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Analysis of wasteland status in India: Targets and reclamation

Dr. K Vasanta[1] and Upasana Dhawan[2]

[1]Science Faculty, Dayalbagh Educational Institute, Dayalbagh Agra, Uttar Pradesh, India

[2]Assistant Professor in Economics, Mata Sundri College for Women, University of Delhi, Delhi, India

Abstract

India faces a problem of land degradation due to many land misuse practices, deforestation, water erosion, wind erosion, salinity, alkalinity, and flooding. The land which is not used due to any type of obstruction, whether it is cultivable or non-cultivable is known as wasteland. Management and reclamation of this wasteland is imperative for meeting the growing needs of the ever-increasing population of the country. New technologies, afforestation, deep irrigation, water controlling, strip farming, terrace farming, agri-horticulture, horti-pastures, energy farms are some of the methods of reducing wastelands. Peoples participation at the grassroot level, through community organization and capacity building is important. Every year due to land misuse and deforestation India is degraded by an estimated 2.1 MHA of land. Due to its varied topography different states in India have different factors playing on land degradation and various methods are employed by the state governments to reduce the wastelands. In 2019, at a UN conference to combat desertification, India has set an ambitious target of restoring 26 MHA of degraded land by 2030. The current pace of efforts and steps taken by the government fall short of helping achieve this target of land degradation neutrality. In a country where nearly 30% of the area is hit by degradation, the revival and restoration of wastelands will be one of the biggest environmental achievements.

Keywords: Wasteland status, Targets and reclamation, water erosion, wind erosion

Introduction

Over the years, India's landmass has suffered from various degradations which increased biotic and abiotic pressure on land. An ever-increasing population and unprecedented pressure on the land is the root cause of the degradation of land in the Country. The soil degradation may be physical, chemical, and or biological in nature. The destruction of soil structure, compaction, reduction in infiltration rate, depletion of soil organic matter, reduction in biomass carbon, salt imbalance, and build-up of soil-borne pathogens, *etc* are some of the factors which result in soil degradation (Lal and Stewart, 1992) [2]. Wastelands are considered degraded when their productivity is diminished, not being used its optimum potential, unproductive. National Wastelands Development Board classifies wastelands primarily into two categories; cultivable wasteland which includes gullied or land having ravines, undulating land without shrubs, marsh land with surface waterlogging, salt-affected land, degraded forestland and plantations, mining and industrial wastes, dunes and strip lands, and uncultivable wasteland which include brown rocky, stony, and shut of rocks, steep sloppy areas and snow-covered or glacier lands. Wastelands mainly consist of culturable and unculturable wastelands. Culturable wastelands are those lands that have the potential for the development of vegetative cover or may be reclaimed at a later stage. It includes gullies and or ravenous lands, wavy upland surface, waterlogged and marshy areas, salt-affected land, shifting cultivation area, degraded forest land, sandy land area, mining, and industrial wasteland, strip land, pastureland, and grazing land. Vegetative cover cannot be developed on unculturable wastelands. These lands being barren cannot be put to significant uses. However, some of the areas of such lands can be converted/changed into pastureland. It includes a rocky barren area, steep mountain slopes, and snow-covered glacial areas. Although no consensus has yet arrived at a comprehensive definition of wasteland, but it is largely accepted that wastelands are basically the areas that are underutilized capacity wise, and which produce less than 20 % of its biological productivity (Mishra *et al*. 2013) [3].

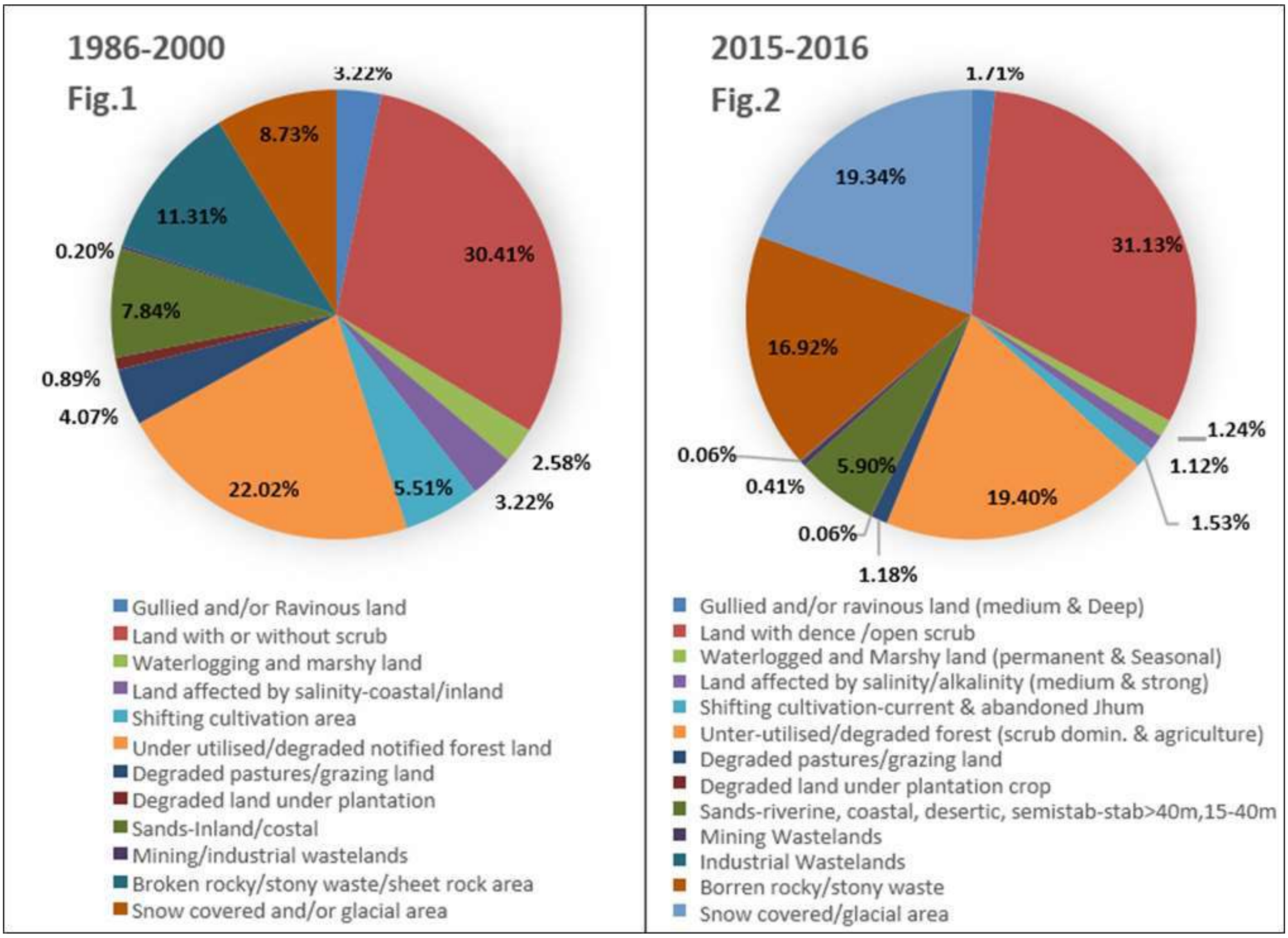
As per the Special Report on Climate Change & Land of Intergovernmental Panel for Climate Change released in August 2019, land-use change, land-use intensification, and climate change have contributed to desertification and land degradation. The report highlights that climate change, including increases in frequency and intensity of extremes, has adversely impacted food security and terrestrial ecosystems as well as contributed to desertification and land degradation in many regions (PRESS information Bureau, GOI, 2020). In India, eroded lands constitute a major portion (Table 1) than other categories. The main cause of degradation is erosion, which results in the loss of topsoil mainly through the action of water and wind or through waterlogging, which results in soil salinization. Natural occurrence of alkaline chemicals substances, upward movement of subsoil chemicals to the surface, artificial addition of chemicals to soil through fertilizers and insecticides, physical causes including waterlogging, geomorphological changes in land caused by mining, presence of industrial pollutants, and anthropogenic drivers include livestock-related activities (grazing), heavy biotic pressures (for fuelwood and fodder), land use changes including urbanization, etc. are the reasons for land degradation. In India, wastelands are largely formed due to physical degradation. The loss of clay, silt, and soil organic matter makes these wastelands deprived of nutrients (Bradshaw and Chadwick, 1980) [1]. Physically degraded wastelands are characterized with gravelliness; dominated by coarser fragments such as sand and silt; deprived of soil fines –silt and clay; and depleted of nutrients especially nitrogen and phosphorus. Thus, the overall fertility and hence, the productivity of wastelands are very much limited, and the soil mass provides only physical support for the growing vegetation**.** Widespread land degradation caused by inappropriate agricultural practices and reckless land use has a direct and adverse bearing on the livelihood and food security of farmers. The burning of crop residue, inadequate organic matter inputs, poor water management and irrigation methods, poor crop rotations practices, overuse of insecticides and pesticides, etc. are also responsible for land degradation. Apart from these, the high rate of population growth and high incidence of poverty in rural areas, over-exploitation of natural resources, etc. are also responsible in conversion of agriculture lands into wastelands.

Table 1: Extent of degraded and wastelands in India

Degradation type	Land area (m ha)
Water erosion (> 10 tonnes/ha/year)	73.27
Wind erosion (Aeolian)	12.40
Subtotal	85.67
Chemical degradation	
Exclusively soils affected by salt	5.44
Salt affected soils and water eroded soils	1.20
Exclusively highly acidic soils (pH<5.5)	5.09
Acidic (pH<5.5) and soils eroded by water	5.72
Sub total	17.45
Physical degradation	
Mining activities and industrial waste	0.19
Water logging (permanent sea water inundation)	0.88
Sub total	1.07
2Total	104.19
Grand total (Arable land and open forest area)	120.72

Source: Degrade and Wastelands of India-Status and Spatial Distribution (2010), ICAR& NASS

A rapid increase in industrial activities, incessant urbanization, and massive infrastructure development is continuously taking away considerable areas of land from agriculture activities, forestry, grassland and pasture, and unused lands with wild vegetation. Reckless Mining activities disturb the physical, chemical, and biological features of the soil and alter the socioeconomic features of a region, and negative effects on water, soil contamination, part or total loss of flora and fauna, air and water pollution, and acid mine drainage. Overburden removal from the mine area results in significant loss of vegetation and rich topsoil (Sahu *et al*. 2011) [6]. High livestock density in arid regions, which are dry and without water causes overgrazing in these areas, resulting in decreased infiltration and accelerated runoff, and erosion of soil. Due to overgrazing, soil loss is 5 to 41 times greater than normal at the mesoscale and 3 to 18 times greater at the macroscale (Sharma *et al*. 1997) [7]. A district and state-wise distribution of different categories of wastelands area is provided by the Wasteland Atlas. The atlas includes mapping of about 12.08 Mha hitherto unmapped area of Jammu & Kashmir also.



***Source*:** Wastelands Atlas, Deptt. of Land Resources, Ministry of Rural Development

Fig 1-2: Comparison of Waste land categories in the year 1986-2000 to 2015-16 (in %)

The change in wastelands between 1986-2000 and 2015-16 has been presented in Fig.1 & 2. It can be seen that there was a reduction in wasteland area in the categories of land having dense shrubs and bushes, waterlogged and marshy land, sandy and coastal areas, degraded pastures and grazing land and gullied and ravinous land etc. Total percentage of wasteland area is 16.96 in between the years 1986-2000 and 20.16 in between the year 2015-16. Fig.1 & 2 are indicating percentage of different wasteland categories in the total wasteland percentage.

Types of wastelands in different states

Wastelands are typically poor in organic matter and plant nutrients. Humus is the organic component of soil, formed by the decomposition of leaves and other plant material by soil micro- organisms. Geology, topography, climate, vegetation, human activity, and the time shape these factors and, in turn, determine soil fertility, biodiversity, nutrient recycling, physical structure, carbon retention, and other ecological functions that make for soil health. The biomass productivity and biomass turnover among wastelands are much lesser compared to that of other land-use systems. Extensive removal of vegetal biomass for fodder, fuel, and timber purpose further leads to exposure of soil surface for water and wind erosion. Soil surface exposure further

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Table 2: Type of Wasteland in different states

Type of Land	State
Gullied Land areas	MP, AP, Rajasthan, Bihar, UP, Karnataka, Maharashtra, Gujrat, Karnataka
Land with or without scrub	MP, AP, Maharashtra, Karnataka, Odisha, Rajasthan, Gujarat
Waterlogged land	UP, AP, Gujarat, Maharashtra, WB,TN, Assam, Bihar
Saline and Alkaline land	Gujrat, UP, Rajasthan, TN, AP, Haryana, Maharashtra
Degraded Forest land	AP, MP, Maharashtra, Bihar, Rajasthan, Odisha, TN, Karnataka
DegradedPastures/Grazing land	Rajasthan, HP, Assam, Arunachal Pradesh, Maharashtra, Haryana, AP

Degraded land plantation	HP, MP, Maharashtra, J & K, TN, Odisha, Haryana
Sandy land	Rajasthan, Assam, WB, J & K, Punjab, TN
Mining areas	Bihar, MP, Rajasthan, TN, Goa, Maharashtra, AP
Barren Rocky areas	J & K, AP, MP, HP, Maharashtra, Gujarat
Steep Slope areas	J & K, HP, Maharashtra, UP, Gujarat, AP,TN
Snow covered areas	J &K, UP, HP, Arunachal Pradesh, Sikkim

Source: Compilation of various sources

Target Analysis

India faces a severe problem of land degradation, or soil becoming unfit for cultivation. About 29% or about 964000 sq km (96.4 million hectares) are considered degraded. India targeted to restore 260000 sq km (26 million hectares) of wasteland into utilization by 2030.

Linear regression to predict time series data

Year	Land (Sq km)	Yearscaled =Year- 1999	Landscaled (Sq Km scaled down by 1000)
2000	638518.31	1	638.51831
2003	556409.38	4	556.40938
2004	638518.31	5	638.51831
2006	472261.95	7	472.26195
2009	566070.36	10	566.07036
2010	471894.30	11	471.89430
2016	557665.51	17	557.66551

Source: Wastelands Atlas & Land use statistics Note: Scaling is performed for easier calculations

To apply a linear regression model on the data, the following is required:

$$K = n \times \sum Year_{scaled}{}^2 - (\sum Year_{scaled})^2$$

$$a = \frac{\sum Landscaled \times \sum Yearscaled2 - \sum Yearscaled \times \sum (Yearscaled \times Landscaled)}{K}$$

$$b = \frac{n \times \sum (Year_{scaled} \times Land_{scaled}) - \sum Year_{scaled} \times \sum Land_{scaled}}{K}$$

Here $n = 7$ as we have 5 data points

Yearscaled	Landscaled (Sq Km scaled down by 1000)	Yearscaled × Landscaled	2 Yearscaled	2 Landscaled
1	638.51831	638.51831	1	407705.6322
4	556.40938	2225.63752	16	309591.3982
5	638.51831	3912.59155	25	407705.6322
7	472.26195	3305.83365	49	223031.3494
10	566.07036	5660.7036	100	320435.6525
11	471.8943	5190.8373	121	222684.2304
17	557.66551	9480.31367	289	310990.821
$\sum Yearscaled$ = 55	$\sum Landscaled$ = 3901.33812	$\sum (Yearscaled.\ Landscaled)$ = 29694.4356	$\sum Yearscaled2$ = 601	$\sum Landscaled\ 2$ = 2202144.716

From the above equations, K can be computed as

$$K = 7 \times 601 - (55)^2$$

$$K = 1182$$

$$a = \frac{3901.33812 \times 601 - 55 \times 29694.4356}{1182}$$

$$a = 601.954528$$

$$b = \frac{7 \times 29694.4356 - 55 \times 3901.33812}{1182}$$

$$b = -5.678974112$$

The above values can be fit into the linear regression line equation

$$Land_{scaled} = a + b \times Year_{scaled}$$

Substituted as

$$Land_{scaled} = 601.954528 - 5.678974112 \times Year_{scaled}$$

To predict the land for 2030, first it must be scaled down into yearscaled (i.e., subtract 1999) hence, the yearscaled = (2030 – 1999) = 31

Substituting 31 into the regression line equation, the obtained landscaled is

$$Land_{scaled} = 601.954528 - 5.678974112 \times 31$$
$$Land_{scaled} = 425.9063306$$

The Landscaled can be converted into Land by scaling it up by 1000, therefore $Land$ = 425906.3306 Sq km

Expected India's target is to use 297665.51 Square km of wasteland by 2030. if things go as, they are in these past years, we would still be off by 43.08% (128240.8206 sq km) by the year 2030. The above analysis is only based on the available data to assume future status of wasteland reclamation. It may not be like exactly what was predicted. Government targets, plans and policies and environment may change time to time. Therefore, so many aspects are responsible or involved in the target achievement. However, looking back to the statistics, India's effort to reclaim wasteland is somehow successful.

Reclamation

State-wise wastelands % change in India is presented in Chart-1. The extent of land degradation varies from one state to another, depending upon the geographical features, soil characteristics, rainfall, land use, land management practices, etc. Large extents of wastelands are mainly distributed in the states of Rajasthan, Madhya Pradesh, Maharashtra, Uttar Pradesh, Gujarat, Andhra Pradesh, and Karnataka. The state of Rajasthan has large tracts followed by Madhya Pradesh, while Tripura has the least degraded lands (Wasteland Atlas of India, 2000). After prolonging and constant efforts, wastelands have undergone a positive change in all states except Jammu & Kashmir. It is seen that the majority of wastelands in India have been changed into various categories of cultivable land, plantation areas, and industrial areas.

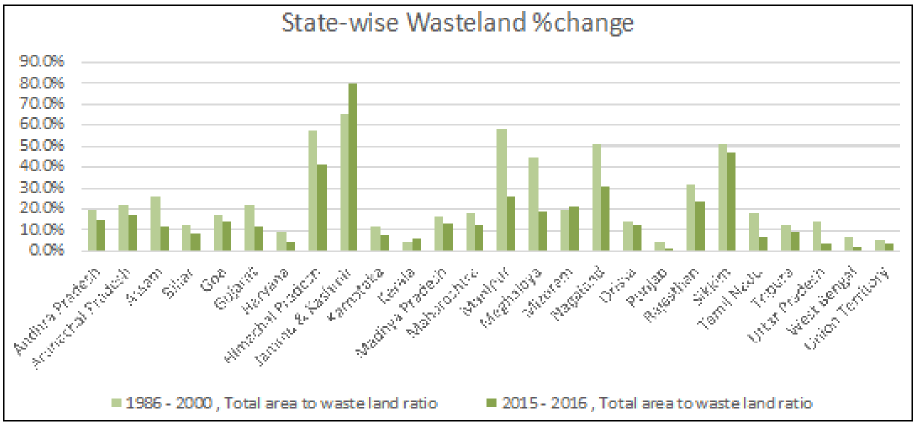

Chart 1: State-wise wastelands % change

Conclusion

There has to be a sustainable use of resources and energy and self-regulatory practices have to be adopted in order to check and reverse the land degradation process. The task of public policies must include the incentivization of such regulation. A sustainable integrated ecosystem approach in watershed management considering all components would help in combating desertification. Rehabilitation of the degraded land through the sustainable management of soil and vegetation would -minimize siltation and enhance the water yield in the catchment. Multispecies approach with native species in afforestation would be more advantageous from the point of resistance to pests and diseases, meeting the local demand, perennial water source and more efficient utilization of environmental resource. This serves as a better cover to the soil and aids in the regeneration of soil. Soil conservation measures, such as contour ploughing, bunding, use of strips and terraces, can decrease erosion and slow runoff water. Mechanical measures, e.g., physical barriers such as embankments and windbreaks, or vegetation cover (and use of vegetative buffer strips and geotextiles) and soil husbandry are important measures to control soil erosion (Srinivasarao *et al*. 2014) [9]. All these measures will reduce the threat of land degradation which nearly one-third of the area in India faces.

There is a severe threat to the ecological balance due to the intense strain on the limited land resources. There is a strain of increasing population of humans as well as livestock and strain of rapid momentum which urbanization is gaining. The quality of land resources is continuously deteriorating. The government needs to develop policies, which would lead to the best possible use and sustainable management of land and water resources. Investments in wasteland reclamation at an increased pace can also help to restore ecosystem services such as climate regulation and increase biodiversity. To accelerate the progress under various schemes, there is a need for initiating actions like increased peoples' participation and community organization need to be strengthened by building their capacity through structured training programs to ensure proper planning, implementation, and monitoring that can achieve quantitative and qualitative objectives of the programs. Development of wastelands mainly in non-forest areas aims primarily at checking land degradation of all types. These non-forest wastelands of the country should be put to sustainable use and the bio-mass availability especially that of fuelwood, fodder, fruits, fiber & small timber should be increased. Agroforestry systems are an appropriate management tool for both acid and salt-affected soils because perennial woody vegetation recycles nutrients, maintains soil organic matter, and protects soil from surface erosion and runoff (Nair 1993) [4]. Sustainable tree plantation is a best practice in wastelands instead of crop production because of the poor productivity of the land. Even though the wasteland is not perfect for food production, the land can be used by adopting good management practices and proper planning. There is a need to grow suitable trees like *Salix babylonica (water willow), Alnus cremastogyne (long peduncled alder), Alnus trabeculosa (trobeculate alder), Morus alba (mulberry), Taxpdoium distichum (swamp cypress), Taxodium scandens (pond cypress).* Acaciacatechu, Acaciaconcinna, Buteamonosperma, Pongamiapinnata, Schleicheraoleasa, Madhucalatifolia, Emblicaofficinalis, Cassiafistula, Strychnosnuxvomica, Odinawodier, Dilleniapentagyrra; ltyliaxylocarpa, Buchananialanzan, Careyaarborea, Terminaliachebula, Pterocarpusmarsupium, Phoenixsylvestris, Mangiferaindica, Dendrocalamusstrictus, Bambusaarundinacea, Azadirachtaindica, Cordiamyxa, Aeglemarmelos, Sapinduslaurifolius, Spondias mangifera, Suaeda salsa, Kalidium folium, Tetragonia tetragonioides, Sesuvium portulacastrum, Arthrocnemum indicum, Suaeda frutic, S. portulacastrum, Suaeda maritime, Sesuvium portulacastrum, Atriplex etc. in wastelands for proper utilization. Government of India is taking up this massive programme through its Integrated Wasteland Development Project Scheme (IWDP) by reviving and restructuring the village level institutions and ensuring adequate people's participation.

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