

1. Details of Module and its structure

Module Detail	
Subject Name	Geography
Course Name	Geography 02 (Class XI, Semester - 2)
Module Name/Title	Soils – Degradation, Erosion and Conservation
Module Id	kegy_20603
Pre-requisites	Basic Knowledge about vegetation, relief, soil, climate
Objectives	After going through this module, the learners will be able to know about : • Soil and Socio-environmental well being • Soil Degradation • Soil Erosion • Soil Conservation • Soil and Agricultural Regions
Keywords	Natural Vegetation, Relief, Soil, Temperature, Precipitation, Length of Growing Period

2. Development Team

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1. Soil and Socio environmental Well Being:

Plant life depends on the soil. The nutrients required by plants is determined by the soil held nutrients and also the proximity to the root surface. Nutrients are supplied to the root surface as roots penetrate the soil and come in contact of the soil colloids which contain the nutrients. Some nutrients move up the roots with the help of water that is present in the soil and is absorbed by the plants. Some nutrients also are absorbed by plant roots and help in transfer of nutrients from the nearby area towards the plant roots.



Fig 1. Plants growing on Soil

https://upload.wikimedia.org/wikipedia/commons/7/7e/Holes_and_plants.jpg

Plants are the main source of food for humans as well as animals. Food scarcity can bring untold miseries, diseases and even death to humans and animals. With rapid rise in world population, the question of food supply assumes greater importance. The ability of a nation to produce food depends on multiple factors including complex socio-economic and political factors and all that impacts the farmer's incentive to produce and supply food grains and other food crops. Of the physical and biological factors that determine food supply, availability of soil and water remain as the most important determinants. In developing countries of Asia, Africa and Latin America, the need to achieve food supply to the growing population is of paramount importance. Healthy soils are therefore critical to agriculture and biotic environment. Soils provide ecosystem services that offer more than just support to agricultural production.



Fig 2: Healthy Soil

https://upload.wikimedia.org/wikipedia/commons/3/39/Agriculture_Soil_Image-.jpg

One of the major problems that is plaguing the soil systems around the world is the issue of Soil Degradation.

Let us study about the causes and effects of Soil Degradation in details

2. Soil Degradation:

As mentioned earlier, Soil degradation impacts human life and prosperity in a severely negative manner. This is problem that has plagued humankind ever since sedentary agricultural practices had begun. *Soil degradation* is defined as "the decline in soil quality caused through its misuse by humans." It is a broad term, and refers to a decline in the soil's productivity through adverse changes in nutrient status and soil organic matter, structural attributes, and concentrations of electrolytes and toxic chemicals. In other words, it refers to a diminution of the soil's current and/or potential capability to produce quantitative or qualitative goods or services as a result of one or more degradative processes (UNEP, 1982).



Fig 3: Degraded Soil

<https://pixabay.com/photos/desert-pattern-crack-land-dry-4718654/>

In the present times, Soil degradation is posing as a massive threat to environmental as well as societal wellbeing since degradation of soils leads to loss of productivity of the soil, thereby reducing the productive capacity of the ecosystem. Soil degradation also affects local climatic regimes and causes severe changes in the water and energy balance. The bio-geo chemical cycles also get affected leading to changes in the carbon cycle, nitrogen cycle, sulphur cycle among others. Soil degradation has to potential to lead to crisis in agricultural production which

may in turn cause higher rates of deforestation, bring more marginal and fragile land under cultivation, higher volume of run off and soil erosion. It also leads to pollution of natural waters and emissions of greenhouse gases into the atmosphere. Soil degradation has to potential to alter human environment relationship in the region where it occurs.

The various elements of Soil Degradation may be understood from the diagram presented.

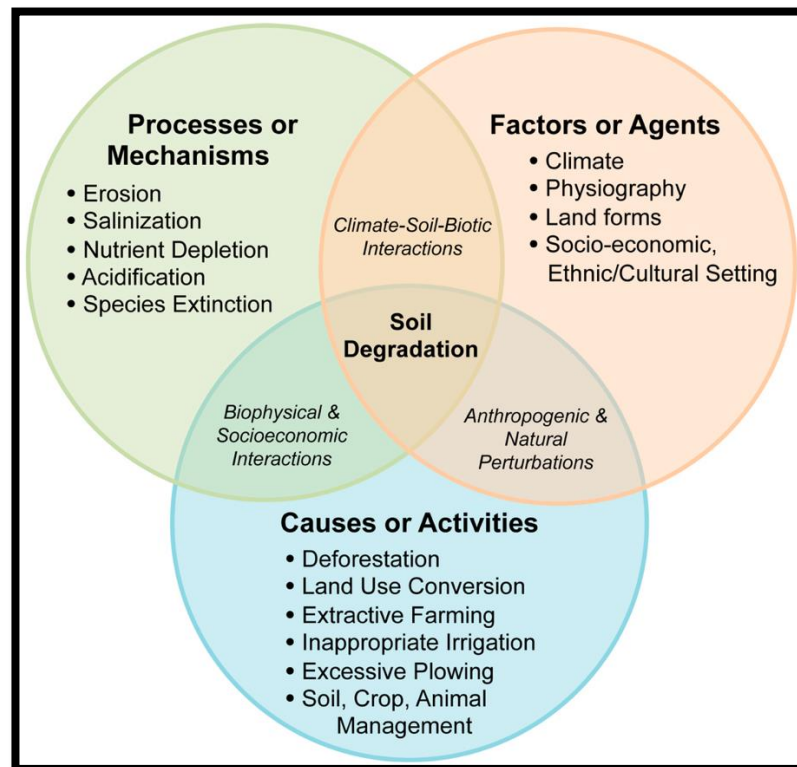


Fig 4: Soil Degradation

https://upload.wikimedia.org/wikipedia/commons/3/32/Soil_degradation_venn_diagram.png

The processes and mechanisms that lead to Soil degradation are, Soil erosion, Soil salinization, depletion of nutrients from the soil, acidification of the soil and extinction of species thriving on the soil.

The agents that assist in the process of soil degradation are, climate, physiography, landforms, socio-economic, ethnic cultural setting.

The various causes that cause soil degradation may be listed as, deforestation, change in land use, extractive farming, inappropriate irrigation, excessive ploughing, soil, crop and animal management.

Types of Soil degradation:

There are three ways by which soil degradation may be perceived or measured.

Physical Degradation of Soils take place when the physical properties of the soil deteriorate. Compaction, creation of hard pan below the surface, soil erosion and laterization of soils are some of the ways physical degradation of soils take place.

Biological degradation of soils occur when organic matter content of the soil reduces. Evidence of shrinking of varieties of flora and fauna that thrive on the soil is also an indication of biological degradation of the soil.

Instances of Chemical degradation of soil may occur when certain nutrients get depleted from the soil, leaching causes changes in the pH levels of the soil and in certain cases toxic chemicals enter the soil and causes imbalances in the soil which is detrimental for the growth of plants.

3. Soil Erosion:

Soil erosion refers to the wearing away of the top layer of the by natural agents like water, wind and also due interference of human beings. Rainfall of high intensity can remove a thin layer of the top soil cover over large areas. This kind of erosion is known as ‘sheet erosion’.

When sheet erosion continues for a long time, small finger like channels appear on the surface of the soil creating tiny channels of runoff on the surface. This form of erosion may be termed as **rill erosion**. When channels formed by rill erosion deepen and widen with unchecked erosion, these enlarged channels are termed as **gullies** and the form of erosion as **gully erosion**. If the gradient of the slope is steep, then the process of gully erosion gets accelerated.



Fig 5: Sheet and Gully Erosion

https://upload.wikimedia.org/wikipedia/commons/e/e1/CSIRO_ScienceImage_4087_Dryland_salinity_has_induced_serious_hillslope_gully_and_sheet_erosion_at_base_of_Mesa_landsc_ape_just_west_of_Charters_Towers_Northern_QLD.jpg

In India, sheet erosion is commonly experienced on the steeper slopes which receive heavy rainfall in areas like Himalayan foothills, north eastern parts of the peninsula and in the Shayadris and Eastern Ghats. Rill erosion is active in the states of Bihar, Uttar Pradesh and Madhya Pradesh. The *chhos* of northern Haryana and Punjab and the *Badlands* of Madhya Pradesh, Rajasthan and Uttar Pradesh are a result of intensive gully erosion.



Fig 6: Badlands of Chambal

https://upload.wikimedia.org/wikipedia/commons/6/61/The_ravines_reminded_me_of_Chambal_Valley_in_India_%2836427459024%29.jpg

Wind can be very effective as an agent of soil erosion in areas that are arid and have sparse vegetation cover. In such areas the soil is dry, loose and friable and the soil particles tend to not stick to each other. It becomes easier for the wind to pick up soil particles and blow them away especially in the event of a dust storm or sand storm. At some instances, the entire top soil may get blown away if wind erosion persists over a long period. In Haryana, Rajasthan, Uttar Pradesh and Gujarat such erosional activities are common.

Human and animal interference also leads to soil erosion. Some of the human induced causes of soil erosion are, deforestation, overgrazing and shifting cultivation.

Forested areas protect the soil cover in the most effective manner by binding the soil structure with the help of roots and also by adding moisture to the soil. Deforestation or cutting down of forests have the severest impact on the soil cover, since it exposes the soil to water and wind erosion. The Badlands of Madhya Pradesh have been formed due to reckless deforestation in the region.

Overgrazing of the slopes is also another significant contributor to soil erosion. Sheep and goats graze over slopes in semiarid regions which in turn loosens the soil structure making it vulnerable to agents of soil erosion. Overgrazing induced soil erosion is very common in parts

of Rajasthan, Gujarat, Madhya Pradesh, low rainfall areas of peninsular India and Himachal Pradesh experience soil erosion due to over grazing.



Fig 7: Overgrazing

<https://upload.wikimedia.org/wikipedia/commons/b/bc/Overgrazing-Rukwa.JPG>

Shifting cultivation is also responsible for soil erosion in the tropical parts. In this mode of cultivation, forest are cleared up in patches, the vegetation burnt down and the land is cultivated for three to four years. After those years the land is abandoned by the cultivators. The patch of land, devoid of vegetal cover becomes extremely vulnerable to wind and water erosion. This mode of soil erosion may mostly be found in areas of Meghalaya, Assam, Tripura, Nagaland and parts of Odisha and Chhatisgarh.



Fig 8: Slash and Burn Agriculture

https://upload.wikimedia.org/wikipedia/commons/0/05/Slash_and_Burn_Agriculture_Shifting_Cultivation_Thailand.jpg

Over irrigation is also another factor that induces soil erosion. If soils are over irrigated, then the soil turns saline since the salts that are found in lower profiles of the soil get drawn upwards along with the pumped water. The salt then reaches the surface of the soil along with the water and increase the salt content on the top layers of the soil making the soil saline.

Concentration of salts on the surface of the land causes infertility of the soil. Over use of chemical fertilizers instead of organic manures can also have detrimental effect on the soil fertility. Unless soil gets humus, the chemical fertilizers harden the soil and reduce it's long term fertility conditions.

Every year, in India, millions of tonnes of soils and associated nutrients get eroded due to the above mentioned agents of soil erosion. More and more land area vet converted to degraded soil in this process. It is thus important to preserve the soil cover as better soil health can lead to higher agricultural productivity of the entire nation.

4. Soil Conservation:

Soil conservation includes all the efforts made towards protecting soil from getting eroded. The methods used for conserving soils may be classified into two broad groups: small measures to check soil erosion at the local level and large schemes of soil reclamation over large tracts of land. Soil conservation in its widest sense includes not only control over erosion but all those measures like correction of soil defects, application of manures and fertilizers, proper crop rotations, irrigation, drainage etc. which aim at maintaining the productivity of the soil at a high level.

Some of the measures adopted for controlling erosion and restoring the productivity of eroded lands can be divided into four categories:

1. Regulation of land use.—This includes all measures for securing such alterations in the existing patterns of land use as are necessary to ensure that the different types of lands are used according to their land use capability i.e. the use for which, in view of their physical characteristics, they are best fitted. Retiring cultivated lands from cultivation in highly areas prone to erosion and bringing them under forests or grazing ; restrictions on or closure of grazing in badly eroded forests or grazing lands, and settlement of shifting cultivators to permanent cultivation are some examples of the types of alterations which are needed.
2. Afforestation and preservation of forests by scientific forest management.
3. Improvement of land use practices on farm lands. This includes such measures as ploughing along the contours and strip-cropping on sloping lands; proper crop rotations ; application of adequate manures and fertilizers ; care of fallows and other uncultivated lands.
4. Engineering measures.—Under this are included construction of bunds and terraces, check dams, channels for drainage of surplus water, gully plugging, etc

The most significant cause of soil erosion is deforestation of forests and uprooting of vegetation from hill slopes, desert margin and other areas that are a part of fragile ecology. Since vegetation acts as a protective layer of the soil, deforestation exposes the top soil and makes it

susceptible to erosion. The ground water supplies are also reduced in the absence of top soil cover. Cutting down of trees has similar harmful effects, Trees act as wind barriers, reducing the speed of the blowing wind.

Some of the methods used for soil conservation is being discussed below:

Contour terracing, Bunding, Construction of bunds across gullies, Levelling of uneven land and growing vegetation on bare land are some of the methods that help check soil erosion at the local level.



Fig 9: Contour Terracing

<https://upload.wikimedia.org/wikipedia/commons/9/92/LongjiTerraces.jpg>



Fig 10: Contour Bunding

<http://aashah.blogspot.com/2013/11/contour-bunding.html>

Large scale conservational practices may include extensive reclamation schemes to reclaim Badlands and ravines. Construction of bunds over gullies, levelling of surface, control of over grazing by animals and afforestation schemes are some of the efforts that in preserve the existing soil cover. Discouraging practices associated with shifting cultivation can reduce soil erosion.

In arid and semiarid regions, the prime motive of soil conservation should be protection of arable land from encroachment of sand dunes through development of shelter belts of trees and agro-forestry. Infertile lands should be converted to pastures to facilitate grazing. Efforts have also been made towards stabilization of sand-dunes in Rajasthan so that the dunes don't migrate into fertile zones and lead to desertification. This initiative has been spearheaded by the Central Arid Zone Research Initiative (CAZRI).



Fig 11: Shelter belt of trees

https://upload.wikimedia.org/wikipedia/commons/c/c4/A_beech_shelter_belt_-_geograph.org.uk_-_1228063.jpg

Farmers undertake the most significant soil conservation work. If the farmers are trained to undertake soil conservational practices the impact of their efforts would magnify. Restrictions on usage in forests can be really effective only if the farmers, graziers and other users of forests understand the importance of these and feel that they are essential in their own long-term interest, besides being vital for the welfare of large populations in the plains. Education for soil conservation, publicity and demonstration aimed at creating among the general public and especially among the farmers an awareness of the erosion problem, its causes and effects, and what they can do to control it must form a very important part of soil conservation programmes. Formation of associations of farmers for soil conservation work has also been proposed in order

to provide a suitable medium through which soil conservation measures can be taken on a cooperative basis at the village level.

Creation of co-operative associations of farmers for soil conservation work would be most useful. Such associations should be constituted by law after a specified proportion of the farmers in an area decide upon their establishment. All the farmers in the area covered by such associations would then be required to make such improvements in their farming practices, and on their fields as may be specified by the association. The establishment of such associations is especially necessary in such areas as the catchments of small streams and nullahs, in case of which soil conservation programmes can be successful only with the cooperation of all the farmers in the area.

5. Soils and Agricultural Regions:

The importance of soil type in determining the economic activities that are found in that region is evident from the modules you have studied earlier.

To understand the dependence of the development of a certain agricultural region on the basis of the soil cover of that particular region cannot be over emphasized.

In case of India, a close study of the soil types and the agricultural regions reveal that there is a very strong association between the them.

To understand this phenomenon, we may compare the maps of the distribution of soil types found in India along with the map of Agricultural regions.

The maps are being presented below

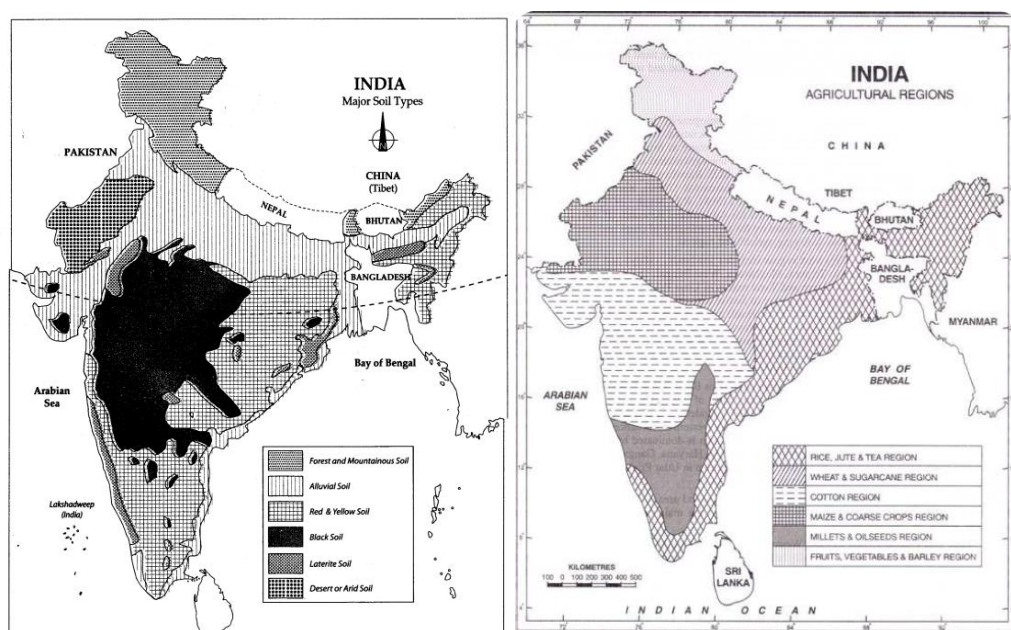


Figure 12: Maps of Major Soil Types of India and Agricultural Regions of India

The maps help us understand that

- i. Areas that are major producers of rice and jute are regions of Alluvial soil. Both coastal Alluvium as well as riverine Alluvium present in the region has been responsible for wide spread rice cultivation and jute cultivation in the area. Jute is grown in the eastern areas of the great plains where the rainfall is heavy and adequate for the crop.
- ii. In hilly tracts, of West Bengal and Assam, where the slope of the land is mild support tea cultivation.
- iii. Wheat and Sugarcane region also falls within the Alluvial belt. Since Alluvial soils differ in texture and consistency, according to variation in climate. Loams and sandy loams in Haryana and Punjab support wheat crop. In parts of Uttar Pradesh, the pH value and the organic content of the soil is ideal for cultivation of sugarcane.
- iv. The cotton region has been developed over the areas where Black Soil is found. Black soil is suitable for growing cotton since the soils are fine grained. The soil also tends to become sticky when wet and develop wide cracks on drying which helps in the process of self-aeration and absorption of nitrogen from atmosphere apart from being able to retain moisture effectively. Despite continuous cultivation Black soils give good yields of cotton crop.
- v. In the arid regions of the western part of India, the soils are low in humus content have high soluble salt content. In these conditions hardy crops like maize and other coarse crops are cultivated.
- vi. In regions of Red soils Millets and oilseeds are cultivated since groundnut and potatoes can be grown in these coarse soils. The soils are airy and with the help of cultivation, millets like Ragi are grown on these soils.
- vii. Forest and mountainous soils are ideal for cultivation of fruits and barley.

The juxtaposition of the maps of soil types and agricultural regions justifies the importance of soil types in determining the type of crops grown in that region and its subsequent impact on the economy of that region.