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Land degradation

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Abstract
In India out of 329 mha land, 96.40 mha has been categorized under degraded land. As we know land is crucial for manufacturing most of food which world's growing population desires but land is deteriorating constantly, because of the rapid population growth. Our natural resources are under great pressure. Land degradation is a process which is induced by humans or by natural phenomenon that affects the quality of the land in an ecosystem. Land degradation results from soil erosion, salinization, deforestation, inappropriate agricultural practices, overgrazing, urbanization, shifting cultivation, unbalanced use of inorganic fertilizers, poor irrigation and water management techniques etc. In India, land shortage, economic pressure on land and the increase in population are the underlying social causes of land degradation. Land degradation decreases quality of land and raises the cost of land management.

Keywords: Land, Degradation, Soil, Erosion, Salinization, Deforestation, Overgrazing

Introduction
Land is the base of life support systems viz. biomass production to supply food, feed, fiber, wood and other biotics for human use. Land use is a kind of continuous or cyclical human interaction to fulfil the different human needs from natural and artificial tools for growth. Present land conditions in many areas are the product of both natural and human influences, due to this land is degrading day by day. Land degradation is defined as deterioration of the physical, chemical and biological or economic properties of soil and long term loss of natural vegetation (UNCCD., 2012) [36]. Land degradation generally means temporarily or permanently diminished land productive capacity. As we are aware that pressures on global land resources are higher than ever in human history Because of the rapidly increasing population and increasing demand. Due to this different types of degradation occurs but main type of land degradation drivers are soil erosion, salinization, deforestation, inappropriate agricultural practices, overgrazing, urbanization, shifting cultivation, unbalanced use of inorganic fertilizers, poor irrigation and water management techniques. Human activities are not only responsible for land degradation but also for soil development through prevention, recovery and restoration. Land degradation is not properly addressed but it is essential to promote awareness so that future land management decision can result to more sustainable and adaptable management of agriculture.

What is Land?
Land refers to delineated part of earth's surface covered with mountains, rivers, desert, island and coastal areas.

What is Land degradation?
Land degradation is defined as deterioration of the physical, chemical and biological or economic properties of soil and long term loss of natural vegetation (UNCCD., 2012) [36]. In India 96.40 mha land is degraded (Desertification Atlas., 2016).
The process wise status of land degradation in India for time frames 2011-2013 and 2003-2005 (table 1).The most significant process of land degradation in India is water erosion (36.10 mha in 2011-13 and 35.61 mha in 2003-05) and least degradation by manmade process (0.41 mha in 2011-13 and 0.37 mha in 2003-05).
Himachal Pradesh is observed with 43.01% of the total geographical area under land degradation in the period 2011-13. Land degradation status of Himachal Pradesh given in (table 2). (Desertification Atlas, 2016). Land degradation area in Himachal Pradesh has increased about 4.55% since 2003-05 to 2011-15. The most significant process of land degradation in the state is vegetation degradation (32.17% in 2011-13 and 28.43% in 2003-05) followed by frost shattering (5.97% in 2011-13 and 5.79% in 2003-05) and water erosion

(4.82% in 2011-13 and 4.20% in 2003-05) and least degradation by manmade (0.01 % in 2011-13 and 2003-05).

Table 1: Land degradation in India

Process of Land Degradation	2011-2013 Area (Mha)	2003-2005 Area (Mha)
Vegetation Degradation	29.30	28.28
Water erosion	36.10	35.61
Wind Erosion	18.23	18.35
Salinity	3.67	4.01
Water logging	0.65	0.60
Frost Shattering	3.34	3.11
Mass Movement	0.93	0.84
Manmade	0.41	0.37
Barren	1.89	1.88
Settlement	1.88	1.48
Total Area Under Degradation	96.40	94.53

Table 2: Land degradation in Himachal Pradesh

Process of Land Degradation	2003-2005 Area (%)	2011-2015 Area (%)
Vegetation Degradation	28.43	32.17
Water Erosion	4.20	4.82
Frost Shattering	5.79	5.97
Manmade	0.01	0.01
Settlement	0.02	0.04
Total degraded area	38.46	43.01

Types of Land Degradation (V N Sahai., 2011) [28]

A. Soil Erosion

The soil erosion may be defined as detachment, transportation and deposition of soil particles from one place to another place under influence of wind, water and gravity forces. Soil erosion is accelerated due to high rainfall intensities soil erosion is accelerated (Keesstra *et al*., 2016) [13], steep slopes (Beskow *et al*., 2009) [4] and the fragile nature of topsoil (Lal, 1998; Rodrigo Comino *et al*., 2016; Ochoa *et al*., 2016) [17, 27, 25]. Erosion occurs when soil remains bare or without vegetation. Soil erosion rates are considered inacceptable more than tolerance levels (Mandal and Sharda, 2013) [20]. That results in irreversible land degradation and must be minimized by effective soil conservation measures (SCMs) (Biswas *et al*., 2015) [5]. Erosion extensively occurs in poorly aggregated soils. Main divers of land degradation in world are overgrazing is (35%), deforestation (30%), agricultural activities (28%), overexploitation for biofuels (7%) (UNCCD., 2016) [37]. There are two types of soil erosion:-

a) Water Erosion

It is the removal of soil particles by the action of water. Water erosion removes the finer and most fertile fraction of the soil. In India 36.10 mha land is affected by water erosion (Desertification Atlas, 2016). Different types of water erosion are observed in India. They may occur singly or in combination.

- Raindrop erosion
- Sheet Erosion
- Rill Erosion
- Gully Erosion
- Stream bank erosion
- Seashore erosion
- Landslides

b. Wind Erosion

It is the removal of soil particles by wind action. Wind erosion damages land and natural vegetation by removing soil from one place and depositing it in another. Wind erosion is also prevalent in the coastal areas where sandy soils predominate and the cold desert regions (Leh and Ladakh).In India 18.23 mha land is affected by wind erosion. There are three types of wind erosion:

- Suspension
- Saltation
- Soil Creep
- Salinization

Increase in the concentration of soluble salts in the soil is called salinization. Salinization refers to a build up of salts in soil, eventually to toxic levels for plants. Soil salinity prevents the natural growth and development of most crops, and causes significant global yield losses (Cao *et al*., 2017) [6]. It has been estimated that about 7 million hectares of land in India are salt affected. Out of which Gujarat has most affected soil i.e. 2.22 million hectares which is followed by Uttar Pradesh i.e. 1.369 million hectares (mandal *et al.*, 2009) [19].

Origin of saline soil:

a. Poor drainage of soil

During the periods of high rainfall, the salts are leached from upper layer and if the drainage is impeded, they accumulate in the lower layer. When water evaporates, the salt is left in the soil.

b. High Water Table

The ground water of arid regions usually contain considerable quantities of soluble salts. If the water table is high, large amounts of water move to the surface by capillary action and the evaporated, leaving soluble salts on the surface.

c. Quality of irrigation water

The ground water of arid regions are generally saline in nature. During dry weather the soluble salts of the ground water may, get carried to the surface and increases the salinity of the land.

d. Excess use of Basic fertilizers

Use of alkaline fertilizers like sodium nitrate, basic slag etc.

e. Salt blown by wind

In arid regions near the sea, lot of salt is blown by wind year after and get deposited on the lands. Due to low rainfall they are not washed back to sea and thus, salinization occurs.

f. Over Flow of sea water over lands

Low lying areas near the sea which get sea water during tides. Due to this salt water accumulate and enrich the soils with salts.

g. Saline nature of Parent rock material

If soils develop from saline nature of parent rock materials, soil would be saline.

B. Deforestation

Deforestation is the removal of the existing natural vegetation cover, especially where the native cover is largely forest (Mawalagedara and Oglesby, 2012) [21]. Deforestation is the clearing away of forests by a process in which an area

depleted its existing natural forest vegetation and resources (Abere and Opara, 2012) [1]. The conversion of forest to an alternative permanent non-forested land use such as agriculture, grazing or urban development is called deforestation (Chakravarty., 2012) [7]. Forests provides carbon storage and other benefits while delivering a lot of environmental and social benefits, such as timber and biomass resources, clean water, wildlife habitat, and recreation (Malmsheimer *et al*., 2011) [18].

C. Overgrazing

Overgrazing is grazing a plant before it has recovered from a previous grazing. Overgrazing takes place when vegetation or pasture is repeatedly removed from land and it is not given enough time to continue growing. Overgrazing causes destruction of vegetative cover by eating and trampling, disturbance of root systems by scuffling, and compaction of the surface reducing infiltration and accelerating runoff and soil erosion (Thomas and Middleton, 1994) [35].

Causes of Overgrazing

- Lack of proper animal management.
- Drought or decline in precipitation.
- Improper land use.
- Overstocking

D. Shifting cultivation

Shifting cultivation is a cycle through which the forest is completely cleaned, the debris is burned, the land is cultivated for a period of one or two spells and then allowed to be planted as a fallow, where the forest grows and cleaned and used for cultivation again. (Mertz *et al*., 2009, Kleinman *et al*., 1995) [22, 14]. Northeast India in Mizoram shifting cultivation is known as Jhum or Jhuming agriculture and the whole process of Jhuming agriculture is called 'Jhum cycle' and the marginal farmers, who are involved in its practice, are called Jhumias (Sati and Rinawma, 2014) [30]. In this system they cultivate in the land for 2-3 yr but after the decline of fertility they shift to another place and abandoned that place for 5-15 years.

E. Urbanization

Urbanization is defined as occupational shift from agriculture to urban based industry (Siva Ramakrishnan and Singh, 2005). Rate of growth of urban population and total population becomes same at this terminal stage (Jaysawal and Saha, 2014) [12]. Urbanisation and population growth are solely responsible for over-exploitation of natural resources, resulting in pollution and scarce resource depletion (Lakshmana, 2008) [16]

F. Excessive use of Chemical Fertilizers

As we know that chemical fertilizers increases plant nutrients in adverse weather conditions or when plant require additional nutrients but chemical fertilizers also have several harmful effects. Excessive use of chemical fertilizers can result in waterway pollution, chemical burn to crops, increased air pollution, acidification of the soil and mineral depletion of the soil and destruction to microorganisms.

Land conservation

Land conservation deals with the integration of all methods of land management and land usethat protect the land against na tural or human-induced degradation. It is the protection of land against physical loss by erosion or against chemical deterioration; that is excessive loss of nutrients by either natural or artificial means.

Different type of conservation measures we take to reduce the effect of soil erosion

a. Strip Cropping

In this system crops cultivated in alternate strips, parallel to one another. Strip cropping is a method of growing field crops in narrow strips either at right angles to the direction of the prevailing wind. In this system erosion-permitting crops (jowar, bajra, maize) grow in alternate strips with erosion checking close-growing crops (grasses, pulses). Strip Cropping reduces the rate of soil erosion and the runoff velocity.

b. Mulching

It is a protective layer of organic matter that cover the top soil between plants. Common materials that we can use as mulch are straw, dry grass clippings, sawdust, leaves and other left-over crop residues. Plastic sheets can also be used as mulch.

Benefits

- It prevents soil erosion.
- It adds organic matter and nutrients to the soil.
- It improves the soil structure.
- It decreases the water loss due to evaporation.

c. Terrace farming

In terrace farming steep slopes are cut into a series of flat platforms so that flat surfaces are available to grow crops. It can reduce surface run-off and soil erosion.

d. Contour ploughing

In this, Ploughing should be done parallel to the contours of a hill slope to form a natural barrier to reduce flow of water down the slope or to minimize soil erosion.

Shelterbelts reduces the wind erosion about a 50 per cent. It is very helpful in reducing wind velocity if we plant shelterbelts across the direction of the wind given in (table 3). An Experiment was carried by Gupta *et al.*, 2013 [11], studied the wind erosion as affected by different types of shelterbelts planted in the desert region of Western Rajasthan, India. They concluded that *C. siamea* has been found most effective in soil conserving and we can see that higher soil erosion from the fields which protected by *P. juliflora* and *A. tortilis.* Because of less branching and fewer leaves at the lower levels in comparison with shelterbelts of *C. siamea* whose shape is cylindrical and have thick branches drooping down to the ground level and more leaf. Therefore *Cassia siamea* is most effective in reducing wind speed and soil erosion.

Mishra *et al.*, 2013 [23] studied the effect of Soil and Water Conservation Measures in Sikkim Himalaya, India**.** The data in (table 4) indicated that the highest runoff was recorded on barren land, followed by cultivated areas. Highest overland flow was recorded to be in the control plot (barren land) where there was no vegetation. The next highest rate of overland flow was recorded for mixed cropping, followed by mandarin-based agroforestry, terrace cultivation and large-cardamom–based agroforestry. Highest soil loss was recorded in large-cardamom based agroforestry because of the steepness of the slope of the land. The next highest soil loss was found on barren land, followed by mixed cropping, mandarin-based agroforestry, and terrace cultivation.

Table 3: Wind erosion as affected by different types of shelterbelts planted in the desert region of Western Rajasthan, India

Type of shelterbelt	Soil loss (kg/ha)
Prosopis juliflora	351.2
Cassia siamea	184.3
Acacia tortilis	300.0
Bare soil	546.8

Table 4: Effect of Soil and Water Conservation Measures in Sikkim Himalaya, India

Practice	Overland Flow(% of rainfall)	Annual Soil loss (kg/ha)
Control Plot	1.34	71.972
Mixed Cropping	1.21	67.665
Terrace Cultivation	1.10	39.447
Large-cardamom-based agroforestry	1.08	210.449
Mandarin-based agroforestry	1.11	56.775

Saline soil Reclamation and Management

Following methods may be used for removal of salts:

a. Leaching down of the soluble salts: The leaching can be done by first ponding the water on the land and lowering it to stand there for a week.

b. Scrapping of the surface soil: When the salts accumulate on the soil surface we can remove salts by scrapping but this is temporary and salts again accumulate on the surface.

c. Use salt free irrigation water: For irrigation we have to use salt free water.

d. Use of Acidic Fertilizer: We can use acidic fertilizers in saline soils (e.g Amonium sulphate) should be used.

e. Use of Organic manures: When sufficient amount of manures are added to soil than the water- holding capacity of soil increases and conductivity of the soil solution decreases.

f. **Chemical Techniques:** This include the applications of gypsum, sulphur, sulphuric acid or hydrochloric acid (Ahmed & Qamar, 2004) [2]. An economical method for the remediation of saline soils is gypsum application (Schultz *et al*., 2017) [31]. Efficient soil mixing with gypsum and rapid sodium removal from the soil solution via proper irrigation can fasten the process of exchange.

g. Ploughing and leveling of the land: It increases the infiltration and percolation rate of land due to this salts leach down to the lower levels.

h. Growing of salt tolerant crops:

- High salt tolerant crops: Paragrass, barley, sugarbeet etc.
- Moderately salt tolerant crops: Wheat, rice, sorghum, maize, flax etc.
- Low salt tolerant crops: Beans, radish, white clover etc.
- Sensitive crops: Tomato, potato, onion, carrot etc.

For reclaiming saline soils, N-fixing legumes not only have the ability to eliminate toxic ions, but also help to increase the levels of soil-N. For example, *Hedysarum carnosum*. It is a pastoral legume which increases the accumulation of Na^+ in the roots and helps to maintain high symbiotic N_2 fixation (SNF) efficiency and subsequent soil-N content under high salinity, suggesting its potential utilization in the improvement of soil fertility under saline conditions (Kouas *et al.*, 2010) [15].

The solutions to overgrazing can be summarized as follows:

- We can stockpiled in the rainy season (spring) so that the re is enough grass in the dry
  season (summer) to prevent the act of grazing too early.
- A grazing map will help to determine how rotational graz ing can be applied.
- Monitoring the growth of pasture and rainfall patterns.
- Proper maintaining pasture residuals in the grazing area.
- Sustainable pasture management.
- Proper land use management practices.

Solution for Deforestation

- **Plant a tree**
  The best technique to tackle deforestation is to plant a tree. Planting a tree could be considered a gift for the world and good mental health for a lifetime. So plant more and more trees.
- **Use less paper**
  Timber is used for the manufacturing of paper products and paper demand increases every year by two to three percent. This means that more and more trees are still consumed by the paper industry.
- **Use recycled products**
  We may have noticed a little label on our new notebook "made of recycled paper" these days. On many other items of everyday use such as books, paper bags, egg packaging and even toilet paper the same mark can be found. We make a conscious effort to reduce the demand for more by preferring products made from recycled.
- **Buy only sustainable wood products**
  We help to reduce the demand for more logging (particularly illegal logging) by ensuring that we only buy products certified by the Forest Stewardship Council (FSC). The FSC is the best international forest management framework which provides a system to work towards sustainable forest management.

Support organizations that fight deforestation

Several international and local organizations are working to pr otect forests from
deforestation and to apply sustainable forestry practices.
Examples of some you may have heard of are:

- World Wildlife Fund
- Greenpeace
- Rainforest Alliance
- Rainforest Action Network
- Amazon Watch

Control for Shifting cultivation

1. **Awareness programme**
   The major environmental problems such as deforestation often continue to occur because of a lack of awareness and knowledge about the problem. Better awareness and education is important. Educate farmers about sustainable land management make them ensure that less forested areas need to be cleared for farming.
2. **Agriculture Training**
   We have to provide agricultural training for the people who do shifting cultivation and also tell them about the cons of shifting cultivations and pros of agriculture.

3. Shifting cultivation control programmes

Government started jhum control programmes in mid fifties and momentum was gained in the fifth plan with the introduction of variety of schemes by different states and Central Government. A scheme for controlling shifting cultivation was in action during 1987-88 to 1990-91 in the seventh five year plan as per the recommendation of task force on the shifting cultivation (1983). The Watershed Development Project for Shifting Cultivation Areas (WDPSCA) of NE region has been launched by Govt. of India with 100% grant to the state plan (Satapathy and Sarma, 2003) [29].

Avoid Excessive use of chemical fertilizers

Chemical fertilizers contaminate ground water, kill beneficial soil living microorganisms and higher amount of nitrogenous fertilizers often causes high sucking pest infestations. By application of organic fertilizers and biofertilizers chemical fertilizers can be avoided. Acidification of soil can take place due to decrease of organic matter in the soil by excessive use of chemical fertilizers causing threats to survival of plants (Velthof *et al*., 2011) [38].

Some organic fertilizers:

1. Farm Yard Manure (FYM)
2. Poultry manure
3. Fish manure
4. Neem cake
5. Groundnut cake

Biofertilizers are preparations of living cells or latent cell with active microbial that help crop to absorb nutrients with their rhizosphere interactions when applied via seed or soil.

1. Nitrogen fixing biofertilizers: azotobacter, rhizobium, azospirillum.
2. Phosphate solubilizing biofertilizers.
3. Phosphate mobilizing biofertilizers.
4. Plant growth promoting rhizobacteria.
5. Mycorrhiza.

Balanced use of fertilizers

We have to do a balanced use of chemical fertilizers so negative impact of chemical fertilizers will be reduced. Singh *et al.*, 2017 [34] carried out an experiment to study the Influence of long term application of chemical fertilizers on crop yield. The result in table 5 revealed that the grain yield of maize is highest in 100% NPK+ FYM, which is superior to rest of the treatments except 100% NPK + lime being at par. Compared to 100% NPK, the application of 100% NPK + FYM recorded higher grain yield of maize. Continuous application of N alone through urea for 42 years, the grain yield of maize and wheat decreases to 0.0q/ha. This might due to increased soil acidity and deteriorated soil quality with the continuous use of N over a period of 42 years.

Table 5: Influence of long term application of chemical fertilizers on crop yield

Treatment	Wheat(q/ha)	Maize(q/ha)
Control	4.6	8.4
100% N	0.0	0.0
100% NP	13.0	21.2
100% NPK	21.2	42.2
100% NPK + FYM	36.6	55.2
100% NPK + Lime	32.1	54.5
100% NPK + Zn	20.3	37.4

- **Seabuckthorn a new approach in ecological restoration of Himalayan Ecosystem**

A multi-proposal plant for soil erosion management, wildlife protection, land regeneration, soil improved and ecological restaurant shown in (figure 1) that can be found mostly in cold mountainous regions, is part of the Elaeagnaceae family. Sharma *et al.*, 2019 [33], studied that root system of seabuckthorn is strong and which helps to fix atmospheric nitrogen with the help of root nodules. It also controls soil erosion, indulge nutrients and improve soil fertility. In an another study by Zhang *et al.*, 2009 [39], concluded that Seabuckthorn has a strong canopy which is suitable for the stabilisation of slopes, helps to reduce surface runoff and stream flow. It's dense canopy intercepts with the rainfall and helps reduce the rainfall speed, thus protecting the soil against soil erosion and stimulating vegetation growth.

Mishra *et al.*, 2009 [24], in his study physio-chemical soil properties were examined under two different lands uses i.e. seabuckthorn crop stand and non-seabuckthorn stand and he concluded that seabuckthorn plant improved soil organic carbon.

Qinxiao and Hongyan, 2003 [26] also demonstrated that in addition to soil erosion control and to help poverty alleviation through economic advantages to China local people, the seabuckthorn also plays an important role in improving soil fertility through nitrogen fixation, recovery of degraded and wasteland areas.

Effect of grass barriers on yield, runoff and soil loss in different slopes of the northwestern hill region (CSWCR&TI Vision, 2011) [8] which is given in (Table 6). Himalayan results indicate that vegetative barriers can reduce runoff by 18%-21% and soil loss by 23%-68% on slopes ranging from 2%-8%. Guinea grass, Khuskhus and Bhabar's vegetative barriers have been successful (after 3-4 years) in reducing soil loss by 6-8 tons $ha^{-1}year^{-1}$ and runoff by 33%-38%. Maize and wheat yields in the hilly region increased by 32 and 10 per cent respectively. Pigeonpea (*Cajanas cajan*) was effective in reducing runoff (28%-29%) and soil loss (2.1 to 2.6 ton ha^{-1}) in the finger millet (*Eleusine coracana* L.)/kodo millet (*Paspalum scrobiculatum* L.)-lentil (*Lens esculentus* L.) due to its very good canopy cover (95%-98%) as a vegetative barrier. With the inclusion of 22 to 41 kg of N ha^{-1} in the field, Pigeonpea boosted SOC. The method increased the maize yield in the hills by 5%-10% and the wheat yield by 10%-15%.

Table 6: Effect of grass barriers on yield, runoff and soil loss in different slopes of the northwestern hill region

Particulars	Slope (%)					
	2	4			8	
	Guinea Grass	Guinea Grass	Khus Khus	Bhabar	Guinea Grass	Khus Khus
Runoff (% of total rainfall)	25.8	33.3	35.1	37.9	38.90	40.52
Soil loss (ton/ha/year)	3.27	6.12	6.72	8.34	9.45	9.87
Maize yield (kg/ha)	2530	2460	2444	2296	2285	2180
Wheat yield after maize(kg/ha)	2852	2693	2555	2362	2415	2385
Dry grass yield (kg/ha/year)	1675	1540	542	1090	1375	485

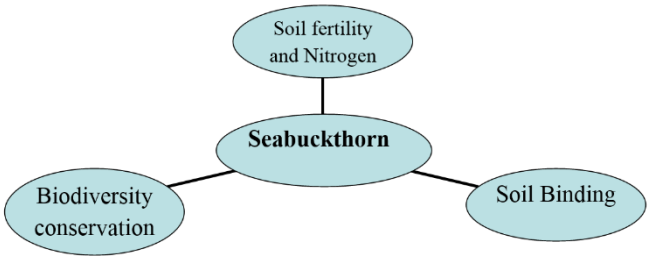

Fig 1: Different attributes of seabuckthorn

Conclusion

Land degradation is a major threat to the food security of a nation. Out of 329 mha land of India 96.40 mha has been categorized under degraded land. Land degradation causes are manifold with faulty agricultural practices being a significant one. With changing climate, land degradation is also increasing due to high intensity storms, extensive dry spells and denudation of forest cover. Sustainable agriculture have tremendous potential of increasing productivity and conserving natural resources.

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