International Journal of Advanced Technology in Engineering and Science
Vol. No.3, Issue 09, September 2015
www.ijates.com
ijates
ISSN 2348 - 7550

Soil and Water Conservation in India

P.Boopathi

M.E., Lecturer (Senior Grade) /Agricultural Technology, 215.Sakthi Polytechnic College, Sakthi Nagar 638 315. Tamil Nadu, India.

ABSTRACT

Soil and Water are the most essential natural resources that cradle the Human civilization, protects environment, satisfies all needs of human being and other living spices in the world. Ever increasing demands for land and water resources due to burgeoning population cause the degradation of these two precious natural resources and put forth immense pressure. In India and out of 329 million hectare (Mha) of total geographical area, 146.8 Mha of lan is degraded due to soil erosion. Indian economy is affected due to this land degradation. India receives good amount of annual rainfall (1190 mm), but due to enhanced need for domestic, agriculture and industrial developmental activities, over-exploitation and laxity of water resource, water becomes scarce commodity. The depleting trend in groundwater level all over India also indicates that the assured supply of good quality water will become a concern for country's development. Hence Soil and Water Conservation measures must have a holistic management approach by interconnecting social and economic development with protection of natural ecosystem. Creation of scientific methods on soil and water resources, use of modern technological tools and equipments for developing conservation strategies, changes in policy to protect natural resources, development of locality specific soil and water conservation measures and involvement of local people in conserving the soil and water resources are the need of the hour. This paper addresses few such strategies on the soil and water conservation.

Key words: Soil and Water Conservation, Groundwater, Climate change, Water resources, Land degradation,

INTRODUCTION

Soil and water are the most essential natural resources and physical base for all life supporting system. Soil acts as a medium where as water sustains life in the World. These two resources are too precious for the mankind as well as the living being in the world, they meet all the needs and protect the environment as well as the civilization. In India, Land degradation has become a serious problem in both rainfed as well as irrigated areas. Degraded lands put forth huge loss to Indian economy. Moneyt lost due to land degradations were documented by various authors (Joshi and Agnihotri, 1984; Parikh and Ghosh, 1995; Joshi *et al.*, 1996; Srinivasarao, 2013) in terms of declining crop productivity, land use intensity, changing cropping patterns, high input use and declining profit. Loss of production in India at Rupees 68 billion in 1988-1989 was estimated by Reddy (2003) using the National Remote Sensing Agency dataset. Additional losses resulting from salinization, alkalinisation and water logging were estimated as Rs 8 billion. Of late, in a comprehensive study made on the impact of water erosion on crop productivity, it was revealed that soil erosion due to water resulted in an annual crop production loss of 13.4 Mt in cereal, oil seeds and pulse crops (Sharda *et al.*, 2010). Out of a total reported geographical area of 329 Mha of India, about 146.8 Mha are degraded by various factors. Water erosion and wind erosion together account for 70% of the total degraded land and the remaining 30% is due to salinity, acidity and combination of other factors. Annual soil loss of India is estimated as 5334 Mt along with these 8.4 Mt of major nutrients also lost (Prasad and Biswas, 2000). Annually, 2052 million tonnes of soil is carried by rivers out of this nearly 480 million tonnes is being deposited in various reservoirs which results in 1–2% loss of storage capacity per year (Dhruva Narayana and Rambabu, 1983). According to National Commission on Agriculture, reservoirs in India are silting up at a rate of three to four times faster than the designed rates. It is a matter of concern that out of 329 Mha geographical areas, about 145 Mha is under cultivation and there is no scope to bring more area under cultivation.

Singh (1999) reported that the cropping intensity at present is only 136%. The per capita cultivable land will reduce to 0.14 ha in 2025 AD compared to 0.33 ha in 1950. The ever increasing population and their impact every aspect of development, such as agriculture, industry and urbanization depend primarily on water resources leading to ever increasing demands of water. Sustainable food production and domestic water requirements are severely affected by increasing water demand, over exploitation of ground water resources and inefficiency of tapping the surface water and also poor harvesting of rain water. FAO has reported that the global water withdrawal increased from less than 600 cubic km per year in 1900 to almost 4000 cubic km per year in 2010. Further, it is assessed that it will increase to 5100 cubic km per year during 2025 with a rise of 8.4-12.2% from the current rate of withdrawal. In 1995, 76% of the world population had water availability of less than 5100 cubic meter per year per capita and it is predicted that in 2025, most of the Earth's population will be living under low water supply. It is projected that the situation of water user categories in the world will not shift much excepting increase in water consumption due to urbanization in the developing countries. The water consumption rate for agriculture will be around 70%, industry around 20% and residential and commercial around 10%. Because of climate change and uncertain rainfalls, the use of water in agriculture will increase by the expansion of irrigated land. From late 1970 onwards, almost all developed and developing nations created intensive irrigation facilities to ensure increased crop production. Subsequently, the global rate of increase in irrigated areas has slowed down mainly due to very high cost of construction of irrigation system and soil degradation problems.

Naturally, more efforts are required to harness the water resource potential and to counter the drought and flood India. The management of soil and water resources in India needs holistic and dedicated approach by linking socio economic developmental activities with eco-friendly environment.

LAND DEGRADATION

A study reported by Barrow 1991 says that 430 Mha land is subjected to severe land degradation in the world and the impact of degradation in Asia will be around 18%. In India, high percentage of area under degraded land is in the following states

Table 1. Land degradation in Indian States

Sl.No.	Name of the State	Area (Percentage)	Reason
1.	Jammu and Kashmir	69.24%	Snow cover and degraded forest
2.	Himachal Pradesh	50.90%	
3.	Nagaland	22.37%	Shifting cultivation
4.	Manipur	59.01%	
5.	Mizoram	21.20%	
6.	Sikkim	53.67%	Degraded forest
7.	Rajasthan	29.64%	Sandy area

The category-wise distribution of wastelands shows that highest percentage (4.76%) belongs to the category 'land with scrub' mainly distributed in the southern states of India followed by 'underutilized forestland' (3.42%) distributed throughout the country. Among the 583 districts, 19 districts mainly distributed in NE states, Jammu Kashmir and Rajasthan have got more that 50% of geographical area under wastelands (MoRD & NRSA, 2005). The severity and extent of soil degradation in the country has been previously assessed by many agencies (Table 2). According to the National Bureau of Soil Survey and Land Use Planning, 146.8 Mha land is degraded in India. Water and wind erosion are the most serious degradation factors in India, resulting in loss of topsoil and terrain deformation followed by acidity and water logging (Fig 1). Based on first approximation analysis of existing soil loss data, the average soil erosion rate was 16.4 ton per ha per year, resulting in an annual total soil loss of 5.3 billion tons throughout the country. Nearly 29% of total eroded soil is permanently lost to the sea, while 61% is simply transferred from one place to another and the remaining 10% is deposited in reservoirs.

Table 2. Extent of soil degradation in India as assessed by different organizations

S.No.	Organizations	Degraded area (M ha)
1.	National Commission on Agriculture (NCA, 1976)	148.1
2.	Ministry of Agriculture-Soil and Water Conservation Division (MOA, 1978)	175.0
3.	Department of Environment (Vohra, 1980)	95.0
4.	National Watershed Development Board (NWDB, 1985)	123.0
5.	. Society for Promotion of Wastelands Development (Bhumbla and Khare, 1984)	129.0
6.	National Remote Sensing Agency (NRSA, 1985)	53.3
7.	Ministry of Agriculture (MOA, 1985)	173.6
8.	Ministry of Agriculture (MOA, 1994)	107.4
9.	National Bureau of Soil Survey and land Use Planning (NBSS&LUP, 1994)	187.7
10.	National Bureau of Soil Survey and land Use Planning, Revised (NBSS&LUP, 2005)	146.8

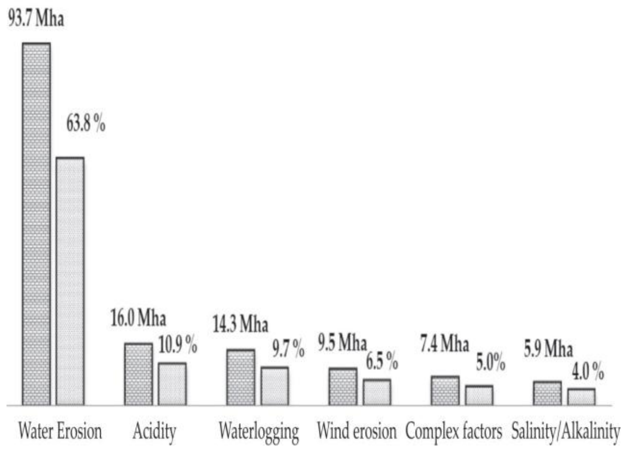

Fig. 1. Contribution of land degradation factors in India

(*Source*: NBSS&LUP, 2005)

ISSUES ON WATER RESOURCES

Himalayan rivers like Ganga, Bramaputra are the important and prominent water source of India, which has a large and intricate network of river systems. Apart from this, a number of water bodies present in the sub-continent make it one of the wettest places in the world next to South America. The main sources of water in India are annual rainfall and snowfall. It is estimated to be 4000 billion cubic metres (BCM).

Central Water Commission estimated the catchment area wise water resource potential of India is about 1869 cu.km. It occurs as natural runoff in the rivers. More than 60% of the share in total water resources potential of all the river systems in India is contributed by Ganga-Brahmaputra-Meghna system, which is amajor contributor. The present utilization of majority of river basins is significantly high and is in the range of 50–95% of utilizable surface resources. The Narmada and Mahanadi has less utilization factor.

Dynamic and Static resources are the two major components of Groundwater resources, the dynamic resource is in the zone of water table and it fluctuates and unsaturated, whereas the static resource will be below the dynamic zone which is perennially saturated. National Water Policy 2002, states that the dynamic groundwater resource is the exploitable quantity of groundwater, which is recharged annually, and is also termed as replenishable groundwater resource. 431 BCM is the annual available replenishable groundwater resource of the country, out of this the net groundwater availability is 396 BCM and the remaining 35 BCM is for natural discharges during non-monsoon season. The annual groundwater draft for the year 2009 was 243 BCM, out of which 221 BCM is utilized for irrigation and 22 BCM is used for domestic and industrial purposes. The overall stage groundwater development of the country is estimated as 61% (CGWB, 2014). According to Chatterjee and Purohit, 2009 the contribution of rainfall to annual replenishable groundwater resource of the country is 67%, indicating the dependence on rainfall for recharge of ground water resources. Due to plenty of rainfall and thick piles of unconsolidated alluvial formations groundwater recharge is significantly high is the Indo-Gangetic-Brahmaputra alluvial belt. Recharge per ha of area in these regions varies from 0.28 to 1.35 m. The coastal alluvial belt also has relatively high recharge, in the range of 0.16 to 0.40 m. whereas the annual recharge is only 0.10 m in Western India with arid climate. Similar is the case with major part of the southern peninsular India. The Ministry of water resources reports that the ultimate irrigation potential created in India till 2014 is 140 Mha. Out of which 76 Mha is irrigated through surface water resources and the remaining 64 Mha is irrigated by ground water resources (CWC, 2014).

CLIMATE CHANGE IMPACT ON WATER RESOURCES

According to some of the studies carried out in the Indian Himalayas clearly says that there is an increase in glacial melt (Kumar *et al.*, 2007). For example in Himachal Pradesh Baspa basin winter stream flow has increased by 75% when compared with the data of the year 1966. 12,930 sq.km volumes of ice and snow are spreads over an area of 97,020 sq. km surface area of Himalayan Mountains. In Himalayan mountains, 10 to 20% of the total surface area is covered by glaciers, while an additional area ranging from 30 to 40% has seasonal snow cover. Indian rivers are fed perennially by the melting of this snow and glaciers. A very conservative estimate given by Bahadur (1999) says that at least 500 cubic km /yr from snow and ice melt water contribute to Himalayan streams, while about 515 cubic km /yr from the upper mountains. The most important fact of glacial runoff is that they release more water in a drought year and less water in a flood year and thus ensuring water supply even during the lean years. Accordance with the climatic condition, the snow line and glacier boundaries are sensitive to change. Almost 67% of the glaciers in the Himalayan mountain ranges have shrinked in the past decade (Ageta and Kadota, 1992; Yamada *et al.*, 1996). The mean equilibrium line altitude at which snow accumulation is equal to snow ablation for glacier is estimated to be about 50-80 meters higher relative to the altitude during the first half of the 19^{th} Century.

Gangotri glacier is shrinking about 28 meters per year as per the records available. Global warming is the major culprit in the faster melting of glaciers than their accumulation due to increase in temperature. According to IPCC (1998) reports glacier melt is expected to increase under changed climate conditions, which would lead to increased summer flows in some river systems for few decades, followed by a reduction in flow as the glaciers disappear in future.

In India over 10 million hectares of area every year is affected by floods, which is also one of the climate change extreme. Out of these 10 million hectares 5 million hectare of the area is under agricultural land. Government of India constituted Rashtriya Barh Ayog (RBA) in the year 1976 to carry out an extensive analysis and to estimate the flood-affected area in the country. They reported that 40 Mha areas are liable to floods (Mall *et al.*, 2006). The report of CWC (2002), says that as many as 99 districts spread over 14 states were identified as drought prone districts in the country. Major drought prone areas are located in the states of Rajasthan, Karnataka, Andhra Pradesh, Maharashtra and Gujarat. The demand for water through population growth and agricultural practices that influence drought because of human activities, and modification of land use that directly influences the storage conditions and hydrological response of catchments and thus its vulnerability into drought (WMO, 2002).

SOIL AND WATER CONSERVATION STRATEGIES IN INDIA

In India, Soil and Water Conservation strategies should be atleast two fold, they are increase the availability of water and also efficient utilization of water. It should be promoted by adopting other techniques such as multiple use of water, proper soil and crop management, low cost micro irrigation,

International Journal of Advanced Technology in Engineering and Science
Vol. No.3, Issue 09, September 2015
www.ijates.com
ijates
ISSN 2348 - 7550

integrated farming system, etc. The first and most important factor which can reduce the soil degradation problems is the adaptation of suitable soil and water conservation measures and cultivating crops based on land suitability. To increase water productivity and rural farmer livelihood security, the micro scale or localized rain water harvesting from the farm lands and multiple uses of rain water is done. The various degraded land categories have to be treated using the available technologies as below:

Gullied or ravenous land

Runoff management is the key to development of gullied and or ravenous land. The first step in transition of sloppy land in to gullied or ravenous land is the prevention of sheet or rill erosion. The other feasible measures for rehabilitation of gullied or ravenous land are preventing damage from river back flow, promoting afforestation and grass land development with involvement of local peoples and government departments and encourage the farmers to go for suitable horticultural plantation in the susceptible regions. Wherever vegetative measures are not feasible or economical appropriate engineering or mechanical measures have to be adopted or both the measures can be combined suitably. Combined use of engineering measures like trench-cum-bund and vegetative barrier of *Vetveria zizanioides* and sambuta (*Saccharum Spp*) reduced runoff and soil losses to half of that observed in control plots and thereby increased test crop (finger millet) yield by 18–33% (Dass *et al.*, 2010). Also, the vegetative filter strips that are typically much wider (more than 5 m) can be established between field borders and water ways (Blanco-Canqul *et al.*, 2004) to protect land and reduce pollution in the water bodies (Srivastava *et al.*, 1998).

Land with or without scrub

Degraded rocky or stony and gravelly upland and shallow hardpan soil areas with very scanty and poor distribution of unpalatable shrubs and grasses as well as low production potential, are recommended for development of silvipastures. Degraded lands when converted to perennial land use like forestlands ensures minimum soil disturbance and enhance soil organic carbon sequestration, thereby reduces the risk of soil erosion (Lal, 2015). Improved soil and water conservation measures including vegetative barriers along with rainwater harvesting techniques are important pre-requisite to establish such production systems.

Water logging and salinization

Water logging is the main problem in the areas of soils with poor drainage capacity. Water logged areas can be efficiently managed by adopting efficient water application technology and modern irrigation system, raising intercrops with integrated nutrient management and adopting crop rotation. In addition vertical drain, sub-surface drain, bio-drain and lining of canal will helps to drain the excess water from these areas.

Degraded forest land

Partly degraded forest areas can be improved by gap filling, reseeding and transplanting with suitable plant species using soil and water conservation measures such as trenching and contour furrowing. These kinds of degraded forest areas should be properly protected through fencing so that seeds already existing will germinate and the condition of the forestland can be improved. The ground flora should be enriched by growing suitable shrub and grass species in contour furrows. Grazing in these areas should be restricted and properly regulated with the involvement of local community. Regular monitoring of developmental activities should be ensured and timely action should be taken to prevent degradation and development of good forest cover. Joint Forest Management is one of the excellent system which aids in the regeneration of degraded forests with the help of the nearby villagers who are dependent on the forest for their livelihood (Binodini, 2016). Co-operation from nearby villages should also be taken to ensure social protection of these forest areas.

Degraded pasture / grazing lands

Degraded grazing lands are mainly distributed in the states of Rajasthan, Haryana etc., and at present almost all grazing lands, especially village commons are in degraded condition. Loss of ground cover has a bearing on infiltration rate causing low moisture storage in soil profile. These lands need priority for rehabilitation and can be achieved with the co-operation and active participation of local people. Degraded vegetation can be regenerated by providing suitable soil and moisture conservation measures and the protection. Inder Dev *et al.* (2016) reported that introduction of fodder trees and grasses/legumes in grazing lands in combination with trenches reduced the runoff to 10.2% compared to 40.5% where there is no soil and water conservation measures and enhanced the biomass production potential of the pasture lands. The approach should be ecologically suitable and acceptable to local people.

Shifting cultivation

Shifting cultivation is a common agriculture practice in the hill regions of India and it is extensively practiced in North Eastern states, Orissa and the Eastern Ghats with an estimated forest area of about 4.35 Mha. Initially the fallow period followed in shifting cultivation is more than 30 years, but now the pressure on agricultural land has increased significantly due to expanding population and the fallow period has reduced to 2- 3 years. The short fallow period between two cultivation is not sufficient for the natural processes of recuperation of the disturbed ecosystem leading to decline of soil fertility and land degradation. The land degraded by shifting cultivation has to be rehabilitated by adopting silvipasture, silviculture and agri-horticulture system. Lenka *et al.* (2012, 2013) reported that in eastern ghats of Odisha, shifting cultivation ravaged hills could be successfully rehabilitated with production-cum conservation based agro forestry systems consisting of Guava / cashew and *Stylosanthes hamata* and Trench system.

Shifting and stabilized dunes

Shifting barchan dunes due to their inherent vulnerability become quite active during summer season and sands starts moving and engulfing the adjoining agricultural lands and engineering structures. This kind of dunes needs immediate attention for stabilization and control of degradation. The stabilization measure includes providing protection from biota, micro wind breaks and re-vegetation in the affected areas. Due to intense biotic activities the top, crest and upper part of the flanks of most of the parabolic dunes are usually covered with loose sand. In such sites sand movement can be checked to a maximum extent by planting suitable grasses and plant species. *Lasiurus sindicus* locally known as ‘sewan grass’ is used as a fodder grass for the desert livestock of Thar desert also used for stabilizing the blowing sand dunes (Sinha, 1996). Singh and Rathod (2002) recommended sowing of *Prosopis juliflora* in sand dunes for early stabilization. *Cassia angustifolia* and *Cenchrus* *ciliaris* or the other local grasses of suitable combinations also can help to improve the biomass production and biodiversity in these kinds of sandy areas.

CONCLUSIONS

Total geographical area of India is 329 Mha, out of this geographical area about 45 % of the land (146.8 Mha) is estimated as degraded. Employing suitable strategies for rehabilitation of such degraded lands are the most urgent need of the country for sustainable production and better livelihood of human being. 187 M ha m is the available water resource potential of India of which utilizable water resource potential is only 110 M ha m. This includes surface and ground water resources also. Indian subcontinent is highly sensitive to climate change, which results in either decrease in precipitation results in decreased surface water inflows and increases the demand for ground water or increase in sudden cloud burst like rains or rains of higher intensity for shorter duration which results in sudden and heavy flooding. Drafting of appropriate policy implications for surface and ground water management, creation of remote sensing and GIS based inventories on land degradation, development of indigenous sensor based instruments for monitoring hydrological parameters, studies on climate change impact on soil and water resources, refinement of soil and moisture conservation and water harvesting structures to detoxify the climate change impacts and participatory water resources management(Public, Private and Government) conserving the soil and water resources are the future challenges for the Indians , particularly scientists and decision makers.

REFERENCES

1. Bahadur, J. 1999. *The Himalayan Environment*. New Age International (P) Ltd., New Delhi. Barrow, C.J. 1991. Land degradation: Development and Breakdown of Terrestrial Environments. Cambridge University Press. New York.
2. Bhumbla, D.R. and Khare, A. 1984. Estimate of Wastelands in India. Society for promotion of Wastelands Development. New Delhi, India.
3. CGWB (Central Ground Water Board) 2002. Master Plan for Artificial Recharge to Ground Water in India, Ministry of water resources, Government of India, New Delhi.
4. Chatterjee, R and Purohit, R.R. 2009. Estimation of replenishable ground water resources for India and their status of utilization. *Current Science* **96**(12): 1581- 1591.
5. CWC (Central Water Commission) 2002. Water and related statistics. Ministry of water Resources. New Delhi.
6. CWC (Central Water Commission) 2014. Annual report 2013-14. Ministry of water Resources New Delhi.
7. Dhurva Narayana, V.V. and Ram Babu. 1983. Estimation of Soil Erosion in India. *Journal of Irrigation and Drainage Engg.* **109**(4): 419-434.
8. Inder Dev, Sudesh Radotra, Khola, O.P.S., Bimal Misri, Sindhu Sareen, Srivastava, A.K. Bhupinder Singh., Sharma, S.K., Chamoli, K.P. and Dinesh Kumar (2016). Natural resource enhancement through silvipastoral establishment in western Himalayan region. *Indian Journal of Animal Sciences* **86**(11): 1296-1301.
9. IPCC, 1998. Special Report of IPCC working group II [Watson, R.T., M.C. Zinyowerea, and R.H. Moss (eds.)]. Inter Governmental Panel on Climate Change. Cambridge University Press. New York.

10. Lal, R. 2015. Soil Carbon Sequestration in Agro ecosystems of India. *Journal of the Indian Society of Soil Science* **63**(2): 125-143.
11. Kumar, R., Hasnain, S.I., Wagnon, P., Arnaud, Y. and Sharma, P. 2007. Climate change signals detected through mass balance measurements on benchmark glacier, Himachal Pradesh, India. In: Climate and anthropogenic impacts on the variability of water resources. Technical Document in Hydrology. Hydro Science Montpellier.
12. Mall, R.K., Gupta, A., Singh, R., Singh, R.S. and Rathore, L.S. 2006. Water Resources and Climate Change: An Indian perspective. *Current Science* **90**(12): 1610-1626.
13. MoA. 1978. Indian Agriculture in Brief (17th ed.). Directorate of Economics and Statistics. Ministry of Agriculture and Irrigation, Government of India, New Delhi.
14. MoA. 1985. Indian Agriculture in Brief (20th ed.). Directorate of Economics and Statistics. Ministry of Agriculture, Department of Agriculture and Cooperation, Government of India, New Delhi.
15. MoA. 1994. Indian Agriculture in Brief (25th ed.). Directorate of Economics and Statistics, Ministry of Agriculture, Department of Agriculture and Cooperation, Government of India, New Delhi.
16. Ministry of Rural development and NRSA 2005. Wastelands Atlas of India-2005, National Remote Sensing Agency, ISRO, Hyderabad.
17. National Bureau of Soil Survey and Land Use Planning (NBSS&LUP). 2005. Annual Report–2005. Nagpur. India.
18. National Bureau of Soil Survey and Land Use Planning (NBSS&LUP). 1994. Global Assessment of Soil Degradation (GLASOD) Guidelines. Nagpur. India.
19. NCA.1976. Report of the National Commission on Agriculture. National Commission of Agriculture, Government of India, New Delhi.
20. NRSA. 2000. Waste Land Atlas of India. Government of India, Hyderabad, India.
21. NWDB. 1985. Ministry of Environment and Forests. National Wasteland Development Board Guidelines for Action. Government of India, New Delhi.
22. Prasad, R.N. and Biswas, P.P. 2000. Soil Resources of India. In *50 Years of Natural Resource Management*; Singh, G.B., Sharma, B.R., Eds.; Indian Council of Agricultural Research: New Delhi, India.
23. Reddy, B.R. 2003. Land Degradation in India: Extent, costs and determinants. *Econ. Polit. Wkly.* **38**: 4700-4713.
24. Sharda, V.N., Dogra, P. and Prakash, C. 2010. Assessment of Production losses due to water erosion in rainfed areas of India. *Journal of Soil Water Conservation* **65**(2): 79-91.