CONSERVATION OF NATURAL RESOURCES - 18CV656

Module -1

Land: Land as a resource, types of lands, conservation of land forms, deforestation, effect of land use changes. Soil health, ecological and economic importance of soil, impact of soil degradation on agriculture and food security, need for soil conservation, sustainable land use planning.

- **Natural resources: -** Natural resources are **materials from the Earth that are used to support life and meet people's needs**. Any natural substance that humans use can be considered a natural resource. Oil, coal, natural gas, metals, stone and sand are natural resources. Other natural resources are air, sunlight, soil and water.

Natural resources can be part of our natural heritage or protected in nature reserves. Particular areas often feature biodiversity and geodiversity in their ecosystems. Natural resources may be classified in different ways. Natural resources are materials and components (something that can be used) that can be found within the environment. Every man-made product is composed of natural resources (at its fundamental level).

- **Land as a resource** :-

Land resources mean **the resources available from the land**, thus the agricultural land which contain natural fertilizer for growth of the products sown; the underground water, the various minerals like coal, bauxite, gold and other raw materials.

We live on land, we perform our economic activities on land and we use it in different ways. Thus, the land is a natural resource of utmost importance. It supports natural vegetation, wildlife, human life, economic activities, transport, and communication systems. However, the land is an asset of a finite magnitude, therefore, it is important to use the available land resources for various purposes with careful planning.

India has land under a variety of relief features, namely; mountains, plateaus, plains, and islands. About 43 percent of the land area is plain, which provides facilities for agriculture and industry. Mountains account for 30 percent of the total surface area of the country and ensure the perennial flow of some rivers, provide facilities for tourism and ecological aspects. About 27 percent of the area of the country is the plateau region. It possesses rich reserves of minerals, fossil fuels, and forests.

Land, a critically important national resource, supports all living organisms including plants as well as every primary production system such as roads, industries,

communication and storage for surface and ground water, among others. Landforms such as hills, valleys, plains, river basins and wetlands include different resource generating areas that the people living in them depend on. Land resource is our basic resource.

Land is a naturally occurring finite resource. It provides the base for survival of living beings. It holds everything that constitutes terrestrial ecosystems. Increased demand on land in modern times due to the rise in human population and resultant activities has resulted in degradation of land quality and quantity, decline in crop production, and competition for land.

- **Types of lands**

1. Residential or Urban Land

- Nowadays residential lands are covered by human basic needs and facilities surrounded by school zones, college zones, campuses, stationery stores, grocery stores, textile shops, some industries, parks, children's playgrounds, and many more. A lot of apartments are covered over the area called residential areas
- However, the ancient residential land was 100 meters or 200 meters away, far from one apartment to another and with less basic amenities.
- In every part of this modern world, districts and states are very well developed and developing, and villages are developing with technological equipment like agriculture, transport facilities, electricity connections, communication facilities, factories in the neighbourhood, shopping malls. , Industrial Zone & Commercial Complexes, Companies This is called Urban Land

2. Commercial Land

- The Land which is allocated to use for commercial purposes is known as Commercial Land, when looking for the term commercial the land hosts Shopping malls, Park or groceries, Complexes, Industries, Restaurants, and Warehouses
- Since commercial land is a one-time investment, land, and building are more expensive
- From this, a person gets a higher return on investment, and business building values are measured by the location and growth of its areas.
- Compared to Residential land, commercial land is more expensive and more expensive to maintain
- It is a global fact that 30% of all areas, districts, and countries of India are occupied by commercial sectors, the sudden rise of commercial sectors provides exclusive employment opportunities to all the people around, basically, the land is used for industry or office buildings, restaurants, shops and other businesses choosing the right land is very important and This will lead to success.

3. Investment Land

- For those who are willing to spend their time and money, investment land will become an unbeatable asset.
- Investing in an undeveloped area will bring more returns in the future or the next generation
- Having property in an underdeveloped area motivates an investor in the future to provide people with basic necessities such as shops, apartments or shopping malls.
- Investing in a piece of land is a very wise idea as it is not created when investing in resale property, but its value is increased in the future and the importance of resale land is determined by the surrounding developments.

4. Wet Land

- Wet lands are covered by water and connected with land, also maintaining the productive Ecosystem in the world and some of the wetlands are often covered by Fresh or Salty water.
- The wetlands are Characterized as Bays, Ponds, Lakes, Rivers and also Oceans. It is also be categorized and seems like
    1. Marshes
    2. Swamps
    3. Bogs and
    4. Fens
- The importance of Wetlands are
    1. It improves the water quality and water supply
    2. It Provides wildlife habitat & Reduces seaside cyclone damages
    3. Also provides Refreshment opportunities to People

5. Range Land

- Naturally, Rangeland is an unaltered land that is ideal for Grazing of livestock, plants, Forbes & Shrubs.
- It has been Characterized as Forest, Desert, Farmland, Pasture and Industrial or urban.
- It always looks like an isolated condition and discontent.
- Perhaps Grazing animals are infected with Toxic and poisonous plants in the rangeland, which can cause illness or death to the animals.
- Rangeland is not good for the daily lives of humans because it is often plagued by poverty and food insecurity. So it also leads to a lack of education, medicine and market opportunities.

6. Agricultural or Farm Land

- Agricultural land is also referred to as farmland.

- India is very popular for agricultural activities like cultivating rice, oats, wheat, flowers, fruits, vegetables and livestock**.**
- Worldwide, 50% of the population is engaged in agriculture. It is used for agriculture and a house cannot be built on a farm without permission.
- Agricultural Land is categorized as
    1. Arable Land
    2. Land under Permanent Crops
    3. Pastures and Hayfields
- Investing in farmland is the safe option, while compared to other Investment opportunities High returns will get from this investment and it also confers safety to investors' money.

7. Forest Land

- The forest land is completely covered with trees, which produce timber and wood products, and with the increase in population, man used the land by clearing the forest to meet his needs.
- Naturally, This is an Important wealth of the country
- These are the types of Forests
    1. Tropical Forest
    2. Temperature Forest
    3. Boreal Forest
- India is now occupied by 25% of the forest area
- According to government law, the forest areas are classified as 1. Reserved forests, 2. Protected forests and 3. Unclassified forests.
- Forests also maintain the ecological balance in our country
- It brings protection from the ravages of floods, droughts, and hurricanes
- The forest plays an important role in controlling soil erosion, flooding, increasing rainfall and providing favorable climatic conditions in a particular area.

8. Barren Land

- Barren land is a desert land, it is made of soil, the tree has no chance to grow even the plant, barren land is dry and bare, it is also called wasteland & Desolation
- Cultivation in sterile land is useless
- In a barren land, the plant has no potential for stunted, rare and limited biodiversity in the ground.
- The Factors that affect plant growth and development are infertile soil, high aeration, Coastal Salt-spray and climatic conditions
- It is also denoted as a type of land
- There is a chance to turn barren land into the forest, but it takes 3 years of patience and proper techniques. It will take up to 5 years of the time period

- In India, 6% is barren and uncultivated areas such as mountains, deserts and Ravines are found.

9. Recreational Land

- The recreational land is not used for residential purposes, no one will build a home there, it is only for recreational purposes only.
- Recreational land is what gives pleasure to a man and gives a pleasant mindset to the people around
- Land utilized for recreational purposes is called recreational land. For Example Beaches, Swimming pools, Children's parks or Outdoor parks, Museums, Playgrounds, Amusement parks, Zoos, Camping Areas, Playgrounds for Schools, Gyms are all under the control of Government Agencies.

10. Transport Land

- Land used to transport goods from one place to another is called Transport Land
- Transportation involves in the way of Walking, Running, Cycling, Public Transit, freight vehicles, skateboarding, private vehicles and manned aircraft.
- It is used to connect different types of cities, towns and villages. Transportation by buses, trains, motorcycles, scooters and cars plays a very important role in human life.
- There are five modes of transportation worldwide
    1. Railways
    2. Roads
    3. Airways
    4. Waterways and
    5. Pipelines

11. Grazing and Pastures Land

- Grazing land is a field completely covered with grass or grass-like plants or herbs suitable for livestock.
- Closed paths of farmland grazed by livestock such as cattle, horses, sheep or pigs are used to produce crops for grazing land.
- Grazing and pasture land are primarily used for livestock fodder plants
- Grazing land are especially a feeding ground for livestock or horses
- Naturally, the development of grazing requires contact with sunlight, plants, soil, animals and water resources
- Farmers turn grass into straw when the conditions for grass growth appear to be low or zero.

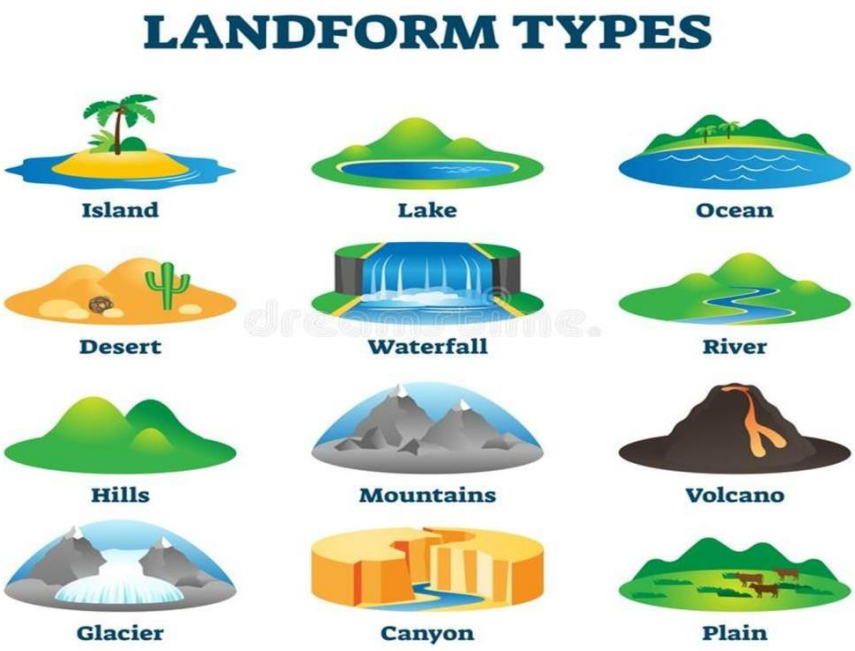

Figure: - Types of lands

- **Conservation of land forms**

Land conservation is the process of protecting natural land and returning developed land to its natural state. Due to the fact that some land has only had minor disturbances and other land has been completely destroyed, a variety of techniques are needed to carry out land conservation. Some of the most common techniques include preservation, restoration, remediation, and mitigation.

Natural and agricultural lands are vital for our water quality and supply, our wildlife, and our tourism. These lands support us; they provide for and clean our water, provide flood control, storm protection, food, recreation, clean air, etc.

When we approach ethical and responsible land conservation in any area of its implementation, we rely on a set of principles to guide the process and ensure the best approach is being taken for the environmental matter. Since the degree of damage and environmental risks greatly vary from case to case, adapting a logical platform to alleviate the harm done - or to reverse the harm altogether - is necessary for the process to yield the best results.

Land conservationists will aim to either restore, preserve, mitigate, or remediate environmental issues.

Land Restoration

Oftentimes in our society, we've already acted too late to prevent an environmental disaster or development design flaw from taking place. When situations like this occur, the best approach land conservationists can take to remedy the situation is to attempt to restore the land to a similar state that it was in prior to human impact.

The process of land restoration can prove to be tricky and a rather delicate process. Tearing down poorly built buildings and planting a few trees isn't the straightforward approach we would like land restoration to be. Instead, environmental scientists must carefully assess the local biodiversity of the area, analyze the history of the affected land, and then take a sustainable route towards restoration.

Land Preservation

The concept of land preservation is why we were able to save and protect so much of the land that we cherish in our society. It's through this technique that we have stopped mass deforestation and inspired organizations to protect our lands and created parks all over the nation for our enjoyment.

This natural philosophy of life drives the idea that land should be left alone - unimpaired by human interference - with minimal maintenance. Some exemptions of this practice can be seen in things like trail maintenance for hikers and controlled burns to prevent massive forest fires.

Land Mitigation

As we've seen from countless environmental disasters to our lands, caused by humans, sometimes the damage that has been done is irreversible for generations to come. It's occurrences like these that have birthed the concept of land mitigation.

Through this technique, we essentially try to write one wrong with a right. If a development project creates direct or indirect harm to local land, balancing out the harm by funding a non-invasive, sustainable project is an approach often taken.

The best solution to land mitigation is to simply not cause the harm in the first place, but mitigating the damage does amount to a better outcome.

Land Remediation

deals with the removal of pollution or contaminants from environmental media such as soil, groundwater, sediment, or surface water. Remedial action is generally subject to an array of regulatory requirements, and may also be based on assessments of human health and ecological risks where no legislative standards exist, or where standards are advisory.

Contaminants and pollutants find their way into our waterways, soil, and ecosystems constantly.

The practice of land remediation focuses on the attempt to remove or remedy the damage done through sustainable practice that doesn't cause further harm. We can see this practice carried out through soil washing, bioremediation, permeable barrier systems, and other treatment methods. It's through land remediation that we are able to aid or eliminate contaminations and often even return a local environment back to its bassline.

Benefits of Land Conservation

- Reducing air and water pollution
- Preserving open and green spaces
- Preserving fish and wildlife habitats, endangered species, and biodiversity
- Managing and protecting watersheds and wetlands
- Maintaining scenic landscapes and recreational amenities
- Preventing soil erosion and improving soil quality
- Reducing the negative impacts of flooding
- Improving resilience to drought and invasive species
- Helping to sequester greenhouse gases
- Protecting sustainable capacities to produce food and fiber
- Limit fragmentation or parcelization

Deforestation

Deforestation is the purposeful clearing of forested land. Throughout history and into modern times, forests have been razed to make space for agriculture and animal grazing, and to obtain wood for fuel, manufacturing, and construction. Deforestation has greatly altered landscapes around the world.

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Deforestation has greatly altered landscapes around the world. About 2,000 years ago, 80 percent of Western Europe was forested; today the figure is 34 percent. In North America, about half of the forests in the eastern part of the continent were cut down from the 1600s to the 1870s for timber and agriculture. China has lost great expanses of its forests over the past 4,000 years and now just over 20 percent of it is forested. Much of Earth's farmland was once forests.

Today, the greatest amount of deforestation is occurring in tropical rainforests, aided by extensive road construction into regions that were once almost inaccessible. Building or upgrading roads into forests makes them more accessible for exploitation. Slash-and-burn agriculture is a big contributor to deforestation in the tropics. With this agricultural method, farmers burn large swaths of forest, allowing the ash to fertilize the land for crops. The land is only fertile for a few years, however, after which the farmers move on to repeat the process elsewhere. Tropical forests are also cleared to make way for logging, cattle ranching, and oil palm and rubber tree plantations.

Deforestation can result in more carbon dioxide being released into the atmosphere. That is because trees take in carbon dioxide from the air for photosynthesis, and carbon is locked chemically in their wood. When trees are burned, this carbon returns to the atmosphere as carbon dioxide. With fewer trees around to take in the carbon dioxide, this greenhouse gas accumulates in the atmosphere and accelerates global warming.

Deforestation also threatens the world's biodiversity. Tropical forests are home to great numbers of animal and plant species. When forests are logged or burned, it can drive many of those species into extinction. Some scientists say we are already in the midst of a mass-extinction episode.

More immediately, the loss of trees from a forest can leave soil more prone to erosion. This causes the remaining plants to become more vulnerable to fire as the forest shifts from being a closed, moist environment to an open, dry one.

While deforestation can be permanent, this is not always the case. In North America, for example, forests in many areas are returning thanks to conservation efforts.

Effect of land use changes.

Land use and land cover changes have significant environmental consequences at local, regional, and global scales. These changes have intense implications at the regional and global scales for global **loss of biodiversity, distresses in hydrological cycles, increase in soil erosion, and sediment loads**

"Land use" is the term used to describe the human use of land. It represents the economic and cultural activities (e.g., agricultural, residential, industrial, mining, and recreational uses) that are practiced at a given place. Public and private lands frequently represent very different uses. For example, urban development seldom occurs on publicly owned lands (e.g., parks, wilderness areas), while privately owned lands are infrequently protected for wilderness uses.

Land use changes occur constantly and at many scales, and can have specific and cumulative effects on air and water quality, watershed function, generation of waste, extent and quality of wildlife habitat, climate, and human health.

EPA is concerned about different land use activities because of their potential effects on the environment and human health. Land development and agricultural uses are two primary areas of concern, with a wide variety of potential effects.

Land Development

- Land development creates impervious surfaces through construction of roads, parking lots, and other structures. Impervious surfaces:
- Contribute to nonpoint source water pollution by limiting the capacity of soils to filter runoff.
- Affect peak flow and water volume, which heighten erosion potential and affect habitat and water quality.
- Increase storm water runoff, which can deliver more pollutants to water bodies that residents may rely on for drinking and recreation.1 Storm runoff from urban and suburban areas contains dirt, oils from road surfaces, nutrients from fertilizers, and various toxic compounds.
- Affect ground water aquifer recharge.
- Point source discharges from industrial and municipal wastewater treatment facilities can contribute toxic compounds and heated water.
- Some land development patterns, in particular dispersed growth such as "suburbanization," can contribute to a variety of environmental concerns. For example:
- Increased air pollution due to vehicle use results in higher concentrations of certain air pollutants in developed areas that may exacerbate human health problems such as asthma.
- Land development can lead to the formation of "heat islands," domes of warmer air over urban and suburban areas that are caused by the loss of trees and shrubs and the absorption of more heat by pavement, buildings, and other sources. Heat islands can affect local, regional, and global climate, as well as air quality.3

Agricultural Uses

- Agricultural land uses can affect the quality of water and watersheds, including:
- The types of crops planted, tillage practices, and various irrigation practices can limit the amount of water available for other uses.
- Livestock grazing in riparian zones can change landscape conditions by reducing stream bank vegetation and increasing water temperatures, sedimentation, and nutrient levels.
- Runoff from pesticides, fertilizers, and nutrients from animal manure can also degrade water quality.
- Agricultural land use may also result in loss of native habitats or increased wind erosion and dust, exposing humans to particulate matter and various chemicals.4
- Some land uses can accelerate or exacerbate the spread of invasive species. For example:

- Certain agricultural land use practices, such as overgrazing, land conversion, fertilization, and the use of agricultural chemicals, can enhance the growth of invasive plants.5 These plants can alter fish and wildlife habitat, contribute to decreases in biodiversity, and create health risks to livestock and humans.
- Introduction of invasive species on agricultural lands can reduce water quality and water availability for native fish and wildlife species.

Soil health

Soil is not an inert growing medium – it is a living and life-giving natural resource. It is teaming with billions of bacteria, fungi, and other microbes that are the foundation of an elegant symbiotic ecosystem.

Soil health is defined as the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans. Healthy soil gives us clean air and water, bountiful crops and forests, productive grazing lands, diverse wildlife, and beautiful landscapes. Soil does all this by performing five essential functions:

- *Regulating water* – Soil helps control where rain, snowmelt, and irrigation water goes. Water flows over the land or into and through the soil.
- *Sustaining plant and animal life* – The diversity and productivity of living things depends on soil.
- *Filtering and buffering potential pollutants* – The minerals and microbes in soil are responsible for filtering, buffering, degrading, immobilizing, and detoxifying organic and inorganic materials, including industrial and municipal by-products and atmospheric deposits.
- *Cycling nutrients* – Carbon, nitrogen, phosphorus, and many other nutrients are stored, transformed, and cycled in the soil.
- *Providing physical stability and support* – Soil structure provides a medium for plant roots. Soils also provide support for human structures and protection for archeological treasures.

Soil health research has determined how to manage soil in a way that improves soil function.

The main principles to manage soil for health are:

Maximize Presence of Living Roots
Minimize Disturbance
Maximize Soil Cover
Maximize Biodiversity

The Basis of Soil Health

Many of these methods of improving soil health pertain to the formation and retention of soil aggregates, or clumps of soil particles. As soils receive carbon input, which can be from crop

residues, root exudates from live roots, dead roots, or other organic sources (e.g. compost or manure), soil microorganisms work to decompose these materials. In the process, they produce compounds that begin to bind soil mineral particles together into microaggregates. With increasing organic matter inputs these microaggregates begin to bind to one another, forming larger and larger aggregates. Soil carbon within these aggregates is considered "protected" from decomposition from biological activity. Due to changes in the chemical structure of soil organic matter that occurs in microaggregates (aggregates smaller than 250 microns in diameter), the carbon in these microaggregates is generally more protected from decomposition than the carbon in macroaggregates (those larger than 250 microns).

Increased soil aggregation from soil organic matter inputs can result in improved soil structure. This improved soil structure results in greater resistance to compaction and increased water retention (especially in sandy and silty soils). In addition to improving structure, organic matter can increase the stability of soil aggregates when exposed to water. This stability can result in increased water infiltration, which means less runoff and erosion. See image below.

Enhancing Soil Health

1) Use plant diversity to increase soil diversity

As plant roots grow, they exude a variety of carbon-rich compounds that will alter the microbial community composition. Some research suggests that increasing the number of plant species may increase the diversity of the microbial community, which may enhance the soil's ability to cycle nutrients and supply plant-available N.

Additionally, the use of crop rotations has been shown to decrease soilborne pathogens and root diseases. A decrease in pathogens has been linked to increases in soil microbial diversity , which can lead to concurrent increases in yield . Currently, it is unclear if increased diversity, absent any pathogen suppression, will increase yields. One recent study showed increased diversity to be associated with higher yields in unfertilized rice fields, but it is unclear if this diversity and yield increase persists with fertilization and under other crops.

2) Keep plants growing throughout the year

Plant roots are thought to contribute more carbon to soil than the above-ground biomass , although the amount will vary depending on crop and tillage practices . In no-till systems, root-derived carbon is more important than residue-derived carbon . Cover crops are a vital tool to increase both root-derived carbon and total carbon input into a soil. For more information on cover crops, visit our focus topic page or the cover crops database.

Soil-background_shortened

Continuous plant growth throughout the year can help reduce water contamination issues, a vital function for healthy soils to perform. The use of a winter cover crop allows for increased nutrient

retention during the rainy months when leaching risk is greatest in California . Perennial crops have also been shown to improve water quality by combating nutrient leaching.

3) Manage soils by disturbing them less

Decreasing tillage can increase overall organic matter content, although it is often constrained to the top several inches. Tillage decreases soil organic matter by exposing the carbon protected within aggregates to decomposition and loss. This loss of soil carbon can result in increased erosion from water and from wind, which is especially important in maintaining air quality in the southern San Joaquin Valley of California.

While no-till practices can result in initial yield reductions, not all studies show this, and in some studies yields have generally recovered after a few years and could be mitigated by increasing carbon inputs (through residues, etc.). Fields that had been cover cropped for 15+ years in California have been shown to have stable or even increased yields from reducing tillage operations. It should also be noted that some California studies have shown that cover crops increase organic matter content more than reducing tillage operations.

Tillage, or other similarly disruptive field operations, has also been shown to more strongly alter soil microbial community composition than other variables such as organic versus conventional management. However, most research so far has not shown any definitive effect of tillage on other biological indicators typically used to measure soil health (microbial biomass, respiration, potentially mineralizable N, etc.)

4) Keep the soil covered as much as possible. Soil cover can take several forms, including cover crops and crop residues.

Crop residues can help to maintain yields in no-till systems in dry climates by reducing evaporation and increasing water retention. Soil cover can also help combat erosion in a number of ways. Soil cover, whether from crop residue or other sources of mulch, helps to absorb the impact energy of raindrops falling on soil, reducing soil particle detachment, as well as crusting and sealing of the soil surface.

It also slows the speed of water moving across the surface, reducing the amount of soil particle detachment and transport. Soil cover, whether as standing vegetation or residue, also reduces wind speed at the soil surface, preventing wind erosion. Even a soil cover of only 30% of the soil's surface can reduce soil loss from wind erosion by 70%. Standing vegetation with some height is more effective at reducing wind speeds than residue lying flat on the surface. Mulch has also been shown to improve biological properties of soil, including earthworm populations and fungal biomass, as well as carbon content.

Ecological and economic importance of soil

Why is Soil Important?

Soil provides ecosystem services critical for life: soil acts as a water filter and a growing medium; provides habitat for billions of organisms, contributing to biodiversity; and supplies most of the antibiotics used to fight diseases. Humans use soil as a holding facility for solid waste, filter for wastewater, and foundation for our cities and towns. Finally, soil is the basis of our nation's agroecosystems which provide us with feed, fiber, food and fuel.

Ecological importance of soil

Soils have a large function in the health of ecosystem functions in the world.

ECOSYSTEM SERVICES

Soil is the link between the air, water, rocks, and organisms, and is responsible for many different functions in the natural world that we call ecosystem services. These soil functions include: air quality and composition, temperature regulation, carbon and nutrient cycling, water cycling and quality, natural "waste" (decomposition) treatment and recycling, and habitat for most living things and their food. We could not survive without these soil functions.

Habitat

Soils are the environment in which seeds grow. They provide heat, nutrients, and water that are available for use to nurture plants to maturity. These plants form together with other plants and organisms to create ecosystems. Ecosystems depend on the soil, and soils can help determine where ecosystems are located (check out the Around the World page for more examples.) These plants then provide valuable habitat and food sources for animals, bacteria, and other things.

Air Quality and Composition

A well covered soil prevents erosion. During times like the great Dust Bowl, wind blows across soils, and suspended them in the air. These are easily inhaled and accumulate in lung tissues causing major respiratory problems. These particles can contain fungi and bacteria, which can cause infection and diseases. They are also important in military operations.

Dust can hide entire armies and tanks in large clouds. Approaching the enemy is much easier when entire armies are hidden in the dust, but all following vehicles tend to be blinded by dust. In dry regions, dust can also alert of an approaching enemy. In very dry regions, every time a weapon is fired, it sends out a cloud of dust, and it is difficult to see if the target is hit. Tank engine's life spans fell from an average of 7500 kilometers to 3500 kilometers in the desert; most of this is due to the damage that suspended sediment causes. In military operations in the desert, take off formations are messed up by high concentrations of dust.

Temperature Regulation

Soil temperature plays an important role in many processes, which take place in the soil such as chemical reactions and biological interactions. This includes important processes like seed germination, bugs and microbes that live in the environment, and how quickly plant and animals break down. In colder soils, there is less biological and chemical reactions compared to warmer ones, therefore, there may be more carbon stored in the soils.

Carbon and Nutrient Cycling

Soil contains large amounts of stored carbon, nearly 5 times more than the plants that grow in it. Natural processes are all cyclical. On a global level, the total carbon cycle is more complex, and involves carbon stored in fossil fuels, soils, oceans, and rocks. Physical, biological, and chemical processes in the soil affect the balance in organic carbon compounds, and if they are released to the atmosphere as CO2, or stored in the soil. This same process occurs with Nitrogen, Phosphorus, and all other materials.

Water Filtration

Without soil and soil particles, water would be running on bare rocks! When it rains, the soil acts as a sponge, soaking water into the ground. From there a few things can happen to the water. The water can be taken up by plants, microbes, and other living things, or the water moves into the underground aquifers and lakes, and flows into streams before eventually making it to the ocean. If rainfall contains harmful pollutants, the soil acts as a filter; contaminants are captured by the soil particles, and the water comes out cleaner in the aquifers and rivers.

Soil filters water as it moves from the land surface into the groundwater. This occurs through physical, chemical and biological process. For example, septic systems rely on these processes to protect groundwater quality as well as maintain the quantity of our water supply. When soils are not protected, soils and nutrients can pollute water, washing away into streams and oceans.

Water Cycling and Quality

Application of excess fertilizers, particularly nitrogen and phosphorus, can result in runoff to streams and rivers or contamination of groundwater. In most freshwater systems, phosphorus is the major limiting nutrient for the growth of photosynthetic organisms (e.g., plants, algae, and some microorganisms like phytoplankton). If a lake or pond receives excess phosphate, it can stimulate these organisms, especially if nitrates are present with it. These organisms block out the light and consume oxygen in the water to the detriment of other organisms (e.g., other plants and fish). Other symptoms include cloudy water that is typically green or yellow. Dead plants and fish and cloudy green water make these water bodies uninviting for recreational activities.

"Waste" Decomposition

Soil is being used to recycle animal waste, which also fertilizes it for crop growth.

Soils are the stomach that converts these "waste" products into newer, better things that can be reused by other creatures. Everything that is living eats, and because of this, everything needs to expel waste products out of their bodies. Humans and other organisms use the soil to decompose these waste materials into new materials. These new materials are used by other living things. Once a living thing dies, it falls into the soil and the biological and chemical processes convert these dead materials into new materials and food for living things. This is nature's way of recycling.

Economic importance of soil

Soil plays a crucial role in the economy of countries. Farming and agricultural industries are probably the most reliant upon soil, particularly in respect to crop production, which has risen dramatically in the last 50 years in order to cope with the demands of an equally rapidly growing global population.

The demand for more crops has increased the demand for plant nutrients in the form of fertilisers. For a long time, many farms relied on animal manure for this. However most farms in the west now use artificial fertilisers, because it allows more control over which nutrients should be applied to the soil and when.

In the developed countries of the world it has been possible to increase the productivity of soils immensely because of the introduction and development of such fertilisers For example, the use of nitrogen fertilisers has increased 15-fold in the UK in the last 50 years, and over the same period yields of some crops have trebled. Research conducted into crop growth, and how soils release nutrients to plants, has enabled farmers to use suitable and better adapted fertilisers for different crops and soils, and thus add to the fertility of their soils.

There are many other economic land uses that are dependent on the soil, particularly forestry. Trees are usually longer term 'crops' in which an important relationship is built up with the soil to establish a nutrient balance.

What is soil degradation?

Soil degradation describes what happens when the quality of soil declines and diminishes its capacity to support animals and plants. Soil can lose certain physical, chemical or biological qualities that underpin the web of life within it.

Soil erosion is a part of soil degradation. It's when the topsoil and nutrients are lost either naturally, such as via wind erosion, or due to human actions, such as poor land management.

Various Causes of Soil Degradation

1.Physical Factors

There are several physical factors contributing to soil degradation distinguished by the manners in which they change the natural composition and structure of the soil. Rainfall, surface runoff, floods, wind erosion, tillage, and mass movements result in the loss of fertile top spoil thereby declining soil quality.

All these physical factors produce different types of soil erosion (mainly water and wind erosion) and soil detachment actions, and their resultant physical forces eventually change the composition and structure of the soil by wearing away the soil's top layer as well as organic matter. In the long-term, the physical forces and weathering processes lead to the decline in soil fertility and adverse changes in the soil's composition/structure.

2. Biological Factors

Biological factors refer to the human and plant activities that tend to reduce the quality of the soil. Some bacteria and fungi overgrowth in an area can highly impact the microbial activity of the soil through biochemical reactions, which reduces crop yield and the suitability of soil productivity capacity.

Human activities such as poor farming practices may also deplete soil nutrients thus diminishing soil fertility. The biological factors affect mainly lessens the microbial activity of the soil.

3. Chemical Factors

The reduction of soil nutrients because of alkalinity or acidity or waterlogging are all categorized under the chemical components of soil degradation. In the broadest sense, it comprises alterations in the soil's chemical property that determine nutrient availability.

It is mainly caused by salt buildup and leaching of nutrients which corrupt the quality of soil by creating undesirable changes in the essential soil chemical ingredients. These chemical factors normally bring forth the irreversible loss of soil nutrients and production capacities such as the hardening of iron and aluminum-rich clay soils into hardpans.

4. Deforestation

Deforestation causes soil degradation on the account of exposing soil minerals by removing trees and crop cover, which support the availability of humus and litter layers on the surface of the soil.

Vegetation cover primarily promotes the binding of the soil together and soil formation, hence when it is removed it considerably affects the capabilities of the soil such as aeration, water holding capacity, and biological activity.

When trees are removed by logging, infiltration rates become elevated and the soil remains bare and exposed to erosion and the buildup of toxicities. Some of the contributing activities include logging and slash and burn techniques used by individuals who invade forest areas for farming, rendering the soils unproductive and less fertile in the end.

5. Misuse or excess use of fertilizers

The excessive use and the misuse of pesticides and chemical fertilizers kill organisms that assist in binding the soil together. Most agricultural practices involving the use of fertilizers and pesticides often entail misuse or excessive application, thereby contributing to the killing of soil's beneficial bacteria and other micro-organisms that help in soil formation.

The complex forms of the fertilizer's chemicals are also responsible for denaturing essential soil minerals, giving rise to nutrient losses from the soil. Therefore, the misuse or excessive use of fertilizers increases the rate of soil degradation by destroying the soil's biological activity and builds up of toxicities through incorrect fertilizer use.

6. Industrial and Mining activities

Soil is chiefly polluted by industrial and mining activities. As an example, mining destroys crop cover and releases a myriad of toxic chemicals such as mercury into the soil thereby poisoning it and rendering it unproductive for any other purpose.

Industrial activities, on the other hand, release toxic effluents and material wastes into the atmosphere, land, rivers, and groundwater that eventually pollute the soil and as such, it impacts on soil quality. Altogether, industrial and mining activities degrade the soil's physical, chemical, and biological properties.

7. Improper cultivation practices

There are certain agricultural practices that are environmentally unsustainable and at the same time, they are the single biggest contributor to the worldwide increase in soil quality decline. The tillage on agricultural lands is one of the main factors since it breaks up the soil into finer particles, which increase erosion rates.

The soil quality decline is exuberated more and more as a result of the mechanization of agriculture that gives room for deep plowing, reduction of plant cover, and the formation of the hardpan.

Other improper cultivation activities such as farming on steep slope and mono-cropping, row-cropping, and surface irrigation wear away the natural composition of the soil and its fertility and prevent soil from regenerating.

8. Urbanization

Urbanization has major implications on the soil degradation process. Foremost of all, it denudates the soil's vegetation cover, compacts soil during construction, and alters the drainage pattern.

Secondly, it covers the soil in an impermeable layer of concrete that amplifies the amount of surface runoff which results in more erosion of the topsoil. Again, most of the runoff and sediments from urban areas are extremely polluted with oil, fuel, and other chemicals.

Increased runoff from urban areas also causes a huge disturbance to adjacent watersheds by changing the rate and volume of water that flows through them and impoverishing them with chemically polluted sediment deposits.

9. Overgrazing

The rates of soil erosion and the loss of soil nutrients, as well as the topsoil, are highly contributed by overgrazing. Overgrazing destroys surface crop cover and breaks down soil particles, increasing the rates of soil erosion. As a result, soil quality and agricultural productivity are greatly affected.

Fatal Effects of Soil Degradation

1. Land degradation

Soil quality decline is one of the main causes of land degradation and is considered to be responsible for 84% of the ever-diminishing acreage. Year after year, huge acres of land lost due to soil erosion, contamination, and pollution.

About 40% of the world's agricultural land is severely diminished in quality because of erosion and the use of chemical fertilizers, which prevent the land from regenerating. The decline in soil quality as a result of agricultural chemical fertilizers also further leads to water and land pollution thereby lowering the land's worth on earth.

2. Drought and aridity

Drought and aridity are problems highly influenced and amplified by soil degradation. As much as it's a concern associated with natural environments in arid and semi-arid areas, the UN recognizes the fact that drought and aridity are anthropogenic induced factors especially as an outcome of soil degradation.

Hence, the contributing factors to soil quality decline such as overgrazing, poor tillage methods, and deforestation are also the leading causes of desertification characterized by droughts and arid conditions. In the same context, soil degradation may also bring about loss of biodiversity.

3. Loss of arable land

Because soil degradation contributes to land degradation, it also means that it creates a significant loss of arable land. As stated earlier, about 40% of the world's agricultural land is lost on the account of soil quality depreciation caused by agrochemicals and soil erosion.

Most of the crop production practices result in the topsoil loss and the damage of soil's natural composition that makes agriculture possible.

4. Increased flooding

The land is commonly altered from its natural landscape when it rids its physical composition from soil degradation. For this reason, the transformed land is unable to soak up water, making flooding more frequent.

In other words, soil degradation takes away the soil's natural capability of holding water thus contributing to more and more cases of flooding.

5. Pollution and clogging of waterways

Most of the soil eroded from the land together with the chemical fertilizers and pesticides utilized in agricultural fields are discharged into waterways and streams. With time, the sedimentation process can clog waterways, resulting in water scarcity.

The agricultural fertilizers and pesticides also damage marine and freshwater ecosystems and limit the domestic uses of the water for the populations that depend on them for survival.

Here are five ways that soil erosion is threatening our food security and the achievement of the Sustainable Development Goals (SDGs):

1. Soil erosion inhibits our ability to grow nutritious food.

By decreasing the nutrients available to plants as well as the space for them to put down roots, soil erosion can decrease crop yields by up to 50 percent. In addition, crops that do grow tend to be of a lower quality: misshapen, smaller and less nutritious. This low-quality produce has effects not only on the farmers who try to sell it, but also the people who will consume fewer nutrients by eating it.

2. Soil erosion leads to ecosystem degradation.

Soil erosion is the removal of topsoil, the most fertile top layer of soil. It, causes minerals and nutrients in soil to deposit elsewhere, often degrading traditional ecosystems. In addition, the deposited sediment can build up in reservoirs or choke off streams and rivers – depriving people of the resources and energy they provide.

3. Soil erosion affects water supplies.

Soil captures, stores and filters water – so when soil erodes, less water can move through it. Without soil, the quality of drinking water in lowland areas may decrease, as the water was never adequately filtered through soil upstream. Additionally, with less soil to absorb a heavy rainfall, floods may become more frequent and intense.

4. Soil erosion damages urban infrastructure.

When soil is not held together by plant roots, it can be easily moved by wind or water. As a result, loose and eroding soil can make floods, landslides and windstorms more severe. These natural disasters not only devastate farms, but can also harm urban infrastructure that provides vital services to city dwellers.

5. Soil erosion contributes to poverty and can lead to migration

Over 68 million people have been displaced from their homes worldwide, many for issues related to climate. Soil erosion only exacerbates the effects of climate change: with less soil, ecosystems have less resilience for adapting to new patterns of temperature and rainfall. As depleted soil exacerbates the effects of weather events, people's livelihoods are increasingly affected – and more people may be forced to move elsewhere.

Need for soil conservation

Soil conservation is essential for:

1. **Reducing climate change's destructive impact worldwide**
2. **Maintaining a balanced climate cycle**
3. **Providing healthy ecosystems where plants, trees, and animals can thrive**
4. **Ensuring healthy agricultural yields through sustainable farming practices**
5. **To maintain an adequate amount of organic matter and biological life in the soil.** These two components account for 90 to 95 percent of the total soil productivity.

6. **To ensure a secure food supply at reasonable prices.** Soil conservation is proven to increase the quality and quantity of crop yields over the long term

because it keeps topsoil in its place and preserves the long term productivity of the soil.

7. To grow enough food not only for ourselves; but also for **people in third would countries where there are food shortages.**

8. **To save farmers money.** Erosion is currently costing farmers over $90 milliona year in lost income due to lower crop yields, and the loss of nutrients from the soil.

9. **To save citizens money.** Soil erosion costs us an addition $9.1 million each year, and probably much more according to recent research.

10. **To improve water quality.** All forms of life need clean water to survive. Agricultural and urban soil erosion are major sources of sedimentation and contamination of water supplies.

11. **To improve wildlife habitat.** Soil conservation practices such as providing buffer strips and windbreaks, or replacing soil organic matter, greatly enhance the quality of the environment for wildlife of all kinds.

12. **For aesthetic reasons.** To provide more attractive and picturesque scenery.

13. **To help create an environment free of pollution where we can live safely.**

14. **For the future of our children, so that they may have enough soil to support life.** It has been said that the land has not so much been given to us by our forefathers, but has been borrowed from our children.

Sustainable land use planning

Sustainable land management (SLM) refers to practices and technologies that aim to integrate the management of land, water, and other environmental resources to meet human needs while ensuring long-term sustainability, ecosystem services, biodiversity, and livelihoods. The term is used, for example, in regional planning and soil or environmental protection, as well as in property and estate management.

Sustainable land management combines technologies, policies, and activities aimed at integrating socioeconomic principles with environmental concerns, so as to simultaneously:

- maintain and enhance production (productivity)
- reduce the level of production risk, and enhance soil capacity to buffer against degradation processes (stability/resilience)
- protect the potential of natural resources and prevent degradation of soil and water quality (protection)
- be economically viable (viability)
- be socially acceptable, and assure access to the benefits from improved land management (acceptability/equity)

PRINCIPLES AND CRITERIA FOR SUSTAINABLE LAND MANAGEMEN

Global concerns for sustainability

- Sustainability can be achieved only through the collective efforts of those immediately responsible for managing resources. This requires a policy environment that empowers farmers and other, local decision makers, to reap benefits for good land use decisions, but also to be held responsible for inappropriate land uses.
- Integration of economic and environmental interests in a comprehensive manner is necessary to achieve the objectives of sustainable land management. This requires that environmental concerns be given equal importance to economic performance in evaluating the impacts of development projects, and that reliable indicators of environmental performance be developed.
- There is urgent need to resolve the global challenge to produce more food to feed rapidly rising global populations, while at the same time preserving the biological production potential, resilience, and environmental maintenance systems of the land. Sustainable land management, if properly designed and implemented, will ensure that agriculture becomes a part of the environmental solution, rather than remaining an environmental problem.

Sustainable Agriculture

- More ecologically balanced land management can achieve both economic and environmental benefits, and this must be the foundation (linch pin) for further

rural interventions (investments). Without good land management, other investments in the rural sector are likely to be disappointing[2]. At the same time, arguing for the continued maintenance of agriculture without reference to environmental sustainability is increasingly difficult. Indicators of land quality are needed to guide us along the way.

- Agricultural intensification is often necessary to achieve more sustainable systems. This requires shifts to higher value production, or higher yields with more inputs per unit of production and higher standards of management (more knowledge intensive). However, sustainable agriculture has to work within the bounds of nature not against them. Many yield improvements can be achieved by optimizing efficiency of external inputs rather than trying to maximize yields.

- The importance of off-farm income should not be underestimated because it i) supplements cash flow on the farm, ii) generates an investment environment for improved land management, and therefore iii) reduce production pressures on land.

Sharing responsibilities for sustainability

- Farmers and land managers must expand their knowledge of sustainable technologies and implement improved procedures of land stewardship. The preferred option is not to tell the farmer what to do (command and control legislation), but to create an enabling environment through policy interventions where farmers are more free to make the right choice. A policy environment where farmers are more empowered, but also held accountable, for achieving the objectives of sustainable land management is essential. However, sustainable land management is the responsibility of all segments of society. Governments must ensure that their policies and programs do not create negative environmental impacts, and society needs to define requirements for land maintenance and develop a "social" discount rate for future land use options that encourages the most sustainable use.

- Concerns for sustainable land management go beyond agriculture to include the legitimate interests of other aspects of land stewardship, including wildlife, waterfowl and biodiversity management. There is increasing evidence that society is demanding that farmers become stewards of rural landscapes, and that agriculture become more than simply putting food on the table. Many of society's environmental values may not represent economic gains for farmers, however, and farmers cannot shoulder all the costs of environmental maintenance.