Intern. J. Environmental Studies, 1985, Vol. 24, pp. 245–250
0020-7233/85/2404-0245 $18.50/0

LOSS OF PRODUCTIVE SOIL IN INDIA

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(Received June 16, 1984)

Soil is an abolutely essential component for agricultural production. In a world where the land available per inhabitant is already at a premium, and is being constantly reduced due to increase in population and other activities, man can ill-afford to lose good soil. Soil quality and its proper management has ramifications that extend virtually to every sphere of economic development of any country. This paper attempts to indicate the nature and magnitude of "soil erosion" in India which may have implications for other countries in the world.

It is axiomatic that agricultural self-sufficiency of any country depends on the fertility of soil and its proper management. However, this fact is often neglected resulting in a grave socioeconomic consequences. Productive soil is being continually lost in the developed as well as developing countries. However, the situation in a country such as India is reaching alarming proportions.[1–3]

Soil provides a medium for a wide variety of biological and biochemical processes, and its reactions are basic to the functioning of the agroecosystem, since it provides plants with the essential requirements for growth. The formation and development of soil is a process spread over millenia. Its destruction or degradation under excessive human pressure or misguided human activity can occur over a few decades or even years, and may be irreversible.

Loss of productive soil should be viewed both in terms of quantity and quality. Quantitatively soil could be lost physically from the agricultural or other land by erosion due to wind or water, and transported from where it is required to another place where it is not necessary. Qualitatively soil can be considered to be lost when its fertility declines due to poor management practices.[1–5]

The magnitude of the productive soil loss can be best illustrated by analysing the losses in India attributed to different causes. As shown by Table I, approximately 175 million hectares out of the total area of 328 million hectares are degraded by soil erosion, wind, water or other factors.[6–8]

WATER EROSION

The erosion of top soil by water constitutes the most serious threat to the land resources of India. Apart from reducing the fertility of 100 hundred million hectares, it has extremely deleterious implications such as the siltation of reservoirs and dams, choking of estuaries and occurrence of floods.[6,9,10,11]

A measure of the rapidity of soil erosion is often given by the speed at which new irrigation and power generation reservoirs fill with silt. Siltation has the greatest economic impact in the filling of reservoirs and dams with the reduction in storage capacity of dams to control flood. This results in huge damage costs and shortens the life of the reservoir or dam. There are numerous cases of the reservoir where the

TABLE I

Nature/cause	Area (million hectares)
Water erosion	100
Wind erosion	50
Waterlogging, salinity and alkalinity	13
Shifting cultivation	3
Other cultivable wastes	9
Total	175

actual rates of siltation are considerably higher than the rates anticipated at the time of their design. For instance, the Mangla reservoir and Tarbela dam in Pakistan, Gibralter dam in California, Ambukalo dam in the Philippines and the Shihmen reservoir in Taiwan are afflicted by unexpectedly high rates of siltation.[9,11,12] In India, a number of studies have revealed that the average annual rate of sedimentation in Bhakra, Nizam Sagar, Ram Ganga, Mayurkashi, Tungbhadra and many other reservoirs is four to six times higher than that estimated at the time of their construction. The life expectancy of these projects, is therefore being reduced significantly by soil erosion (Table II). The Ram Ganga Project in UP commissioned in 1973 had a life of 185 years; however, on account of silt load, the life of the dam has been reduced to a mere 48 years.

At one estimate nearly 20 percent of the live storage capacity of the major and medium reservoirs in India would be silted up by the end of this century which means a total loss of irrigation potential of about four million hectares.

Fuel wood is one of the prime factors causing water erosion in the country. In India, the estimated fuel wood consumptions amounts to 133 million tonnes per year.[13,14] Commercially useful wood such as teak, soft wood and bamboo have already been exploited. However, there are contrary reports to indicate the denudation of forests. For example, studies conducted by the Indian Space Research Organisation using satellite photography and remote sensing have shown that the actual area under forest is much less than suggested by the government. No more than 12 percent of the country's land surface is actually under adequate tree cover as against the target of 33 percent prescribed by the National Forest Policy.[15]

Soil erosion attributable to deforestation has not been given the attention which the gravity of situation demands. The rate of erosion in the catchment area of the Yamuna is 300 acres per feet per 100 sq miles, and of the Ganga 400 acres per feet per 100 sq miles. The bed of the Ganga is rising by 7–8 centimetres every year, while the

TABLE II

Sedimentation rates of some reservoirs in India

Name of the reservoir	Year of completion	Originally estimated life (years)	Revised estimated (years)
Bhakra	1959	88	47
Hirakund	1956	100	35
Maithon	1957	246	24
Ram Ganga	1973	185	48
Nizam Sagar	1931	170	50

bed of the Brahmaputra has risen by 5.50 meters in the last half century. In the eastern hills of Nepal, 38 percent of the land area consists of fields which have had to be abandoned because the top soil had washed away, while downstream in the plains of the Nepalese Terai the same top soil causes the beds to rise by 15–30 cm per annum.

There are other losses too. According to some estimates, every year about 6000 million tonnes of soil is washed away into the sea, which in terms of NPK fertilizers amount to 5.37 million tonnes.[15,16]

Evidence of damages caused by water erosion is also offered by the land slides, and severity of floods studies have shown that the incidence of flooding in Indian has been far higher in the last 25 years than during the previous 60 years.[16] The losses caused by floods during 1976–78 amount to Rs. 3180 crores which works out at an average of Rs. 1000 (£62.5) crores per annum.

Probably the most pernicious single result of firewood scarcity is the burning of cowdung to which many people in India have been forced. Annually between 60 and 80 million tonnes of dried dung, which represents 300 to 400 million tonnes of wet, are burned for fuel, thus robbing farmland of badly needed nutrients and organic matter. The plant nutrients wasted annually in this way equal more than a third of India's chemical fertilizer use.[17] Organic manure helps to preserve a porous soil structure which absorbs and holds water. Otherwise, the soil may become compacted and water will run off its surface, causing erosion. Thus the crops of farmers who apply manure to their fields tend to survive in far better shape than the crops of farmers who rely solely on chemical fertilizers. One can easily see the gravity of the problem; indeed, India's National Commission on Agriculture declared that the use of cowdung as a source of non-commercial fuel is "virtually a crime."

Water erosion can be controlled in situations where there has been no total loss of the top soil. Partially eroded soils can be saved from further damage by generating a natural vegetative cover and protecting it from further degradation; this may be supplemented by gully plugs and terraces to prevent the formation of ravines. Strict legislation and public participation is an essential component to reverse the trend of deforestation and soil degradation.

WIND EROSION

Removal or depletion of vegetation or vegetative residues which protect the land is the basic cause of soil erosion by wind. In India, nearly 50 million hectares area is seriously affected by wind erosion; excessive or untimely tillage, improper implements and excessive live stock grazing, all contribute to the erosion. Once erosion sets in, the land is caught in a vicious circle because the loss of its top soil renders it increasingly less capable of sustaining vegetation, just when it needs it most to save it from further damage.[18,19]

Damage from wind erosion is extensive. Dust storms resulting therefrom are almost unbearable. People in villages, town and cities are inconvenienced, and sometimes serious illness or death results from prolonged dust inhalation. Fences, ditches and channels are blocked, buried or rendered uninhabitable. Crop damages, particularly in the seedling stage by blowing soil, is often a major concern.[19,20]

Western India is considered to be one of the dustiest places in the world. Observations indicate that the dust blows upto 6000–10,000 metres in the Thar region. This is the main cause of mid-tropospheric divergence that occurs over the region and which does not allow sufficient precipitation to occur in spite of good

atmospheric humidity. Measurements over a three-year period of dust blowing from the surface to a height of three metres indicate that the average amount of dust varies from 0.5 quintal to 4.2 quintal per hectare in Jodhpur. However, where wind speed is high, an average of 5.11 quintals per hectare is recorded.

Overgrazing also exacerbates the problem of soil degradation. For sustained long-term productivity grass and range land must be carefully evaluated and not overexploited. Overgrazing breaks down the dynamic equilibrium which once existed between live stock and natural range land.

Desertification is by no means limited to India alone. Approximately 65 million hectares of productive land in the southern portion of Sahara are estimated to have become desert in the last 50 years. In Sudan, the desert is reported to have advanced 90–100 kms in the last 17 years. Some 78.5 million people are believed to live in areas currently becoming desertified. One United Nations study had estimated that production losses due to desertification are $26 billion per year, and the cost of halting desertification are $4.5 billion annually for a period up to the year 2000 A.D.[18–20]

The control of wind erosion lies primarily in curbing the indiscriminate grazing of nomadic herds so that natural vegetation may get a chance to re-assert itself, and in the creation of wind breaks and shelter which reduces the velocity of strong winds and thereby erosive effects. Experiments in Rajasthan have shown that excellent pastures can be developed by merely closing areas to grazing, and that once such pastures have been established, under controlled conditions and rational grazing, they can support four times the number of animals as are being carried by the same land today.

WATER LOGGING, SALINITY AND ALKALINITY

No doubt irrigation increases crop by improving water availability for intensive agriculture, but it also creates severe ecological and environmental problems. One of the main causes of soil degradation is water logging, salinization and alkalinization in the irrigated areas of the country. Without adequate drainage excessive or unwise irrigation can lift the salts to the soil surface, this reduces the fertility and hence agricultural productivity. In India, out of the 40 million hectares of irrigated land, at least 13 million hectares had been lost to water logging salinity and alkalinity.[6,21]

In other countries too, water logging and salinity in canal-irrigated areas have reached alarming proportions. For instance, in Pakistan out of total 15 million hectares of irrigated lands as many as 11 million hectares are suffering from water logging and salinity. Syria, Iraq and Egypt are also facing similar problems.

The threat of this type soil degradation is particularly serious in the black cotton soil of India. In the Deccan black soil area, the top soil loss in a single year is as high as 4–100 tonnes per hectare.[7,15] In the Shivalik hills, 6 cms of top soil representing nearly 2400 years of ecological history may disappear in one year. The formation of 1 cm soil takes about 500 to 1000 years depending on the parent material and weather intensity.

The problem of water logging in canal irrigated areas can be controlled by lining the canals, drainage and distributories, as well as the construction of field channels so that just as much as water may be applied to the soil as is really necessary. The lining of canals and distributories would not save only valuable lands from damage but would also save water losses which often amount to as much as 40 percent of the water released from the reservoir. Varieties of food grain that can withstand higher levels of salinity and resistance to water logging may also be promoted.

SHIFTING CULTIVATION AND OTHER CULTIVABLE WASTES

In India, an expanding population had increased the pressure to expand the cultivated area. This pressure, coupled with political expediency and lack of expertise had resulted in more and more utilization of marginal land, for which either technology is not available for farming on a sustained basis, or if available had been disregarded for socio-economic reasons. Thus, the expansion of agriculture on steep hill sides has led to serious erosion. In north-eastern regions alone, where shifting cultivation is extensively practised, nearly 2.7 million hectares of forest land is affected by nearly half a million tribal families.[15]

Open quarrying, mining and blasting disturbs the ecosystem and causes soil degradation. Extensive roads net work in the hills, though essential, changes the run-off pattern resulting in gully formation. Such roads have frequently to cross geologically unstable slopes resulting in recurring land slides which cause damage to life and property and disrupt communication. Where hill cutting has to be done, the soil is simply dumped into the rivers thereby enhancing the sedimentation problem of the rivers.

There are other ways too in which soil structure, fertility and productivity may be damaged. The first of these concerns is multi-cropping which takes place on account of the continued application of large quantities of inorganic fertilizers and pesticides. There is a need to monitor and maintain the fertility of soil through soil testing at regular intervals.

Another important concern is the diversion of good agricultural lands to urban uses. Land is not only disappearing under buildings and roads but also being destroyed to produce bricks. It has been estimated that the brick work for a modest house for a family of five requires about 120 tonnes of soil. Thus to house the existing urban population nearly 3000 million tonnes of soil would have to be excavated. As agricultural land is a precious commodity steps should be taken to ensure that urban growth takes place only on a comparatively inferior soils.[7]

The above analysis vividly reveals that soil erosion is one of the pressing and difficult problems that India is facing. If the present trend continues, it seems that all the efforts for producing more food may not compensate for the areas lost as a result of soil degradation. India can barely manage to produce 130 million tonnes of food grain from 143 million hectares of agricultural lands, while China produces significantly more than 300 million tonnes from a mere 112 million hectares. The ability of India to feed her people will depend on the fertility of its soil. By the end of this century, the country will need a production of at least 230–250 million tonnes as against 130 million tonnes at present.

Thus, if adequate food for the country's expanding population is to be produced, the present rates of soil erosion cannot be continued. Deforestation, overgrazing, excessive cultivation, unwise irrigation, and urbanization all will have to be controlled. Soil conservation and other forms of agriculture development must receive priority in national planning.

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