or *jhumming* in the northeastern states.

Efforts have been made to estimate the loss of available nutrients by using the average content of nutrients in the top soil of each of the 24 soil types in India, the land area under each type, and the annual erosion rates in these soils estimated by the Central Soil and Water Conservation Research and Training Institute, ICAR. India loses nearly 74 million tonnes of major nutrients due to erosion annually. However, nearly 61% of the eroded soil is merely moved, and the effective loss is the remaining 39%. Thus, the country loses 0.8 million tonnes of nitrogen, 1.8 million tonnes of phosphorus, and 26.3 million tonnes of potassium every year. However, according to the Government of India, the quantity of nutrients lost due to erosion each year ranges from 5.8 to 8.4 million tonnes.

Off-site impacts of erosion

Higher erosion rates have resulted in the sedimentation of river beds, siltation of drainage channels, irrigation canals, and reservoirs. Siltation has changed the hydrology of several watersheds of the country, resulting in a greater frequency and severity of floods, and reducing water availability in dry season. The storage capacity of many reservoirs has been reduced drastically due to accelerated erosion and deposition. Siltation of major river courses and spillover sections due to excessive deposition of silt is observed extensively in Bihar and Uttar Pradesh since many flood-prone rivers flow through them. The total area affected by this problem is estimated to be 2.73 mha (Das 1977, Mukherjee *et al.* 1985). The Ganga and Brahmaputra carry the maximum sediment load, about 586 and 470 million tonnes, respectively, every year. Approximately 6 000 to 12 000 million tonnes of fertile soil are eroded annually and a significant proportion of it is deposited in the reservoirs resulting in a reduction of their storage capacity by 1%–2%.

The siltation rate of reservoirs in India has been estimated to be much higher than the values assumed at the time of designing. This has drastically reduced the life of projects, which involved huge investments. River valley projects reservoirs are prematurely getting silted up due to deposition of eroded soil. Against the designed rates of siltation (tonnes/ha/year) of 0.29 (Nizamsagar) to 4.29 (Ramganga), the actual siltation rates vary from 6.57 (Nizamsagar) to 17.3 (Ramganga). The siltation rate of the Mayurakshi reservoir is 20.09 against the designed rate of 3.61 (Bali 1994). The annual sediment load inflow into many reservoirs ranges from 0.6 to 122.7 ha-m/ 10 000 ha.

Flooding

The increasing frequency of floods in India is largely due to deforestation in the catchment areas, destruction of surface vegetation, changes in land-use, increased urbanisation, and other developmental activities. Processes leading to flooding are becoming more common due to increased sedimentation and reduced capacity of drainage systems. Increased gully erosion and ravine formation results in increased run-off and peak discharge for any given rainfall from watersheds. Increased sedimentation in streams, canals and rivers reduces their capacity but increases their width. Satellite imagery of Himalayan torrent shows that between 1990 and 1997 the width of torrents has increased by 106% and that of rivers by 36%. Consequently, streams and rivers overflow their banks, flooding the downstream areas.

These are of frequent occurrence in many parts of India, especially in hilly terrain, causing a disruption of normal life and considerable damage to the productive land system. The problem of human-induced waterlogging in India is more common in canal command areas (surface irrigation) because irrigation facilities are often introduced without adequate provision for drainage resulting in a rise of the water table.

Chemical degradation

Loss of plant nutrients. India has, over the past four decades, increased its annual food production from about 50 million tonnes in 1950/51 to 193.6 million tonnes in 1995/96. The increase in production is largely because of increased inputs – mainly nutrients and water – and partly because of an expanded cultivated area. Although the use of fertilisers has increased several fold, the overall consumption continues to be low in most parts of the country. Several studies have shown that in most regions there is a net negative balance of nutrients and a gradual depletion of the organic matter content of soil

It is estimated that every year, 20.2 million tonnes of the three major nutrients – nitrogen, phosphorus, and potassium – is removed by growing crops (Tandon 1992) but the corresponding addition through chemical fertilisers and organic manures falls short of this figure. It was determined that only 23% of the applied fertiliser is consumed by plants; the remaining 77% is either leached out beyond the root zone or lost by volatilisation, etc. Thus, out of 20.2 million tonnes of nutrients removed by plants, only 2.66 million tonnes comes from fertilisers and nearly 3 million tonnes from organic sources. This leaves a little less than 14 million tonnes, which is obviously contributed by soil. If the loss of nutrients due to soil erosion is included the loss of nutrients from the top soil is 43 million tonnes, which amounts to 0.24% of the nutrient reserves of the soils. According to Brandon, Hommann, and Kishor (1995), the annual loss in production of eleven major crops in India due to depletion of nutrient as a result of unsuitable agricultural practices amounts to 0.5 to 1.3 million tonnes. This estimate, however, does not take into account the loss due to erosion. The problem of maintaining the nutrient balance and preventive the consequent nutrient deficiencies will be a major concern in most cultivated areas.

Salininisation. Salt-affected soils are widespread in the arid, semi-arid, and sub-humid zones of the Indo-Gangetic Plain. Alkali soils dominate in areas with a mean annual rainfall of more than 600 mm, while saline soils are dominant in the arid, semi-arid, and coastal regions. About 7 mha is salt-affected, of which 2.5 mha represents the alkali soils in the Indo-Gangetic Plain and nearly 50% of the canal-irrigated areas as affected by salinisation and/or alkalisation due to inadequate drainage, inefficient use of available water resources, and socio-political reasons. Typical examples of salinisation caused by the rise in ground water are observed in Uttar Pradesh, Haryana, Rajasthan, Maharashtra, and Karnataka. A recent study by Sehgal and Abrol (1994) shows that a total of 10.1 mha is affected by salinity-alkalinity, of which about 2.5 mha occurs in the Indo-Gangetic Plain. Improper planning and management of surface irrigation systems contributes heavily towards salt affectation especially in canal command areas.

Salinity/sodicity directly affects the productivity of soils by making the soil unfavourable for good crop growth. Indirectly, it lowers productivity through adverse effects on the availability of nutrients and on the beneficial activities of soil microflora. According to Brandon, Hommann, and Kishor (1995), the loss in crop production due to salinity in India amounts to 6.2 million tonnes (FAO data) and 9.7 million tonnes (Indian data).

Pollution

Heavy metals. The pollution of soil with heavy metals due to improper disposal of industrial effluents, use of domestic and municipal wastes and pesticides, is becoming a major concern. Though no reliable estimates are available of the extent and degree of this type of soil degradation, it is believed that the problem is extensive and its effects are significant. Some commercial fertilisers also contain appreciable quantities of heavy metals, which have undesirable effects on the environment. The indiscriminate use of agro-chemicals such as fertilisers and pesticides is often responsible for land degradation.

Crusting and sealing are results of the impact of raindrops on bare soil. Red and black soils are especially vulnerable. Soil structure, infiltration and permeability characteristics are affected adversely to a considerable extent due to excessive grazing, fire and mismanagement of soil under cultivation but the data are too sketchy to arrive at even a rough estimate of the total area affected.

Response

A reclamation of the nearly 187 mha of existing degraded land in the country and concurrent efforts to arrest further degradation, as estimated, are of the utmost importance. Combating further land degradation and investing in conservation of land for the present as well as future generations will be a major task involving the promotion of sustainable development and nature conservation. This will be a major challenge in the coming decades that will involve a paradigm shift from the purely technical to a more holistic sustainable land management system that will be environmentally responsible, socially beneficial and economically viable.

Existing response

- Watershed management programmes have been taken up extensively in the recent past. The Soil and Water Conservation Division in the Ministry of Agriculture has been playing a key role in implementing integrated watershed management programmes with a plan to cover 86 mha. 26 mha (27 river valley catchments and 8 in flood prone rivers) are considered highly critical and have been given a priority under 35 centrally-sponsored projects. Over 30 000 hectares of shifting and semi-stable sand dunes have been treated with shelter belts and strip cropping (ESCAP 1995).

- The National Bureau of Soil Survey & Land Use Planning and the Central Soil and Water Conservation Research and Training Institute, ICAR, have jointly initiated the preparation of soil erosion maps of different states using the components of Universal Soil Loss Equation. A similar assessment needs to be carried out for other degradational processes also. In addition the All-India Soil and Land Use Survey, MoA, is engaged in generating spatial and non-spatial information on the soils of India and preparing of thematic maps like land capability classification, hydrological soil grouping irrigability classification, etc. The state governments are also working on various aspects of soil conservation following the guidelines of the centre.

Policy gap

Land management has been largely unsystematic, arbitrary and, by no means, sustainable. So far the country has not implemented a well-defined integrated land use policy. This lacuna has largely been responsible for the current phase of land degradation. To make things worse, there is no rural fuelwood as well as grazing and fodder policy also at the national level with the result, that grazing is far beyond the carrying capacity and extraction of fuel and fodder from forests is also far beyond the sustainable limits, creating enormous negative impacts on the forests and land.

Knowledge/information/data gap

Although land degradation is recognised as a serious problem, information available on the severity as also the area affected by various forms of degradation is limited, highly variable and sketchy.

Policy recommendations

- A well-defined integrated land use policy at the implementable level should be developed at the earliest, as also rural fuelwood and grazing and fodder policies to guide management of land and forest scientifically and sustainably.
- A National Land Use Commission entrusted with the responsibility of laying down such policies, implementing strategies and monitoring guidelines with support from the existing All-India Soil and Land Use Survey, National Bureau of Soil Survey and Land Use Planning and the Forest Survey of India under the stewardship of the Planning Commission will go a long way to address most of land-related issues.
- To ensure that land is put under right kind of use guarding against any deleterious effects, it is imperative that it is put to use according to its capability. For this purpose, guidance from the USDA Land Capability Classification with modifications to suit Indian conditions can be taken, which along with scientifically sound land management practices would address land degradation problems and maintain land quality for sustainable use.
- Land management in conjunction with water management needs to be the core of any agenda for national development as the two resources are absolutely inter-dependent and cannot be dealt with independent of the other. As far as possible, land should be managed on a natural watershed basis as it presents an ideal unit for most effective management and rational utilisation of land and water resources for optimum production with minimum hazard to the resources.
- Increasing the utilisation of irrigation potential, promoting water conservation and efficient water management along with expansion of irrigation facilities, especially

in drought-prone areas, need urgent attention to enhance production without harming land and soil. To ensure sustainability of production in rainfed areas, *in situ* soil and moisture conservation on mini-watershed basis, irrespective of whether they belong to forest department, private bodies or local communities, should be a major thrust area for increasing productivity levels.

- A correct assessment of the nature and extent of the existing degraded land through a rapid inventory using remote sensing techniques and GIS needs to be carried out as early as possible with scientifically sound criteria and indicators. Advantage of the Soil and Terrain Database (SOTER) and Global Assessment of Human-induced Soil Degradation (GLASOD) can also be taken. This will enable the adoption of measures to counter various types of degradation at the right time and place.
- Ministries or departments such as the MoEF, MoA, MoRD, MoWR, MoM, MoI, etc., at both the national as well as state level, are involved in land use in the country. The Land Use Commission should involve them, NGOs and other stakeholders to develop a coordinated approach for land use and management and for resolving related cross-cutting issues.
- Policy issues in sustainable land management may include coordination of land titling, economic policy, nature conservation policy, and population policy. Therefore, national strategies for sustainable use of land resources need to thoroughly harmonise, adapt, and integrate the different strategies and policies of governments, which are directly or indirectly linked to the use of land by stakeholders.
- Soil nutrient mining results in serious soil health and ecological problems, which needs urgent attention. Integrated Plant Nutrient System (IPNS), have to be adopted to improve fertiliser use efficiency and reduce the potential danger of pollution from higher nutrient use in agriculture.
- A systematic monitoring mechanism needs to be developed to assess the balance between input and withdrawal of nutrients to guard against possible nutrient depletion (Sarkar et al. 1991). Also, there is a need to define the threshold values for such additions and for promoting a balance with use of organic manure, chemical fertilisers, bio-fertilisers and agrochemicals to ensure sustainability and increased production.
- Domestic and municipal wastes, sludges, pesticides, industrial wastes, etc. need to be used with utmost caution to avoid the possibility of pollution of soil through heavy metals and other toxic substances which are often present in them.
- Shifting cultivation with a short fallow cycle does not allow enough time for the land to recuperate naturally and is responsible for large-scale (about 4.5 mha) land degradation in several parts of the country. The practice, a socio-economic outlet, needs to be discouraged and alternatives to the people engaged in the practice need to be provided in a phased manner for their livelihood.
- Limited land resources and an increase in rural population, both produce land shortages through fragmentation of holdings resulting in small farms, low production per person and increase in landlessness, which leads to poverty. Land shortages and poverty farther lead to non-sustainable land management practices, one of the important causes and effect nexuses of land degradation. The major challenge in the agriculture sector is to check the fragmentation of land holdings which can be achieved by: providing security of land rights and land tenure; encouraging the efficient use of marginal lands; developing

areas of untapped potential thereby correcting uneven utilisation of land; and using the irrigation potential efficiently. A tenure regime should be clear, flexible and secure.

- Implementation of land-related policies is a complex and sensitive task. It would require government as well as non-governmental sectors such as communities, private bodies to come to a common platform. Additionally, the steps, mechanisms and institutional structures for policy implementation need to be drafted along with a detailed action plan clearly designating responsibilities and taking into consideration the intrinsic character of land, the concerned user groups and future possibilities.
- Improvements in sustainable land use and development impinge on the interests of all stakeholders—both individuals and groups. Therefore, a multi-level stakeholder approach for the planning process is essential to obtain socially balanced results in which the economic and ecological objectives are both given due weightage. All stakeholders such as farmers/conservationists, owners/tenants, individuals/communities as well as administrators, planners, governments, etc. should participate in problem analysis, express and evaluate their needs, interests and aims, and then negotiate options and priorities for action. This approach implies democratic and, to some extent, formalised procedures, but which are based on a sound information foundation that includes data on the properties of the land, the land uses and their functions in the recovery of the ecosystem. In a multi-stakeholder approach, three principles must converge—good land husbandry, sustainable land use, and an enabling institutional environment. Technology transfer and training needs for farmers, especially women, small and marginal farmers and other disadvantaged sections of rural society are of paramount importance.
- Failure of land-users and community leaders to recognise or to be educated about the causes, urgency, seriousness, and full consequences of degradation often works against any measures to counter degradation. In this context, the negotiated participatory approach needs to be adopted to mitigate some of these adverse effects.
- An increase in industrialisation, urbanisation, mining and infrastructure development is taking away considerable areas of land from agriculture, forestry, grassland, pasture, etc. resulting in environmental disturbances. To harmonise such developmental activities and make them compatible with surrounding land use and guard against any form of land degradation,

  an Area-wide Environment Quality Management (AEQM) approach needs to be adopted.
- The agricultural extension system of the country needs revamping to make it more efficient and far-reaching and the lab-to-land concept needs to be translated to practice so that multidisciplinary technical information, viable land use options and alternatives identified for various agro-ecological and socio-economic units and crop combinations and crop rotations suitable for them, as suggested by the ICAR, can be advanced to the land users for more vigourous and effective land management results.
- Education, training, research, and technology development would enable to focus on analysing and adapting conditions and principles for sustainable land use as well as resource conservation technologies and practices. Research institutes should look for ways of working closely with land users and communities.
- Informal and formal institutions and organisations – from farmer groups, local NGOs and communities to ministries, government policies, and legislations can only be sustained, if they are accepted and

supported by their respective populations. This means that local knowledge systems, norms and values, must be respected. Negotiation processes among all stakeholders, which must be a part of good governance and administrative management, can be enhanced by better information and knowledge about land user's visions, options and needs with respect to sustainable land management.

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