BIO-RESOURCES LAND AND WATER

Shakuli Saxena
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CHAPTER 1

THE LAND RESOURCES: CHARACTERISTICS PATTERN AD IMPORTANCE

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We will examine several kinds of land and its resources in this unit. Land is one of the most valuable resources since it is something that we all rely on. We spoke about the land resources in this lesson, including their significance and typical patterns. Due to several human-made activities, all resources have drastically diminished. In this chapter, we've also spoken about how to solve these issues. The most valuable resource that supports human activity, natural vegetation, animals, and transportation and communication networks is land. Simply said, the land is "the solid portion of the earth's surface." A general division of the earth's surface into aquatic and non-aquatic regions is possible. The basis for the existence of the living world is provided by land, a naturally occurring finite resource. It contains every element that makes up a terrestrial ecosystem.

Due to the growing human population and contemporary way of life, there is an increasing demand for land resources, which has led to decreased agricultural output, deterioration of land quality and quantity, and competition for available land. An portion of the earth's surface known as "land" includes all of the characteristics of the biosphere that are immediately above or below it, including those of the near-surface. As of 1994, the world's land area was estimated by the Food and Agriculture Organization to be 144.8 million sq km, or roughly 29% of the earth's surface, of which 30% was made up of forest and woodland areas.Prior to the start of the world's widespread human disruptions thousands of years ago, forests and woods likely spanned close to 6.0 billion hectares. Since that time, croplands, pastures, towns, or barren wastelands have taken up around 16% of that area, as shown in Figure 1.

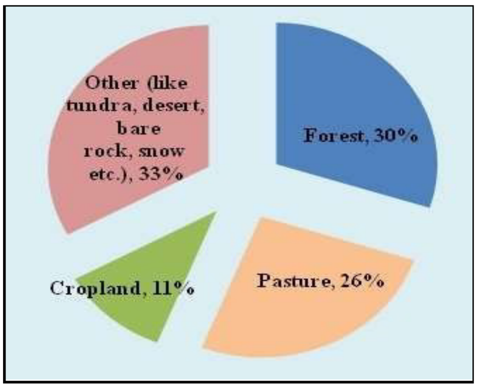

Figure 1: Illustrate the global land use trends and ecological.

The part of the environment that may be used to sustain life is known as a natural resource. To put it another way, these resources are products and services that our environment provides. They include of sources of energy, minerals, land, food, forests, water, atmosphere, plants, animals, and other necessities for maintaining life. India is huge and diversified, and it has many valuable resources. The plain portion of the land, which makes up around 43% of the total area, may be farmed. About 30% of the country's land is made up of mountainous regions, which are essential for their natural resource abundance as well as its scenic beauty and services. In addition to forests and agricultural land, the plateau region possesses a significant deposit of mineral resources. The lush river valley in the mountains and plateau also makes it a good place for human settlement. With a per capita land availability of 0.89 hectare in 1951, but a steep reduction over time to just 0.37 ha in 2016, the heavy weight of the population and rising demand for the same have placed significant strain on land resources. There is a 60% decline in the amount of available land. Thus, it is abundantly evident that the population growth is negatively correlated with the amount of available land. The supply of land will decrease as the population grows and vice versa [1].

Resources of Land Defined

Land resources include subsurface water, diverse minerals including coal, bauxite, and gold, as well as other raw materials. Agricultural land includes natural fertilizer for the development of the goods sowed. The term "land resource" describes the land that is available for use, such as non-agricultural areas for construction, creating townships, etc. Natural resources are things that happen in the world in their natural state, untouched mostly by human activity.Land, population, and management approaches: The Fundamental Relationship Arable land's ability for production and susceptibility to deterioration rely on the management techniques used as well as on the underlying soil and other factors.

This confluence of variables may influence the population that can be sustained and the level of life in cultures that are reliant on agriculture. An area's land resource may become stressed as a result of an increase in population due to the increasing need for output. People's standards of life decline if no alternative source of income can be found. The level of life could grow or more people might be sustained at the same standard of living without a decline in the natural resource base, but, if superior management techniques are available. In order to meet the rising needs of a growing population, a sufficient quantity of land of acceptable quality and appropriate production technology are thus necessary [2], [3].

Stress on Land Resources

Land resources are definitely under stress right now; 16% of arable land is degraded, and that number is rising. . The management and technologies required to replace them aren't always accessible, and traditional land management methods are either failing or are no longer suitable. The main cause of this predicament is the rising demands on land brought on by the unparalleled pace of population expansion and the consequences it has. Sustainability in land management is also being hampered by global change externalities.

Land Availability

There are limited limitations to the amount of land resources that can be produced, notwithstanding the contribution of technology to an increase in the number of people that the terrestrial biosphere can sustain. The FAO estimates that there is some potential for rainfed agriculture on a gross area of about 2.5 billion hectares of land in the developing world2. However, two-thirds of this land are rated as having significant constraints due to topography or soil conditions, and not all of this land is suitable for agricultural production. However, there are disparities in the distribution of land both within and across nations, and these differences in access to land in relation to population demand are more important than worldwide totals. By the year 2000, 64 countries would not be able to support their populations from land resources alone using production systems based on low inputs, according to FAO's analysis of the potential production from available land and projected population growth in 117 developing countries.

Resources like land are becoming more limited, and this is especially true of property that may be used for primary biomass production or for conservation-related activities. Conflicts relating to this rivalry are occurring more often and are growing more complicated as there is increasing competition for land among various users. The peri-urban periphery is often where this conflict is most noticeable, as the pressures of urban growth collide with agricultural operations and recreational needs. The economic value of land usually rises quickly as a result of such circumstances, and land tenure develops into a significant political problem. The usage of land is influenced by a variety of global change-related issues, either directly or indirectly. These include biophysical factors like climatic changes or disasters caused by nature or humans, as well as socioeconomic factors like trade liberalization, market globalization, decentralized decision-making, privatization, and the widening gap between the "haves" and the "have-nots."

The Influence of Population

Despite the fact that the population growth rate has decreased since 1980, the real population growth rate is larger than it has ever been. Up to the end of the century and until AD 2025, additions will average 97 million annually. The emerging world is predicted to account for 95% of this growth. According to current estimates, Africa's population will have increased by approximately five times by the years 2050 and 2150, respectively. Production technology has made significant strides over the last century, including the creation of crop types that are more productive and the expansion of irrigation and fertilizer usage. However, it is becoming harder for technical advancement to keep up with the increasing demands brought on by population expansion. This is partially due to agriculture being expanded into more remote places where physical constraints restrict potential production and failure chances are greater. Geographically speaking, the success of technology in meeting these demands has been uneven. It has been best in regions with low recent population growth, like Europe and North America, and has met with varying degrees of success in Asia and Latin America. It has generally met with the least success in sub-Saharan Africa, where food production per capita has actually decreased by almost 20% since 1960 [4].

A proportional rise in the urban population at the cost of the rural population has coincided with growth in the overall population during the previous 50 years. . This tendency has a double effect. On the one hand, migration to urban areas may lessen the overall need for agricultural land while boosting the market for producers. On the other hand, since urbanization decreases the overall amount of land accessible for agriculture, primary items like food, fiber, and fuel must be produced from a declining land area by a diminishing relative population. The disproportionate movement of economically active men to urban areas, leaving women, children, and the elderly to carry the rigors of agriculture, is another cause. Government measures that favor urban residents and their employers, such as low food prices, usually worsen the problem by penalizing food producers, who are typically a less vocal and well-organized political group. A rise in per capita consumption has been encouraged by urbanization as a result of population expansion and migratory consequences, further increasing the demands on land resources.

"An area of the Earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, including those of the near-surface climate, the soil and terrain forms, the surface hydrology , the near-surface sedimentary layers and associated groundwater and geo-hydrological reserve, the plant and animal populations, and the human settlements," according to FAO/UNEP a repository for monetary development for people, organizations, or communities Support the production of biotic resources for human use, including as food, fuel, and fiber provide plants, animals, and microbes biological environments. Regulation of the storage and movement of surface water and groundwater, which plays a role in the determination of the global energy balance and the global hydrological cycle satisfy human beings' demand for minerals and raw materials serving as a filter, modifier, or buffer for removing pollutants. Give industry, leisure, and other development-related activities a physical location. Evidence from the historical or prehistoric record should be preserved and protected.

Create a space where humans, animals, and plants may migrate from one location to another. It becomes the critical obligation of land users, authorities, scientists, and planners based on the crucial function of knowing and exploiting the land. It seems that humans have been using the land's resources organically for their needs in order to survive. Therefore, the combination of biophysical and human driving factors results in land usage. Throughout many eras, there has been a transition from traditional to contemporary means of utilising land resources. How to use land resources to meet the needs of both present and future generations is a growing concern in actual development. Land use is also defined by the plans, actions, and human involvement necessary to create, alter, or sustain a certain kind of land cover. This definition of land use creates a clear connection between human activity in the environment and the state of the land. As a result, it may be described as the human use of land that takes into account both the way in which biophysical features of the land are included and the objectives for using the land.

Land Classification and Utilization

The vast majority of the land in India that is suited for agriculture and has already been put under cultivation is one of the most important aspects of land usage in India. Statistics on land use are available for almost 93% of the 3287.3 lakh hectare total geographic area. The main factor determining a region's classification as land is whether it is grazed, farmed, or wooded. India's land area is divided into the following groups.

Net Sown Area: The net area used for cultivating crops and maintaining orchards is referred to as net sown area. Due to the rehabilitation of arid and unusable land in recent years, the net sown area has significantly grown. Forests: A forest is a clump of trees that predominate. On a specific piece of ground known as forest land, where the bulk of trees are present. Cropland areas that are simply left fallow for the current year are included in this category. For instance, a planted area may be classified as current fallow if it is not cropped again in the same year. Other fallow land includes those which has been briefly farmed for one to five years. Such fallow land was discovered in the Indian states of Tamil Nadu, Bihar, Meghalaya, Mizoram, Andhra Pradesh, Karnataka, Delhi, and Rajasthan. It was caused by insufficient water supply and silting of rivers and canals. Land that is either fallow or covered with useless bushes or jungles is referred to be cultivable wasteland. This category also includes lands that were farmed in the past but have gone uncultivated for five years straight. Reh, Bhur, Usar, and Khola areas of Uttar Pradesh, Haryana, Punjab, and numerous other Indian states were formerly farmed but are now unproductive owing to nutrient deficits in the soil [5], [6].

Diverse tree crops and groves: This category includes all cultivable land that is used for agriculture but is not included in the area planted. A reported 1.21% of the nation is made up of such areas. In Tripura, a large amount of the state's territory is covered with various tree crops and groves. Permanent pasture and grazing land: Included in this category are all grazing grounds, such as meadows and village commons, which make up around 4% of the reporting area.

Land used for non-agricultural purposes: This category covers all lands used for construction of roads, trains, and other structures, as well as all areas submerged in rivers and canals and used for purposes other than agriculture. Barren and uncultivable land includes all areas that cannot be brought under cultivation unless at a significant expense. Such land may be found in small, isolated parcels or inside farmed land. They are often desert or mountainous.

Land Resource Types: Land resources may be divided into the following groups depending on the kind of resource that is present in a given area:

1. Resource Forests
2. Resources for Minerals
3. Agricultural resources
4. Resources for water
5. Sources of soil

Resource Forests

The land's forest resources are a crucial resource since they serve human needs while carrying out ecological tasks. The ecosystem benefits from the forest's many services, including those that provide humans access to food, shelter, cover, fodder, and wood fiber. The Latin word "Foris," which meaning outdoors, is where the term "forest" originates. One of the most significant natural resources on the planet is its forests. Forests occupy almost a third of the surface area of the planet. Overall, 21.02% of India's entire geographical area is presently covered with vegetation. . India has a total forest area of 6, 90, 899 km2. According to Indian law, "all lands with a tree canopy density of more than 10%" are considered to have forest cover [7].

Talking about “resources” makes sense only when human interest gave them that role. Thus, forestland resources are all those attributes of forests that have any kind of present or potential value to people. The available resources are continuously changing because culture and knowledge change and evolve. Some resources become obsolete, and on the other hand, some resources emerge and develop with new needs and knowledge. The UN Conference on Environment and Development held in Rio de Janeiro in 1992 has given forests an increasingly important role in the context of sustainable development and environmental conservation. The concept of sustainable forest management has been recognized as a fundamental guiding principle by all participating countries. Forests play an important role in maintaining fertility of soil by shedding their leaves which contain many nutrients. Forests are also helpful in binding up of soil particles with the help of roots of vegetation. Therefore, cutting of forests will affect the soil adversely.

The meaning of Forests

Forestland resources are all those characteristics of a forest that have any kind of present or potential values to the people. No doubt, forest plays a key role in providing a number of resources and services to human kind. Forest resources are crucial to the economy of any nation because they are a highly complex, ever-changing environment made up of both living and nonliving things, such as trees, shrubs, animals, and other living things, as well as nonliving things such as water, nutrients, rocks, sunlight, and air. Forest differs greatly from meadows and pastures in terms of composition and density. Forests are important to both humans and the natural world because they provide many aesthetic benefits, recreational opportunities, and other benefits.

Wet Evergreen Forests in the Tropics

These are the typical rain forests of India, found in places like the Western Ghats, portions of Karnataka, the Cachar and Brahmaputra valley of Assam, and the Andaman-Nicobar islands of India.

Forests of Tropical Moist Deciduous

On the basis of dominant species, they are typically of three types: Sandal, Teak, and Sal forests. These forests are distributed at Eastern side of Western Ghats, Chhota Nagpur, Khasi Hills, and a narrow belt along the foothills of Himalayas where the annual rainfall is 150-200 cm. and drought period is for 1-2 months. Littoral and Swamp Forests There are three subcategories of these forests: coastal, tidal, and freshwater swamp.

Beach woodlands:

These woodlands are located close to sandy river delta flats and ocean beaches. Tidal forests are those that develop over river deltas, streams that run down the coast, and the marshy edges of islands. Elephant grass is particularly widespread in fresh water swamp forests, which develop in depressions where rainwater or swelling riverwater collects for a while. Dry Deciduous Forests in the Tropics They run from the foot of the Himalayas to the extreme South and make up around 40% of India's total geographical area, where the annual rainfall ranges from 75 to 125 cm and the dry season lasts for about 6 months [8].

Forests of tropical thorns

These forests, which are common in Punjab, Haryana, Rajasthan, Gujarat, Delhi, the Bundelkhand region of Uttar Pradesh, parts of Madhya Pradesh, Maharashtra, and Tamil Nadu, are found on rocky substrata with annual rainfall ranging from 25 to 75 cm. These woods, which may be found in parts of Andhra Pradesh and Tamil Nadu, get rain from the receding monsoon [9].

Subtropical Montane Forests:

These may be divided into three sub-categories because they display both forms of mixed vegetation because they are midway between tropical and temperate forests: Nilgiri and Palni Hills in the South; Mahableshwar and adjacent regions of Maharashtra; Mount Abu in Rajasthan; Pachmarhi in M.P.; Parasnath in Bihar; Kalimpong and

West Bengal's Darjeeling.

Pine forests may be found on the eastern foothills of the Himalayas and on the Khasi, Naga, Manipur, and Lushai hills. The origin and distribution of minerals are closely linked to the history of the biosphere and to the entire geologic cycle, and almost every aspect and process of the geologic cycle is involved to some extent in producing local concentrations of minerals. Mineral resources are broadly defined as elements, chemical compounds, minerals, or rock concentrated in a form that can be extracted to obtain a sustainable commodity.

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CHAPTER 2

RESOURCES FOR CROPS AND AGRICULTURE

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Another essential land resource that provides for the needs of millions of people is agriculture. Crops have a direct impact on economic growth, animal feed, and human nourishment. Cropland is a term used to describe areas used for the cultivation of harvestable crops. Cropland may be divided into two categories: cultivated and uncultivated. Examples of farmed farmland include row crops and crops growing near together. Pasture or hayland that rotates with rows of or crops growing near together are examples of other farmed farmland. Horticulture farmland and permanent feed land are both regarded as non-cultivated cropland. The 2007 National Resources Inventory estimates that there are 357, 023,500 acres of farmland in the United States. On agricultural acres, the bulk of the food and fiber produced in the US and exported to other countries is produced. The land may be categorized on the basis of its quality in accordance with the resources that are readily accessible on it. The seeds of less than a dozen plant species account for over 80% of human food. Over time, man has developed new tools and methods to improve agricultural productivity.

Water Resources

As we all know that water is essential source of life, human body contain about 70%. Water is elixir of life and in the present context, there is a lot of crisis on water resources. Drinking water is not in plenty on this planet. So the water is most important thing of land resources. Land is providing a substratum to all living and nonliving components, the entire living component has been established in the form of families, group and clusters and use the surrounding land absolutely free of cost. Nobody pay the charges of natural land resources. With providing the surface area to the living beings, the land contain different types of resources in her lap like as water, minerals, soil etc. as a non-living component, the water resources are present in plenty on the land surface as well as inner side of the land in the form of ground water. All the rivers are flowing freely due to the existence of land on this planet. As we know very well that very little amount of water is present in the form of fresh water, which is directly consumed by human beings.

Approximately 70.8% of the earth surface is covered with water mainly in the form of ocean. It is estimated that the hydrosphere contains about 1360 million cubic km of water. Of this about 97% is in the oceans and inland seas, where the high salt content does not permit it for human consumption. Water flows through the landscape. The condition of the land surface affects the flow and quality of water. Land surface condition can be characterized at any location by the type of land use, soils, and climate and terrain conditions prevailing there. The effects on water resources can be measured by the water yield, flooding, groundwater, pollution, and sediment. The connection between land and water resources can thus be viewed on two axes i.e., land characteristics and water characteristics. Both of these characteristics are interconnected. Land characteristics tend to be relatively fixed in time, and spatially extensive. Water characteristics tend to be spatially concentrated, such as at points of measurement of stream flow or water quality [1].

Soil Resources

It is a matter of common observation that living organisms exhibit a very specific liking, disliking, preferences, or sort of repulsion towards a particular type of substratum. This is mainly because the substratum is typically the fundamental part of the habitat of the living organism. Soil is a common name for a highly generalized uppermost surface or layer of the earth that comes in most intimate contact with all living terrestrial biotic components, and it is a dynamic system that is capable of supporting the producers and consumers of the biosphere in particular, as a crucial component of our ecosphere.

A mixture of humus, inorganic materials, and organic debris that comes into direct contact with both biotic and abiotic factors makes up the soil, which is the topmost layer of our terrestrial environment and is formed by the weathering of rocks. Growing vegetation can add to the fragmentation process, which is a result of the interaction and co-action of light, temperature, water, air, wear and tear, and geological activities on the land surface. Soil Formation: Soil formation is a complex process that involves both biotic and abiotic components, with the latter factors playing a major role [2].

Physical and chemical processes such as cooling, freezing, glaciation, erosion, corrosion, and dissolution are all simultaneously aided by chemical processes such as hydration, hydrolysis, oxidation-reduction, carbonation, and chelation. Weathering is the process of reducing large, complex rocks into smaller units and dust. In reality, pedogenesis is primarily caused by biological processes carried out by lichens, algae, fungi, bacteria, protozoa, insects, mollusks, annelids, and other organisms that use larger parent rock material or parts of it for various biological processes. Pedogenesis or Soil Development - This includes changes in the raw forms of the rock material as a result of the combined effect of climatological, biological, and other abiotic factors, through various types.

This layer/profile creation process is largely influenced by the climate, particular geological up-levels, and activities of its biotic communities. It may be of recent origin, dating back just a few decades, or extremely old, dating back thousands of years. The O-horizon is made up of fresh or only partially decomposed organic matter and is very variable in most of its physico-chemical characteristics. It is extremely active and full of biotic activity. This is the top layer, and only recently-fallen leaves, dead animals, fruits, and other items of this kind are present there.

Consequently, it contains partially decomposed organic matter as well as biotic populations of small insects, fungi, bacteria, and other organisms that are essential to the decomposition of organic matter. The Oe zone is located just below the Oi zone, where decomposition of organic matter has already started. A-Horizon is the first mineral layer and is rich in accumulated organic matter. It is also known as the zone of eluviation or the layer of downward loss. This zone also exhibits a downward loss of various soluble salts, clay, iron, etc., and typically lower layers of this zone are richer in components like silica.

1. **A1 zone:** Also known as the humic layer, this layer is dark and abundant in organic material; in this zone, amorphous and finely divided organic matter combines with mineral matter.

2. **A2 zone:** In this zone, typically raw mineral material of light colors is found and has less organic material.

i. B-Horizon is the mineral strata of the soil, immediately below the
ii. A-Horizon, and is rich in iron, aluminum compounds, etc. along with clay and humus.
iii. C-Horizon is primarily composed of weathered or broken down parental rock material in loose texture.
iv. R-Horizon is the name of the parent rock zone from which that particular soil has evolved.

Hard substratums require strong and small feet, provide better running surfaces, but prevent burrowing, as in the case of rodents, rats, rabbits, earthworms, etc. They also have low water retention capacities and poor humus, all of which contribute to the great diversity in animal distribution and adaptation [3], [4].

In general, it is accurate to state that a nation is what nature has created it to be. A nation with abundant natural resources, like India, might nonetheless be impoverished due to certain negative circumstances. But it won't be simple to make a nation affluent if nature hasn't been kind and hasn't provided it with many resources. It goes without saying that the kind of soil, the temperature, and the amount of rainfall affect the quality and quantity of agricultural riches in a nation. In turn, agricultural goods serve as the fundamental foundation of commerce and industry. The availability of abundant coal deposits or waterfalls from which power may be produced is another factor influencing industrial growth. Industry localization relies on the accessibility of electricity and raw resources, both of which are primarily governed by nature. The geography of a nation has a significant impact on the availability of affordable and effective transportation. Thus, natural resources, or "land," as economists refer to them, have an impact on all facets of economic activity, including agriculture, commerce, and industry. The land or environment has a decisive impact on shaping a people's way of life, vocations, and level of living.

Agriculture

Agriculture has always been connected to the production of vital food crops. Forestry, dairy, fruit farming, poultry, beekeeping, mushroom and arbitrary cultivation are now included under agriculture, in addition to farming. Today, agriculture is recognized to include all aspects of agricultural and livestock processing, marketing, and distribution. So, the production, processing, marketing, and distribution of agricultural goods may be referred to as agriculture. A particular economy's whole existence depends on agriculture. The foundation of each nation's economic structure is its agriculture, as shown in Figure 1. A fairly big proportion of the population has access to work possibilities in agriculture in addition to supplying food and raw materials. The importance of agriculture as a land resource is listed below:

1. Source of livelihood
2. Contribution to national revenue and GDP.
3. Supply of food as well as fodder
4. Significance to the International Trade
5. Marketable surplus
6. Source of raw material

7. Foreign exchange resources
8. Great employment opportunities
9. Food Security

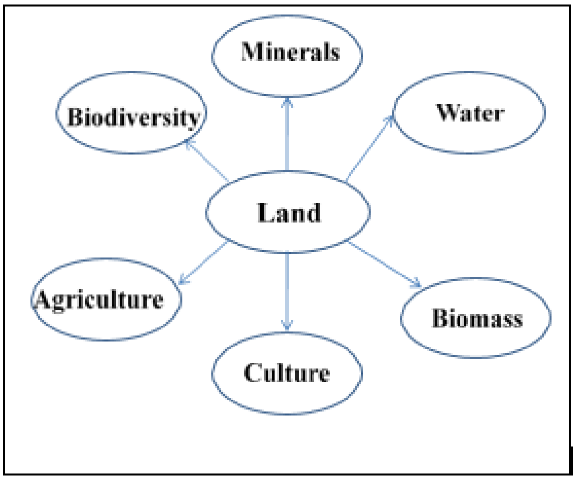

Figure 1: Illustrate the Resources provided by land.

Minerals

Due to the fact that they provide raw materials to the primary, secondary, and tertiary sectors of the economy, mineral resources are among the most significant natural resources that determine the industrial and economic growth of a nation. Mineral usage predates civilisation itself. Humanity's essential requirements, including food, clothing, shelter, and energy, are met by minerals. You will examine the mineral resources in unit II in depth. "Minerals are important to man. The food he consumes, the clothing he wears, nay even his own body are all composed of a variety of minerals and even of their salts [5].

Biomass

The reliance on biomass energy, especially for cooking and heating, is strongest in sub-Saharan Africa where the majority of the population lacks access to, or cannot afford to pay for, alternatives such as modern fossil fuels or electricity. While biomass plays a crucial role in meeting basic energy needs and has the potential to contribute to climate change, Africa is the world's largest consumer of biomass energy.

Water

Water is another very important resource of land. It is important because it is needed for life to exist. Many uses of water include agricultural, industrial, household, recreational and environmental activities. Virtually all of these human uses require fresh water. Only 2.5% of water on the Earth is fresh water, and over two thirds of this is frozen in glaciers and polar ice caps. Water demand already exceeds supply in many parts of the world, and many more areas are expected to experience this imbalance in the near future. It is estimated that 70% of world-wide water use is for irrigation in agriculture. Climate change will have significant impacts on water resources around the world because of the close connections between the climate and hydrologic cycle. Due to the expanding human population competition for water is growing such that many of the world's major aquifers are becoming depleted. Many pollutants threaten water supplies, but the most widespread, especially in underdeveloped countries, is the discharge of raw sewage into natural waters.

Culture

There is a great relationship between land resources and social, mental, emotional, physical, and spiritual wellness of human beings; these all things provide harmony and balance in the society and lead to the development of a culture. The culture of any place always depends on the land resources availability as the resources will be available in and around of any society, the culture develops on the basis of these resources.

Biodiversity

Biodiversity, which can be defined as the variety and variability among living things, is another crucial resource for maintaining the ecosystem because without the different ecosystem components performing their jobs properly, it would be impossible for natural cycles to occur. Biodiversity has many benefits for the environment, some of which are listed below. Food security, nutritional health, and sustainable livelihoods are all supported by biodiversity. Important resources for medical research are provided by biodiversity. Infectious illness regulation and management include biodiversity.

Other Relevance

The earth's land area, which is around 140 million square kilometers, makes up less than a third of its total area, yet it is nonetheless essential to human survival since it is land that: Conserve the genetic variety and biodiversity of the land Regulates the water and carbon cycle serves as a repository for essential resources including minerals, fossil fuels, and groundwater. Turns into a landfill for solid and liquid waste establishes the foundation for transportation and habitation operations. Even more significant, the topsoil, which is just a few centimeters deep, is the life support system for all species, including humans.

Land Resources are at Risk

In Leopold's book Land Ethics, he claimed that the earth functions as a boat with two types of boats, rich and poor, and that people are moving from one side of the boat to the other. Land provides us with a variety of resources to meet our daily needs, but in our overloaded desires, we forgot that land has a specific carrying capacity [6], [7].

State of the World's Land Surface

The main causes of this degradation are deforestation, fuel wood consumption, overgrazing, agricultural mismanagement, the establishment of industries, and urbanization. According to UN studies, 23% of all usable land has been degraded to such an extent that its productivity has been affected. Soil erosion and degradation, which occurs due to loss of green cover, strong winds, chemical pollution etc., have severe effects on the environment. They affect the soil's ability to act as a buffer and a filter of pollutants, regulator of water and nitrogen cycles, habitat for biodiversity etc. About one quarter land highly degraded. Another 8 percent are moderately degraded, 36 percent are stable or slightly degraded and 10 percent are ranked as "improving." The remaining shares of the earth's land surface are either bare or covered by inland water bodies.

Large parts of all continents are experiencing land degradation, with particularly high incidences down the west coast of the Americas, across Mediterranean region of Southern Europe and North Africa, across the Sahel and the Horn of Africa, and throughout Asia. The greatest threat is the loss of soil quality, followed by biodiversity loss and water resources depletion. Some 1.6 billion hectares of the world's best, most productive lands are currently used to grow crops. Parts of these land areas are being degraded through farming practices that result in water and wind erosion, the loss of organic matter, topsoil compaction, salinization and soil pollution, and nutrient loss.

According to its intended use, land may be divided into many categories, including net sown area, forest, current and other fallows, cultivable wasteland, various tree crops and groves, permanent pasture and grazing land, land used for non-agricultural purposes, and barren and uncultivable land. Land resources may be categorized as Forest Resources, Mineral Resources, Cropland Resources, Water Resources, and Soil Resources based on their availability. The land's forest resources are a crucial resource since they serve human needs while carrying out ecological tasks. In addition to supplying human civilization food, housing, cover, fodder, and wood fiber, forests provide a variety of ecological services. The Latin word "Foris," which meaning outdoors, is where the term "forest" originates. Forest cover refers to any areas having an area more than one hectare and a canopy density of more than 10%, regardless of ownership or legal status. Mineral resources are generally understood to be concentrated forms of elements, chemical compounds, minerals, or rock that may be exploited to create a sustainable commodity. Areas utilized for the cultivation of harvestable crops are referred to as cropland [8].

There are two types of cropland: cultivated and uncultivated. Human bodies contain over 70% water, which is a vital component of life. Water is the essence of life, and there is a serious situation with water supplies at the moment. On this planet, there is a scarcity of drinkable water. Therefore, the most valuable resource on land is water. All elements, both living and nonliving, are supported by land. The soil is the topmost layer of our terrestrial environment. It is created by the weathering of rocks and is a mixture of humus, inorganic materials, and organic debris. The soil serves as a surface for the growth of vegetation and a habitat for living things while also coming into direct contact with biotic and abiotic factors.

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CHAPTER 3

THE RESOURCES MINERAL

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Mineral resources may be found in many different locations on earth and are essential to preserving humankind's way of living. You will come across specific terminology and ideas about mineral resources in this subject. Natural resources such as minerals are priceless. They serve as important raw materials for many fundamental industries and are a significant source of development. India has a long history of mining minerals going back to the Harappan period. The broad availability of minerals serves as a foundation for the expansion and development of India's mining industry. Huge resources of several metallic and nonmetallic minerals are abundant in the nation. The Indian economy's mining industry is a significant sector. Since gaining independence, there has been a noticeable increase in the amount and price of minerals produced.

Humans consume almost all of the earth's resources in a variety of ways. Metals are needed to make machines, sand and gravel are needed to build roads and buildings, silicon and nickel are needed to make computer chips, gypsum and limestone are needed to make concrete, clay is needed to make ceramics, gold, silver, copper, and aluminum are needed to make electric circuits, and diamonds and corundum are needed to make jewelry and abrasives. A volume of rock rich in one or more beneficial minerals is referred to as a mineral resource. In this context, the term "mineral" may apply to any substance that originates from the earth and is used to describe a valuable material.

Mineral Resources

Mineral resources are one of the many different kinds of land resources and their significance that you covered in unit one, and they are crucial for meeting human society's needs as people have become more civilized. For the development and proper operation of the bodies of all species, including humans and plants, certain minerals are necessary. Humans utilize a broad range of minerals in the modern world, many of them in significant quantities to support their industry-based civilisation. The existence of these resources, which might be thought of as a nonrenewable legacy from the geologic past, is directly reliant on current culture. Although the earth's natural processes continue to create fresh reserves, they do so too slowly for humans to utilise them right now. Minerals are therefore a limited and depleting resource, regardless matter how great the deposit of a particular material.

Minerals are naturally occurring, solid, inorganic substances. Any material that is naturally found in the earth's crust and is not generated from animal or plant stuff is referred to as a mineral. The earth has undergone a number of geological processes during its development. These processes took millions to billions of years to create the minerals, making them nonrenewable. Mineral extraction and processing are done via mining. There are over 100 minerals that are mined, including nonmetals like stone, sand, and salt as well as metals like gold, iron, copper, and aluminum. In addition to minerals, coal is another important resource that is mined. Mineral resources are necessary, naturally occurring minerals or commodities that are found in large quantities on or in the earth and are exploited for their prospective applications or their intrinsic worth. The two main types of mineral resources are metallic and nonmetallic, and they come in a variety of forms and dimensions. Minerals like Gold, Silver, Tin, Copper, Lead, Zinc, Iron, Nickel, Chromium, and Aluminium are a few examples of metallic resources. Minerals like sand, gravel, gypsum, halite, uranium, jewels, and stones are examples of nonmetallic resources[1], [2].

Examples:

Pegmatite water and other substances or elements do not penetrate the minerals that have been separated from the magma during the process of fractional crystallization. The residue created after this process will be silica and water-rich, as well as containing additional rare earth elements. Some components necessary for creating a phosphorescent image tube for a color television may be extracted from this residue. Lithium, tantalum, niobium, boron, beryllium, gold, and uranium are some of them. Due to their high weight, minerals will crystallize from a magma body; certain heavy minerals will sink to the bottom of the magma chamber. Therefore, the layer that has developed at the bottom of the magma chamber will have a larger concentration of these elements.

Deposit of hydrothermal ore

The concentrated hot aqueous fluid travels through the pore space and crack in rocks. The hydrothermal ore deposit may happen in a specific location when the ground water flows deep and warms up by coming into touch with an igneous rock. If the cooling happens quickly after coming into touch with an igneous body, this led to the buildup of elements in the rocks.

Massive Sulfide Deposits:

These deposits develop in the foci of oceanic spreading. Hot fluids that circulate above the magma chamber at the oceanic ridge on earth have the power to extract numerous elements from the rocks they travel through, including Cu, S, Zn, and others. When these heated fluids return to the ocean bottom and come into touch with cool groundwater or ocean water, metals like sulfide minerals and Chalcopyrite quickly precipitate.

Deposits of Ore Bound to Strata

Lake sediments and sea sediments also include this kind of deposition. Lead, zinc, and copper may all be present in greater concentrations in this sort of mineral. The term "strata bound deposition" refers to this idea. Chemical precipitation, sometimes referred to as sedimentary ore deposition, concentrates substances in lake or ocean water.

Resources for Metallic Minerals

Metallic mineral resources are those that have a metallic sheen, include metals in their natural state, and may be melted to create new goods. In addition, they are chemically composed of metals, which can only be extracted by mining. Gold, Silver, Copper, Tin, Iron, Lead, Zinc, Nickel, Chromium, and Aluminum are a few examples of metallic minerals.

Resources from Nonmetallic Minerals

Nonmetallic mineral resources are those that have a chemical makeup devoid of metals that can be extracted yet nevertheless have a nonmetallic sheen or luster. Sand, stone, gravel, clay, gypsum halite, and uranium are a few examples of nonmetallic mineral resources. These minerals may be recycled for intermediate use by grinding, combining, cutting, and reshaping.

Mineral Resource for Fuel

The world's primary mineral resources are fuels, which include fossil fuels like coal, crude oil, and natural gas. Because they are typically derived from the remains of dead plants and animals, these fuels are also known as fossil fuels and are made of hydrocarbons. Burning fossil fuels produces a lot of thermal energy, which is extremely useful. Fossil fuels, when used properly, have replaced water-driven mills and the burning of peat or wood for heat, as well as permitted large-scale industrial growth[3].

Once a deposit has been found on land or in the water, mineral resources are mined; this process is often carried out using a variety of techniques, most frequently employing opencast quarrying, underground mining, or pumping. The method of mining is determined by the kind of mineral found. Like oil and gas, salt is often recovered by pumping; in this situation, the salt is dissolved in water and pumped from underground. These minerals are taken out of the earth and then refined and processed into a form that can be used by humans on a regular basis. The removal of any undesired impurities and further processing to boost the concentration of the valuable mineral are typically steps in the mining process. Near the mine, metallic minerals may be melted or processed to produce metal, or the concentrate may be sent to another location for further processing.

Before consumption, oil and gas are also refined further. The rich minerals that are included in a mineral deposit must then be retrieved from the earth once it has been discovered. The cost and bulk of a mineral will determine how it is moved from one area to another. Transporting heavy, inexpensive minerals like aggregates across long distances is not cost-effective, while valuable minerals like metals or oil may be flown or sent worldwide.

Environmental Issues Caused by Mining

All of the local flora is destroyed by surface mining, and the dust that is released into the air pollutes the surrounding environment. Large craters are left behind once the material is dug out. The water table drops when hills that serve as watersheds are mined away, as in the case of the Aravallis in Rajasthan. The hills serve as the area's watershed. Unfortunately, the hills also include vast reserves of valuable minerals, such as talc, marble, and granite. A total of 1, 75,000 people are employed in the mining industry and other connected businesses, while another 600,000 people rely on mining activities in some way. 9700 industrial facilities related to mining are located in Rajasthan alone. Over the last 20 years, since large-scale mining got started, the amount of forest cover has decreased by 90%. A cone-shaped depression is created when the mines descend below the subsurface water table and begin to draw water from the surroundings, causing the land to dry out and have an impact on agriculture. The natural drainage system and ground water table of the whole area have reportedly been negatively impacted over time, according to several studies. The amount of pollution has also grown. Rivers and other bodies of water get contaminated during the processing of the mined material, which is often done on-site and uses a lot of water, cyanide, and mercury. The amount of waste material, such as slag, is often far more than what is useable and is left behind as unattractive unstable piles. Heap leach gold mining, in which rivers of cyanide are poured over enormous mounds of low grade ore to extract the metal, is of special concern. Precious metal mining is more intensive and ubiquitous now than it was centuries before, with far-reaching effects. Heap leach mining is expanding and has already resulted in a number of catastrophic mishaps.

The majority of the world's nations completely depend on mineral resources for their economic growth and development. Mineral resources are useful and natural materials for producing value commodities; they play a significant part in our economy. The majority of industrial items that we use in modern civilization, including trains, roads, vehicles, computers, plastics, pots, cans, metals, coins, and fertilizers, are made from refined minerals. The earth's crust contains mineral resources in all regions of the globe, but they are often found in very tiny quantities and can only be exploited locally with the aid of certain geological processes.

Mineral resources are nevertheless divided into groups according to their chemical make-up, color, hardness, affinities, and elements. Different types of minerals are extracted from the earth in various ways, and before exploration can begin, specific mineral deposits and availability are typically surveyed using methods such as remote sensing, gravity meters, magnetometers, and geochemical surveys[4], [5].

India's Mineral Resources

Given that India has such a large variety of plants, animals, and minerals, we may argue that it is a naturally wealthy country. There are several throughout the nation. Due to its diverse geological structure, India possesses a great diversity of mineral resources. Minerals may be divided into two primary groups, metallic and non-metallic, based on their chemical and physical characteristics. Metals are obtained from metallic minerals. Metal is produced from iron ore, copper, and gold, which fall under this group. Ferrous and non-ferrous metallic minerals are subdivided further into the category of metallic minerals. All minerals that include iron are classified as ferrous, including iron ore itself, whereas minerals that do not contain iron are classified as non-ferrous, including copper, bauxite, and other materials. Non-metallic minerals are either of biological origin, such as coal and petroleum, which are formed from buried plant and animal life, or inorganic in origin. Other non-metallic mineral kinds, such as mica, limestone, graphite, etc., are inorganic in nature.

Uses and Importance of Mineral Resources

As you may already be aware, minerals play a crucial part in human existence. The mineral may be divided into three categories: metallic, nonmetallic, and energy resources based on its chemical makeup and usage. Metals such as aluminum, copper, gold, iron, lead, nickel, thorium, uranium, and zinc are highly significant and utilized in a variety of ways, including as construction materials, alloys, electrical products, money, jewelry, nuclear weapons, and energy production.

The nonmetallic category includes materials used in the steel industry, abrasives, fertilizers, chemicals, feldspar, fluorspar, nitrates, sulfur, and other applications such as roofing and insulation. Minerals are used as an energy source to produce compressed natural gas, diesel, and gasoline for various types of vehicles. Oil is used for heating, generating electricity, and manufacturing steel whereas coal is utilized for both[6].

These strategic metals are those required for highly specialized purposes like national security, military, or aerospace that have no economically viable domestic supply and must be imported from other countries that may not be friendly. The U.S. government has stored these metals, which also include manganese, cobalt, platinum, and chromium, in case shipments are interrupted. The number of reserves and consumption rates determine how long the world's mineral resources will survive. Some mineral resources will soon run out; for instance, the world's supplies of Pb, Zn, and gold will probably do so in around 30 years. U. S. Pt, Ni, Co, Mn, and Cr resources in less than a year. In order to continue using rare minerals, it will be necessary to find new sources, raise prices to make difficult-to-find sources more lucrative, boost efficiency, practice conservation or recycling, switch to other materials, or just stop using them altogether.

Resources in Mineral Danger

The growth of mineral resources and sustainability first seem to be at odds with one another. In a strict sense, mining is unsustainable since it depletes limited resources. For instance, the quantity of copper in the earth's crust is limited, and with each unit that is removed, more of the overall copper resource base is put to use. Therefore, it might be claimed that if we keep mining, the minerals would ultimately run out. However, this viewpoint disregards the fluctuations in mineral supply. In actuality, the non-renewable nature of minerals may not be as restrictive as it first seems. The advantages of mining are far more sustainable than they first seem to be due to five considerations. First, mining corporations continuously renew, amplify, or "sustain" their reserves via the processes of exploration and development. The mineral resources still exist in the earth's crust are far less than the current reserves. Exploration and development result in the identification of newly undiscovered mineral resources as well as—potentially even more crucially additional reserves at active mines and established deposits. Exploration technology advancements lower the cost of discovery while increasing the rate of mineral deposit discovery. By combining structural projections with advantageous stratigraphic horizons in volcanic rocks, predictive models for enormous sulfide deposits, for instance, enable targeting of fully buried deposits[7].

Mining of Sustainable Minerals

"Mining that is financially viable; socially responsible; environmentally, technically, and scientifically sound; with a long-term view of development; uses mineral resources optimally; and ensures sustainable post-closure land uses" is the definition of sustainable mining. The establishment of long-term, sincere, mutually beneficial relationships based on honesty, collaboration, and openness between the government, communities, and miners is another. Mining operations that have wide societal support are more likely to provide social and economic value that will persist beyond the life of the mine. Technically, scientifically, and environmentally sound, suggesting good management of natural resources. And the last one makes best use of mineral resources[8], [9].

You have learned that a mineral resource is a volume of rock that is enriched in one or more usable materials as a result of the numerous elements of mineral resources that have been covered in this lesson. In this context, the term "mineral" may apply to any substance that originates from the Earth and is used to describe a valuable material. Any material that is naturally found in the earth's crust and is not generated from animal or plant stuff is referred to as a mineral. Metallic mineral resources are those that include metal in their natural state, have a metallic sheen to them, and may be melted to produce new goods. Nonmetallic mineral resources are those that have a chemical makeup devoid of metals that can be extracted yet nevertheless have a nonmetallic sheen or luster.

The primary mineral resources in the world are those used to produce fuel; such examples include fossil fuels like coal, crude oil, and natural gas. Once a deposit has been found on land or in the water, mineral resources are mined; this process is often carried out using a variety of techniques, most frequently employing opencast quarrying, underground mining, or pumping. The method of mining is determined by the kind of mineral found. Like oil and gas, salt is often recovered by pumping; in this situation, the salt is dissolved in water and pumped from underground. All of the local flora is destroyed by surface mining, and the dust that is released into the air pollutes the surrounding environment. Large craters are left behind once the material is dug out. The water table drops when hills that serve as watersheds are mined, as in the case of the Aravallis in Rajasthan[10].

The metallic minerals, such as aluminum, copper, gold, iron, lead, nickel, thorium, uranium, and zinc, are highly significant and utilized in a variety of ways. The nonmetallic category includes materials used in the steel industry, abrasives, fertilizers, chemicals, feldspar, fluorspar, nitrates, sulfur, and other applications such as roofing and insulation. Minerals are used as an energy source to produce compressed natural gas, diesel, and gasoline for various types of vehicles. In a strict sense, mining is unsustainable since it depletes limited resources. For instance, the quantity of copper in the earth's crust is limited, and with each unit that is removed, more of the overall copper resource base is put to use.

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CHAPTER 4

WETLANDS' IMPORTANCE AND PURPOSES

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Land has a variety of natural resources, including energy resources, mineral resources, water resources, and resources for forests and land. One of the most valuable resources available is water, which is crucial for all ecosystems and all living things in addition to humans. In seas and oceans, there is around 97.5% salt water, with the remaining 2.5% being considered freshwater. The majority of freshwater resources, such as rivers, lakes, ponds, wetlands, groundwater, etc., serve as water sources. A wetland is a piece of land that has been heavily flooded. Except for Antarctica, every continent on earth has wetlands. These wetlands are important from an ecological, social, and economic standpoint. Wetlands replenish the ground water, serve as a barrier against flooding, boost ecological variety, etc. As a result, these wetlands must be conserved, protected, and preserved on a local, national, and international scale. Every year on February 2, there is a celebration known as World Wetlands Day to raise public awareness of the value of wetlands. Wetlands are a crucial reservoir not just for humans but also for the sustainability of the environment. You will discover the many kinds and significance of wetlands, wetlands in India, and case studies of the Sundarbans and the Bharatpur Sanctuary in this subject.

Wetlands have long been used by humans. Human civilisation first appeared close to marshes or bodies of water. In more recent years, especially around 1960, the term "wetlands" has come into widespread usage and refers to all types of land areas which are characteristically high in water content. The majority of these civilizations were founded on the coasts, along rivers, or in prime agricultural lands and rich forests, all of which possess areas which can be called "wetlands." Wetlands have been defined by a number of organizations; some of the key definitions are included below: "Areas of marsh, fen, peatland, or water, whether natural or artificial, permanent or temporary, with water that is static, flowing, fresh, brackish, or salt, including areas of marine water, the depth of which at low tide does not exceed six meters," is how the Ramsar Convention defines wetlands.

According to the Tidal Wetlands Act, "wetlands" are defined as areas that are adjacent to or are submerged by tidal waters, including but not limited to banks, bogs, salt marshes, swamps, meadows, flats, or other lowlands subject to tidal action, including those areas that were once connected to tidal waters, and whose surface is at or below an elevation of one foot above local extreme high water. "Wetland may incorporate riparian and coastal regions adjacent to wetlands and islands or bodies of marine water deeper than 6 meters at low tide lying within the wetlands," according to the Ramsar treaty[1].

i. **Bog:** A bog is a section of moist, spongy ground that contains soil comprised of decomposed plant debris. Bogs commonly surround bodies of open water, have a poorly drained, typically acid region rich in plant wastes, and have distinctive vegetation. Bogs are mostly populated with sedges, heaths, and sphagnum.

ii. **Bottom:** The surface underneath any body of water; often Bottoms, also known as Bottom land.

iii. **Everglade:** Everglade is a marshy area with multiple branching canals and clumps of tall grass. Everglades often have sawgrass and are sometimes surrounded by slowly flowing water. Lowland that is entirely or partly submerged in water is known as a fen. Health is a plot of undeveloped, open terrain that is overgrown with plants. A tract of wasteland is a large amount of open, uncultivated land that is generally flat, has poor drainage, coarse soil, and a peaty or humus-rich surface.

iv. **Marsh:** A marsh is a low, damp area that is often flooded, usually devoid of trees, and characterized by grasses, sedges, and rushes. A territory, location, district, etc. that has wetlands such as marshes, swamps, or bogs is referred to as a marshland.

v. **Meadow:** Areas of grassland utilized for grazing are known as meadows. In a highland location close to the timber line, there are these expanses of grassland. The majority of the vegetation in these meadows is grass, particularly a stretch of wet low-lying, mostly flat grassland. A tract of wet, marshy terrain is referred to as a mire. Other names for this kind of ground include bogs, marshes, thick muck, and wet, slimy soil. Moor: A moor is a large area of bare, peaty, waste ground that is often covered with heath and is typical of high latitudes and elevations with poor drainage. These are often sedge- and grass-dominated and peaty[2], [3].

Typically, areas between land and water are where marine and coastal wetlands may be found. There are no rivers that affect these marshes. The open ocean, the continental shelf, beaches, rocky shorelines, lagoons, and shallow coral reefs are examples of marine wetlands. These maritime wetlands feature water that is much salinized and are not heavily influenced by rivers or estuaries. In these wetlands, mangroves, mudflats, or sabkhas may be found. Estuarine: Estuarine wetlands are found when freshwater combines with salt water from the ocean. Mangroves and saltmarsh wetlands are examples of estuarine wetlands. There are tidal habitats in deep water with a variety of fresh, brackish, and marine water chemistry. Salt and brackish marshes, intertidal mudflats, mangrove swamps, bays, sounds, and coastal rivers are examples of estuarine wetlands.

Riverine: Rivers and streams, as well as other bodies of moving water, are the source of riverine wetlands. This restricted method eliminates floodplains next to the channel and habitats with more than 0.5% salinity. Freshwater perennial streams are made up of the deep-water habitat enclosed inside a channel.

Lacustrine: Lakes and ponds are connected to lacustrine wetlands. Submerged macrophytes, diatoms, algae, herbs, and floating ferns predominate in these wetlands. These wetlands consist of inland water bodies that are at least 20 acres in size, located in topographic depressions, devoid of emergent trees and shrubs, and have less than 30% plant cover. Lakes, bigger ponds, sloughs, lochs, bayous, and other similar water bodies are examples of this kind of wetland. Ocean-derived salts may be found in these wetlands. These wetlands are non-tidal wetlands that have an emergent plant cover that is mostly made up of things like trees, bushes, moss, etc. The majority of marshes, floodplains, bogs, and swamps are classified as palustrine wetlands. These wetlands' water chemistry is typically fresh but may sometimes be brackish and salty. In order to create an environmental continuity over the surface of the globe, all of the aforementioned wetlands may interact with one another.

Classification of Peat Land

The word "peatland" refers to wetlands where there has been significant peat buildup of at least one foot . The peatland substrate is a biologically constructed organic structure. Many wetlands all around the globe depend on peat for their survival. Peat is a kind of plant material that has partially decomposed and contains more than 65% organic content. Grass, plants, bushes, and trees may all help to accumulate organic waste. Peat builds up over time, forming the substrate, affecting the groundwater, and changing the wetland's surface morphology. Several features are regarded as crucial for classifying the various kinds of peatlands. Floristics, physiognomy, morphology, hydrology, stratigraphy, chemistry, and peat features are some of these traits. The following describes these people: Floristics: Characteristics of plants that may be substituted for or utilized as indicators of environmental conditions include plant composition of vegetative communities[4].

Fens in depressions that get surface runoff and/or ground-water recharge from nearby mineral-soil sources are known as minerotrophic fens. Compared to ombrotrophic, there are more nutrients available and more alkaline water, which are favorable for a variety of plants and lead to a higher floralistic diversity. Wetlands are moist, and because they are wetlands due to how the water table is situated in relation to the surface of the earth, it follows that there is subsurface water movement. Wetland, according to MoEFCC, is a collective word for a variety of water features, including lakes, marshes, swamps, estuaries, tidal flats, river flood plains, and mangroves. Freshwater, which is the source of life for all living things, including humans, is a resource that is fast running out and is thus likely to be the subject of conflict due to conflicting demands.

Wetlands' Importance and Purposes

Wetlands are significant ecosystems that provide many advantages to humans, fish, and animals. These include flood management, groundwater recharge, animal habitat provision, water storage, water quality protection, and improvement. Wetlands' distinct and particular qualities lead to these vital roles. However, wetlands are one of the planet's most productive ecosystems. These wetlands are similar to coral reefs and rain forests. These wetland habitats may include a wide range of species of bacteria, plants, insects, amphibians, reptiles, birds, fish, and mammals. The plants and animals that live in each wetland are influenced by the climate, the form of the terrain, the geology, and the amount and velocity of water. Food webs are the dynamic, intricate interactions between the many creatures that live in wetlands.

You might think of wetlands as "biological supermarkets." They provide food that attracts a variety of animal species. These animals spend all or a portion of their life cycle in wetlands. Detritus is a term used to describe the small organic particles that are formed when dead plant leaves and stems decompose in water. This enriched material is consumed by aquatic insects, shellfish, and small fish, which in turn provide food for higher tropic level animals like predatory fish, amphibians, reptiles, aquatic birds, and mammals. A wetland's activities and the importance of those functions to people relies on a complex web of interactions with the other ecosystems in the watershed. A watershed is a region of land where water, sediments, and dissolved substances flow from higher altitudes to a common low-lying outlet or basin, such as a river, lake, lake, underlying aquifer, or estuary[5].

Wetlands are incredibly significant and are essential to the watershed's ecosystem. Stalled water, nutrient-rich soil, and primary productivity all work together to promote the development of the plants and animals that are the source of our food. During mating seasons, many species of birds and animals move to these wetlands in search of food, water, and shelter. The global cycles for water, nitrogen, and sulfur include variety in microbial, plant, and animal life. Researchers found that maintaining the atmosphere may be another purpose of wetlands. Wetlands, as was already established, store carbon in their soil and plant communities rather than releasing it as carbon dioxide into the sky. Consequently, wetlands aid in reducing global warming. Due to the variety of services and tasks they provide, they are quite important.

Wetlands are unpredictable to people since they have a big impact on the water's quality. The wetlands are the literal kidneys of the earth's ecosystem. Through leaching, percolation, etc., they replenish the ground water. Wetlands serve as a kind of water filtering system. They also catch surface runoff and remove harmful contaminants from the water. Wetlands help local populations with water storage and supply. As you are aware, these wetlands are natural ecosystems that can hold plenty of water. The wetlands' water is of excellent quality and is utilized for a variety of tasks, including irrigation, hydropower production, drinking, and other uses. The wetlands absorb water from precipitation or rainfall and release it.

i. **Flood control:** Large amounts of water are stored in wetlands, which then gently release the water onto the earth's surface. Wetland vegetation slows the flow of water, and it distributes and channels water across flood plains more gradually. As a result, these wetlands are crucial for flood prevention[6].

ii. **Animal and Plant Habitats:** Wetland habitats are essential for a variety of fish, bird, and other wild animal species. Wild animals may find a variety of macro- and microhabitats, food, water, cover, and other essential elements in wetlands. Wetlands are home to a wide variety of animals, including migratory waterfowl, wood ducks, cattail swamps, songbirds, beavers, muskrats, geese, swans, and others.

iii. **Recreation, research, and tourism:** Wetlands provide locals and researchers recreational and research possibilities. Wetlands are stunning examples of earth's ecosystems, making them tourist attractions. As you may already be aware, the tourism sector is one of the fastest expanding in the globe. The tourist industry's fastest expanding activity is eco-friendly or naturally oriented leisure. Wetlands are thus crucial from an economic standpoint.

iv. **Food Resource:** Wetlands are significant food supplies. In addition to providing food for wild animals, these wetland habitats also benefit humans. Many freshwater fish species such as Labeo rohita, Catla catla, Cirrhinus mrigala, Channa punctatus, Channa marulius, Heteropneusteus fossils, Mystus cavasius, Mystus aor, Mystus, tengara, Mystus mystus, Clarias batrachus, Rita rita, Xenetodon cancilla, are main edible fish species of these ecosystems. On the other hand, wetlands are home to a large number of marine species. In many regions of the globe, these species are also edible and are used as food. The wetlands were further described in the convention as "areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 m.

An Examination of the Sundarbans

One of the many and most fruitful natural groups are mangroves. Different ecological roles are provided by these mangroves. These are found where the land, the sea, and the sea meet the land. They serve as a barrier against cyclones and tsunamis, among other natural disasters. They maintain pure offshore seas by retaining terrestrial silt and recycling nutrients, which in turn encourages phytoplankton photosynthetic activity and the expansion and durability of coral reefs. They provide food for several creatures, including humans, and serve as a crucial habitat. Because of these combined ecosystem services, mangroves are also very valuable economically. These ecosystems also operate as carbon sinks, either storing carbon. Mangroves are seriously endangered everywhere in the globe due to human and natural forces, with current worldwide yearly loss rates of 1%–2%[7].

One of the seven natural wonders of the world, the Sundarbans is a vast forest in the Bay of Bengal area. Sundarbans are found in the Ganga, Meghna, and Brahmaputra river systems' delta area. Districts in West Bengal, India, as well as districts in Bangladesh are covered by this unique forest. The Sundarbans are situated in the Bay of Bengal's Ganga, Brahmaputra, and Meghna river delta. It is made up of a network of mudflats and islands that are divided by anastomotic channels and tidal waterways and are produced by the accumulated sediment loads that these rivers bring from their Himalayan sources. Location of the Sundarbans: 21°32′ to 22°40′N and 88°05′ to 89°51′E. 10,000 km2 of these woods are covered, 62% of which are in Bangladesh and 38% in India. The Sundarbans has a tropical climate with a dry season from November to April. Between 1500 and 2000 mm of precipitation fall on the Sundarbans in total each year. Tropical cyclones and lesser tidal events often affect the region during the monsoon season, resulting in catastrophic flooding and wind damage. Minimum and highest seasonal average temperatures range from 12 to 35 degrees Celsius, respectively[8], [9].

They provide defense against the harshest consequences of natural disasters, including cyclones and tsunamis. They may operate as a massive long-term carbon sink, store terrestrial sediments, and provide as habitat for a variety of wildlife, including the endangered and protected Royal Bengal tiger. The Sundarbans are significant on both a national and international scale. The Sundarban has had effects from human activity, climate change, and severe weather occurrences during the past two to three centuries. Forests in the Sundarbans are more incrementally impacted by human activity. These actions may degrade the land, raise the sea level, and increase salinity. Due to the effect of climatic variables, path-dependent development regimes, and environmental elements, Sundarbans conservation is very challenging[10].

The Sundarbans are crucial to the nation's socioeconomic well-being in addition to its ecological significance. It is the nation's greatest single source of forest resources. As you are aware, the forest supplies industry with raw resources. Along with typical forest goods like timber, fuelwood, pulpwood, etc., the Sundarbans frequently see large-scale harvests of non-wood forest products such thatching materials, honey, beeswax, fish, and crab and mollusc resources. The Sundarbans' vegetated tidal flats serve as an important environment that produces food and cleans water.

The forest also serves as a storm barrier, coastline stabilizer, nutrient and sediment trap, and energy storage system. Last but not least, the Sundarbans provide a visual draw to travelers on a local, national, and international scale. Many companies, including those that manufacture newspapers, matches, hardboard, boats, and furniture, depend only on the raw resources found in the Sundarbans environment. For over half a million disadvantaged coastal residents, the diverse goods assist to provide major job and income prospects.

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CHAPTER 5

CHANGES IN LAND COVER

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As we learned in the previous chapter, land resources are highly important to humans. Since the dawn of civilization, humans have engaged in a variety of land-based activities, with the results today visible in the shape of dam, building, and road construction. As the human population grows, numerous land use plans have been developed to meet human needs for basic services. Natural resources are used in a variety of ways by humans, making them either directly or indirectly reliant on them. However, due to man's rapid development, he has forgotten his moral obligation and has focused only on his own well-being. As a result, all of these activities have placed a heavy burden on the planet, resulting in the diversity of the modern concrete jungle. The area was utilized for farming, orchards, and forestry colonies. We quickly ran out of land resources due to the high demand of our large population, and today the situation is much worse since we have turned a significant portion of agricultural land into development projects for human welfare. Without any consideration for the future, we have degraded highly productive land in this phenomena. The moment has come to reconsider how natural resource management should be done. The nation's infrastructure is growing quickly. Industrialization has to pick up speed, particularly if it is centered on manufacturing. Urbanization must occur. For all of these procedures, land is a must. In addition, the government must purchase land for a number of uses.

This high population expansion is largely attributable to declines in famine-related fatalities and newborn mortality rates. Additionally, improvements in public health and medicine have raised life expectancies in many nations across the globe. Human progress has been maintained and the economy has improved thanks to industrialization. However, this fast population expansion and development has happened unevenly over the globe at the same time that the world's natural resources are being used in an unsustainable manner, which has a negative influence on the environment. The main causes of land uses are human activities and choices made on the land. In actuality, the direct cause of land cover change is human activity, which results from a variety of societal aims. Analyzing the underlying dynamics that drive or restrain the related human actions is necessary to comprehend these societal aims.

Changes in land cover and eventually land use are also caused by biophysical driving factors and shocks. Delhi's industrial and economic growth has been very fast during the last 20 years. As the National Capital Territory, Delhi is one of the major hubs for business, trade, and manufacturing in northern India. In reality, industrial growth in Delhi and the surrounding regions has occurred rather haphazardly and without much forethought, which has resulted in growing population and environmental issues. In actuality, non-agricultural activities have taken over around 60% of its most productive agricultural land. This regional plan's main goal was to locate economic activity related to significant environmental and demographic concerns beyond the NCT area.

The widespread exploitation of the earth's biotic and abiotic resources by human activities is changing the surface of the planet at a pace that has never been seen before. Due to the close connections between land cover energy exchange and biogeochemical cycles, the cumulative effects of land use change may affect the structure and operation of ecosystems, which in turn can have an impact on the climate system. Land disturbances may have a long-term impact on ecosystem and climatic processes due to the long time scale dynamics of ecosystem processes.

Large-scale vegetation changes have been caused by climatic variations in the earth's orbit around the sun across geological time periods. For instance, the little ice age that ended in the 1700s destroyed Iceland's forests, and 6000 years ago, an area of lush greenery that is today the Sahara desert replaced it. On a shorter time period, fires, herbivore activity, extreme weather, and human activity have changed the earth's landscape and created new ecosystems. The use of fire to preserve open environment and the demise of great Pleistocene creatures following the advent of humans in North America are two examples of how ancient human actions had an influence on the landscape [1].

The past 300 years have seen a worldwide expansion and intensification of human impact on the land. The increase of agribusiness and deforestation are both major worldwide environmental problems today. The world's land area is used for agriculture to the tune of 40%, while tropical deforestation, particularly in the Amazon basin and Southeast Asia, continues unabatedly. Such significant shifts in land use and cover have the potential to alter regional and global climate, degrade freshwater supplies contribute to air pollution, fragmented habitats result in biodiversity loss and species extinction, and they may also promote the spread of infectious diseases. It is abundantly obvious that changing land use and land cover is one of the main causes of climatic change.

The term "land cover" describes the surface of the earth's atmosphere, including the distribution of plants, water, soil, and other natural elements. The term "land use" describes how people have utilized the land through time. Despite the fact that land use is often inferred from the cover, the words land use and land cover are interchangeable because of their close relationship. Important elements that impact ecosystem conditions and functioning include land use/cover and its dynamics. The biogeochemical cycle has been significantly altered over the past 40 years by land use cover change dynamics, which has also affected soil quality, biodiversity, soil carbon and water cycling, the capacity of biological systems to support human needs, and ultimately the climate itself. Paved roads, grass, trees, and rooftops make up the land cover. Knowing the quantity and distribution of roofs, pavement, grass, and trees would be crucial for a hydrologic analysis of rainfall-runoff characteristics. A more comprehensive word for human alteration of the earth's surface is land cover change, sometimes known as land change. A clear correlation exists between the rate of land cover change and the advancement of human civilisation. A significant portion of the land has been altered by humans to grow food and other necessities, which has an impact on the ecosystem [2].

Land use is the term for human activities that take place on a piece of land. Humans alter the landscape, particularly in metropolitan areas. The ecology and the economy are affected by these developments. The land cover can be divided into six categories: rangeland, forest, cropland, parks and reserves, wetland mountain desert, and urban land. Humans use these land areas for various purposes, including housing, grazing livestock, gathering wood for building materials, growing plants, and recreation. Therefore, the increasing urbanization opens up possibilities for new urban growth, but it has also resulted in significant losses of arable land, forest area, and water bodies. Long considered a sign of regional economic vigor, urban development, in particular the transfer of residential and commercial property to rural regions on the outskirts of metropolitan centres, is. However, the expenses of infrastructure and the repercussions on the environment, such as the deterioration of air and water quality, the loss of agriculture, and the destruction of forests, outweigh its advantages.

Urbanization is the process of moving from rural to urban regions in order to get additional amenities not found in the neighboring rural areas' periphery. Urban areas are undoubtedly a gift to human civilization provided they are developed in a regulated, organized, and well-planned way. However, uncontrolled urbanization might pose major environmental risks. More over half of the world's population lived in cities in 2008, and by 2030, that number is projected to rise to 81%. There is a growing interest in comprehending the effects of global urbanization on a wide range of environmental factors, including loss of arable land, habitat destruction, decline in natural vegetation cover, and climate at local, regional, and global scales. This is due to the acceleration of global urbanization in both intensity and area.

Developmental activities have either made rural regions more urban or drawn people from rural areas to the cities. Both circumstances are hazardous to the environment because people are moving from their homes in rural regions to new homes in cities, often leaving their village homes abandoned. Urbanization was ultimately brought about by the extreme population pressure; the people living there have significantly impacted the local ecosystem. These locations can no longer provide for basic human needs, much alone those for survival, since pollution levels are rising quickly and the groundwater is being extracted more quickly. Urban sprawl significantly contributes to the shift in land use in emerging nations with high rates of urbanization. People move in large numbers from rural to urban regions as well as from minor to larger cities before arriving at metropolises like Delhi, Bangalore, Mumbai, etc. in fast-developing nations like India. With the beginning of the industrial revolution in the 1970s and the subsequent globalization in the 1990s, the pace of urbanization in India accelerated. Over the last 25 years, urban agriculture has become more widespread across the world. Urban house gardens, for instance, have been a great success in Havana, Cuba, and Sao Paulo, Brazil, respectively. Urban agriculture helps recycle organic waste and offers locally produced food, but if chemicals are utilized, it might pollute the land and water [3].

Industrialization

Along with industrialization, there are significant changes in how civilization interacts with the environment. Socio-metabolic transition, which has been referred to as the change from an agricultural to an industrial society, causes fundamentally different patterns in social metabolism. Urban sprawl has resulted from the population growth in cities brought on by industrialization, which has been one of the key causes in the development of the nations. According to Kavzolu, industrialization and urbanization may have detrimental consequences on the environment, especially on fundamental ecosystems, animal habitat, and global biodiversity since they often proceed in unplanned or unregulated ways in developing nations. Land use change does not happen consistently throughout time or space. In reality, it is now evident that the so-called "forest transition" has actually been paused or even reversed in various regions of the globe due to the huge conversion of natural land cover.

Food, bio-based energy, and fiber goods are in greater demand, which is a challenge for agriculture. According to several research, agricultural methods will change to meet the rising need. The integration of environmental and sociocultural services into agricultural output, however, faces difficulties due to adaptability. Crop selection, crop rotation, crop use, and production intensification are just a few ways that farmers may adjust their practices to meet the rising demand. The removal of yield-limiting constraints such crop water availability by technological means is a trend, as is the growing use of agricultural biomass as a renewable energy source. The latter is often encouraged by laws passed by governments [4].

Additionally, the use of irrigation to boost and stabilize agricultural production is gaining popularity, particularly in regions with little rainfall and soils with low water-holding capacities. Additional explanations for these shifts include the potential for more unpredictable precipitation patterns as a result of climate change and the rising water requirements of new, more productive cultivars. For instance, irrigation is already close to being economically feasible in the German federal state of Brandenburg at the present market rates for agricultural commodities. Additionally, there is a link between irrigation and the generation of bio-energy: when farmers provide fuel to power plants, it is increasingly crucial to maintain constant yields even during drought years. Agriculture serves several purposes. This indicates that it supports public goods such as the character of rural landscapes and its ecosystem services in addition to commercial output. The simplistic goal of agricultural management, which focuses only on maximizing financial gains, may result in erosion, a loss of water quality, a drop in biodiversity, and a reduction in socio-cultural services. Despite the fact that these services are visible at a geographical scale higher than a farm, the decision-making at the farm level determines how visible they are. Therefore, maintaining a balance between agriculture's economic production needs and its provision of environmental and social services is essential for sustainable development. Policies are put in place to reward farmers for providing public goods, which encourages them to maintain this balance [5], [6].

Expanding Population

Using district level data for India from 1951 to 1991, it is possible to evaluate the relationships between population increase, socioeconomic development, and agricultural intensification. For every census year between 1951 and 1991, the results overwhelmingly show that population pressure has positive and substantial impacts on each aspect of agricultural intensification. According to study results for the years 1961–1991 population growth is positively correlated with changes in each of the three intensification aspects. Even after adjusting for regional variations in agro climatic conditions and levels of social and economic development, the findings remain valid. In recent decades, there has been a dramatic shift in how land is used worldwide. Although a number of complicated variables are significant at smaller sizes, population increase is often used as a stand-in for land use change. Population increase has put additional strain on land resources due to the rising need for food. An undesirable state known as overpopulation occurs when there are more people on Earth than the planet can support. The gap between natality and mortality in populations is overpopulation. Environmental deterioration is brought on by a variety of factors, including population expansion and other effects. For emerging nations like India, the effects of this population expansion are seen in three different ways.

Effects of Changing Land Cover

You probably already know that changes in land cover are a result of physical and biological processes, and that these changes are mirrored in changes in human population and behavior. Land directly suffers from human activity's alteration of the land's layout. The two activities population growth or decline will have an impact on the land cover. However, the situation of today is changing due to population growth. Enhancing the fundamental infrastructure that gives people access to housing, food, and clothing is unquestionably necessary today. Changes in land use and cover have existed from the beginning of time and are both a direct and indirect result of human activities taken to protect vital resources. The massive clearing and control of the earth's terrestrial surface that takes place today may have begun with the burning of regions to increase the availability of wild animals and escalated rapidly with the advent of agriculture. The density of people on Earth has risen as a result of industrialization, especially in metropolitan areas. The land cover is changing quickly as the population grows, seriously affecting the land cover [7], [8].

Biodiversity

The phenomena of variety and variability in living organisms is known as biodiversity. The biodiversity has been significantly reduced on a large portion of the land since it has been turned into a concrete jungle. The major consequences of land cover change on habitat are habitat loss and habitat degradation. Humans have drastically altered the country's vegetation and colonized a variety of geographical masses. The once-forested area has been developed for farming or residential use. Due to the habitat diversion, a variety of plants and animals have been left without homes. Since humans need only the most basic amenities to thrive on our planet, and since these needs are entirely met by exploiting biodiversity, growing populations are the primary driver of biodiversity loss. The fragmentation of existing habitat into smaller sections, which exposes forest borders to outside influences and reduces core habitat space, has an effect on the habitat appropriateness of forests and other ecosystems around those under intense use. Smaller habitat regions often sustain fewer species, and fragmentation may result in local or even global extinction for species that need undisturbed core habitat. Deforestation is the main source of this shift, particularly when it is followed by agriculture since tillage disturbs the soil and causes more soil carbon to be released. The primary changes in the terrestrial emissions of other greenhouse gases, including methane, and nitrous oxide, are also caused by changes in land cover. .

Changes in land cover also affect albedo, which is a key factor in the global climate system and affects how sunlight reflects off of the ground surface. In essence, this phenomena is reliant on land uses. If the land is covered with plants, water, structures, or other forms of development. The region of concern has a varied albedo because flora has a different albedo than water and other bare ground. In addition to altering surface albedo, these changes also affected the evaporative heat transfer from vegetation and the surface's roughness, which affects heat transfer between the relatively stagnant layer of air at the earth's surface and the troposphere. The urban heat island effect, which causes metropolitan regions to experience higher temperatures than surrounding rural areas, is an illustration of this [9].

Pollution

Water, soil, and air pollution are all significantly influenced by changes in land use and cover. Land clearance for agriculture and the collection of woody biomass may be the earliest of them. When vegetation is removed, soils become much more susceptible to wind and water erosion, particularly on steep terrain, and when fire is present, pollutants are also released into the atmosphere. It also lessens the viability of the land for future agricultural use and releases enormous amounts of phosphorus, nitrogen, and sediments into streams and other aquatic ecosystems, all of which have detrimental effects. . Even worse effects from mining may result, such as contamination from hazardous metals released during the operation. The contamination of surface water by runoff and erosion and the pollution of groundwater by the leaching of excess nitrogen have both significantly grown as a result of modern agricultural methods, which involve high inputs of nitrogen and phosphorus fertilizers. . Agriculture also releases other agricultural chemicals, such as pesticides and herbicides, into ground and surface waterways, and in certain situations, these chemicals continue to be pollutants in the soil. Burning biomass from plants to remove weeds and crop wastes from agricultural fields continues to be a significant source of local air pollution and is now prohibited in many places.

Other outcomes

The long-term threat to the production of food and other necessities posed by the conversion of productive land to non-productive uses, such as the conversion of agricultural land to residential use and the degradation of rangeland by overgrazing, may be the most significant issue for the majority of the human population on Earth. The process of converting a natural environment into a social ecology is called land use. The process is difficult since it incorporates the effects of society, economics, and environment. Natural conditions have an impact on land usage in many ways, but they are also constrained by a variety of technological, economic, and natural conditions. The most immediate and important contributing element to the change in land cover is land use. There will be significant strain on the world's land due to population growth, especially in Africa and Asia. To feed the population, more intensive land usage will be required. The conversion of grasslands and forests may also add more area to agriculture. We have looked at a number of elements of land cover change in this course. You have already discovered that the distribution of plant, water, soil, and other physical elements on Earth's surface, together referred to as land cover, defines the physical properties of that surface. The use of land by people and their habitats is referred to as land use.

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CHAPTER 6

LAND DEGRADATION'S CAUSES AND EFFECTS

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As you may already be aware, nature has been extraordinarily generous to humans from the dawn of time. The abundance of natural resources on our planet, including the forest, land, water, minerals, and energy, ensures that people have all they need to survive. Millions of species find a home in these natural resources, which benefit humans as well as other species. The existence of water, land, minerals, energy, wind, forests, and animals on earth predated the emergence of man by a very long time. As a result, human beings have used these natural resources since they first appeared in the natural world. The earth's other species, including humans, have relied heavily on the land as a resource. Land resources include forest, agricultural land, mountainous, hilly, plain, and plateau terrain, among others. Humans need land resources because they supply agricultural land, forest land, and other types of land utilized for forestry, agriculture, mining, and other purposes. In addition to these uses, land also serves as a food source and habitat for other plants and animals, a watershed or reservoir, a storage area for solid waste produced by human activity, and a place to build homes, businesses, roads, and other infrastructure.

Land is divided into many categories according to its natural state, including agriculture, wasteland, wetlands, desert dry land, rangeland, grassland, and snowy land. Land degradation, biodiversity loss, environmental pollution, and solid waste creation are major environmental problems in India. One of the critical global challenges is land degradation, and it will continue to be a significant global issue in the future. Resources found on land are crucial not just from an economic standpoint but also from an ecological and social one. As you are aware, the land is where many significant biogeochemical cycles, including those involving carbon, nitrogen, sulphur, phosphorus, calcium, and magnesium, are completed. However, during the last several decades, humans have overused the land. The land is being degraded as a result of anthropogenic or man-made activities, which might include solid waste disposal, mining, improper farming methods, population boom, urbanization, and industrialisation. Natural catastrophes including earthquakes, landslides, floods, and forest fires may also cause land degradation. Land degradation is also brought on by overgrazing, desertification, and water logging. 2.5% of the world's land area is made up by the 328.73 million hectares that make up India's total geographic area, of which 304.89 million hectares are the reported area and Only 264.5 million hectares are used for a variety of uses [1].

You probably already know that India is a nation of villages, home to around 16% of the world's population of people and 20% of its animals. About 178 million hectares of India's entire geographical area have already been turned into wastelands. About 40 million hectares of degraded forest are also included in this. About 144 million hectares of the country's entire land area is arable, however 80.6 million hectares of that area have been degraded by poor agricultural methods, making about 56% of the total. Only 11% of the overall geographic area is now covered in deep forests. As was already noted, the primary causes of land degradation in

India include the population growth, bad agricultural methods, urbanization, industrialization, deforestation, overgrazing, shifting agriculture, mining operations, dumping of solid waste, etc. In addition to lowering land productivity, land degradation has negative effects on the environment, society, and the economy. The loss of biodiversity, illnesses, soil acidification, soil alkalization, and other effects are among these effects. It is clearly evident from the foregoing description that the majority of land resources have been degraded, are degrading, or are in danger of degrading. You will gain in-depth information on the many causes and effects of land degradation in this course.

Land Degradation Definitions

Varied international bodies/agencies, scientists, and others have provided varied definitions of land degradation. According to the OECD, "Land degradation is the decline or loss of biological or economic productivity due to natural processes, land uses, or other human-made activities and habitation patterns, such as land pollution, soil erosion, and the eradication of vegetation cover." According to the United Nations Convention to Combat Desertification, "Desertification is the most severe form of land degradation and is a global development and environment issue." The production of food, livelihoods, and other ecosystem services are all severely impacted by "land degradation caused by extreme drought and human activities that degrade the quality of land," according to the World Health Organization. Land degradation is "the process of deterioration of soil or loss of fertility of soil in which physical, chemical and biological properties are degraded due to natural or manmade activities," or "It is the process of reducing the productive potential of the land, including its major uses, its farming systems, and its value as an economic resource [2], [3]."

Land Degradation Factors

Although there are many reasons for land degradation, you need first be aware of its many types. The first category on this list is physical degradation, which is a decline in the physical characteristics of the soil. Landscape, soil structure, texture, bulk density, moisture content, water holding capacity, etc. are examples of physical qualities. Chemical deterioration, which mostly results from nutrient deficiency, is the second category. Chlorides, nitrates, phosphates, magnesium, zinc, calcium, and other nutrients are among the chemical characteristics of land. The third kind of land degradation is biological degradation, which is the destruction of soil biodiversity and soil organic matter. All of the plants and animals that live in terrestrial ecosystems are considered to be part of the biological qualities of land.

Causes of Land Degradation by Nature

Land Degradation Factors

In other terms, land degradation is the process of soil deterioration or loss of soil fertility in which physical, chemical, and biological qualities are lost as a result of natural or artificial activity. Although there are many reasons for land degradation, you need first be aware of its many types. The first category on this list is physical degradation, which is a decline in the physical characteristics of the soil. Landscape, soil structure, texture, bulk density, moisture content, water holding capacity, etc. are examples of physical qualities. Chemical deterioration, which mostly results from nutrient deficiency, is the second category. Chlorides, nitrates, phosphates, magnesium, zinc, calcium, and other nutrients are among the chemical characteristics of land. The third kind of land degradation is biological degradation, which is the destruction of soil biodiversity and soil organic matter. All of the plants and animals that live in terrestrial ecosystems are considered to be part of the biological qualities of land [4].

Causes of Land Degradation by Nature

The causes of land degradation may be divided into two categories: human and natural. The following list of natural causes of land degradation is not exhaustive.

Earthquake: A seismic wave is created when there is a rapid release of energy in the lithosphere, causing the earth's surface to shake. The most terrifying natural occurrence in human history is an earthquake. Near the epicenter, where the vibrations start and spread, the most damage often happens. Land deterioration may result from an earthquake. Because it has the ability to alter the topography of any region. Land is eventually destroyed by landslides, severe flooding, and earthquakes.

Landslides: A landslide is a sudden slide of soil and worn rock particles down a slope brought on by gravity. In mountainous areas, particularly those that are located along riverbanks or close to the shore, landslides are frequent occurrences. Sooner or later, landslides occur as a consequence of the constant erosion caused by water movement. Landslides are considerably exacerbated by river flooding, particularly during dry spells. Landslides often occur in India's northern and northern-eastern Himalayan areas. Landslides can also brought on by human activity. Landslides degrade the environment by removing rich soil from the ground. Effects of Landslides: Landslides often occur in mountainous or hilly terrain. Landslides are thought to be natural. The earth's terrain is drastically altered by landslides. Additionally, nitrogen deficiencies in the terrestrial ecology are brought on by landslides.

Flood: A flood occurs when there is an excessive amount of water and it covers normally dry ground. Flooding is the act of water covering territory that would not typically be covered by water, according to European Union Floods Directives. Flooding affects a 7.351 million acre area of the nation, according to the Central Water Commission and Ministry of Water Resources of the Government of India. Flooding is also to blame for the problems that 40.96 million people are experiencing, including the deaths of 1800 people, 85599 livestock, and 14 lakh people [5].

Deforestation

As you probably already know, woods are incredibly precious resources that not only help to keep the air clean but also help to maintain the fertility of the ground by dropping their leaves, which are rich in essential nutrients. According to the Forest Survey of India, a forest is any area larger than one hectare with a tree canopy density more than 10%. The area covered by forests in India is estimated to be 69.20 mha, or 21.02% of the nation's total geographic area, according to the FSI's State of Forest Report. With the aid of their roots, forests may help bind soil particles. Rhizosphere, or regions of roots, also maintains the soil's moisture and nutritional content. Additionally, the rhizosphere is home to several beneficial microorganisms, which are significant biotic communities in charge of recycling nutrients in soil. Loss of tree cover is referred to as "deforestation." Deforestation is the process of turning forest land into non-forest for a variety of reasons, including agricultural grazing, urbanization, industrialization, and the production of goods for sale, among others. The United Nations Environment Programmed estimates that each year, over 7.3 million hectares of dense tropical forests and about 14 hectares of closed forest are lost. Deforestation will thus have a negative impact on the land. Whether the deforestation is man-made or natural is unknown. According to the United Nations Framework Convention on Climate Change, subsistence farming accounts for 48% of deforestation, commercial agriculture for 32%, water logging for 14%, and the collection of fuel wood for 5%.

Deforestation is brought on by a number of factors, such as urbanization, industrialisation, agricultural practices, overexploitation, etc. Food, infrastructure, transportation, and other needs increase with population growth. Landslides: A landslide is a sudden slide of soil and worn rock particles down a slope brought on by gravity. In mountainous areas, particularly those that are located along riverbanks or close to the shore, landslides are frequent occurrences. Sooner or later, landslides occur as a consequence of the constant erosion caused by water movement. Landslides are considerably exacerbated by river flooding, particularly during dry spells. Landslides often occur in India's northern and northern-eastern Himalayan areas. Landslides can also brought on by human activity. Landslides degrade the environment by removing rich soil from the ground. Effects of Landslides: Landslides often occur in mountainous or hilly terrain. Landslides are thought to be natural. The earth's terrain is drastically altered by landslides. Additionally, nitrogen deficiencies in the terrestrial ecology are brought on by landslides [6].

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Due to building work, many woods throughout the globe have degraded. Forest area is also being converted to agricultural land to meet the need for food. Effects of Deforestation on Land: Deforestation and excessive grazing cause around 5.37 million tons of NPK to be lost from land each year in India. Deforestation has a number of negative impacts on the land, which are shown in Fig. 6 and further addressed below: It alters the composition and structure of the plant cover. Also impacted by deforestation is the hydrological cycle. Knowing that trees draw water from the earth and release it into the air, deforestation has caused the trees to stop evaporating water, which has led to significantly drier weather. Desertification and drought-like conditions are brought on by deforestation, which lowers the amount of water in the soil.

As you are aware, trees are valuable resources that safeguard the environment. Deforestation causes landslides, floods, and soil erosion. Surface water runoff, which travels significantly quicker than subterranean flows, is produced in deforested regions. Deforestation reduces the quality of the soil. Decrease in soil microbial populations as a result of declining soil organic matter levels. The physical characteristics of soil deteriorate due to deforestation. . Negative changes in soil nutrients brought on by deforestation include a decrease in the availability of the primary nutrients, micronutrient shortages, and nutrient imbalances. Deforestation reduces the soil's ability to control surface drainage. Along with contributing to erosion, this tendency lessens the top soil's fertility and capacity to replace essential minerals [7].

1. The decline in biodiversity is partly a result of deforestation.
2. Soil erosion is also a result of deforestation.
3. Flooding in a region is made more frequent by deforestation.

Desertification

The greatest danger to land deterioration is desertification. Tuberville used the phrase "desertification" to describe excessive soil erosion brought on by deforestation. Land deterioration known as desertification occurs in arid, semiarid, and dry sub humid regions. The United Nations defines desertification as "a process leading to reduced biological productivity with reduction in plant diversity in the lands, carrying capacity for livestock, in crop yields, and human." The UNO Conference on Desertification defined desertification as the "destruction of the biological potential of land, and can ultimately lead to desert like conditions." "Land degradation in arid, semi-arid, and dry sub-humid areas is a result of various factors, including climatic variation as well as human activities," according to United Nations Conference on Environment and Development. Rapid soil erosion caused by wind and water, a decline in species variety, and a decline in the overall productivity of terrestrial ecosystems are all symptoms of desertification [8].

Desertification's Effects

Floods, air pollution, storms, and other natural calamities may pollute the soil as a result of desertification. Desertification renders soil unusable for farming, which might result in significant food loss. Due to water shortages brought on by desertification, both human and animal life is in jeopardy. The soil changes as a result of desertification, and rain no longer reaches the soil. Plants don't obtain the necessary quantity of water for healthy growth as a consequence. One or two seasons of unproductive soil may be overcome, but if desertification episodes occur repeatedly, the land may entirely lose its fertility.

Aridity of soil is brought on by Desertification

The amount of moisture in the soil is reduced. As you are aware, moisture is crucial for organisms to survive. In wet soil, many different types of earthworms, bacteria, fungus, and other organisms exist. Plants and other biological communities also get water from dampness. All of the moisture from the land evaporates as a result of desertification.

Land loses biodiversity as a result of it. There are living organisms on land, including bacteria, fungus, molluscs, annelids, arthropods, and others. Some of these organisms are crucial to increasing the productivity of the land. Many species cannot thrive on land as a result of desertification. It lowers the land's production.

Over-Grazing

Overfeeding on grassland is referred to as overgrazing. Grazing cattle on vegetation before it has fully recovered from a grazing stage is another common practice. Additionally known as "intensive grazing." When pasture or vegetation are repeatedly removed from the land, overgrazing occurs. Pastures are overused as a consequence of the enormous expansion in the population of animals. This makes grass and other plants unviable, and a lack of vegetation cover causes soil erosion. It has a variety of impacts on the environment, particularly on soil and vegetation characteristics. Around the globe, excessive grazing is thought to be the main factor contributing to soil erosion. Overgrazing accounted for 35.8% of all kinds of deterioration, according to Oldman. It has been noted that a drop in legumes and an increase in forbs are the first symptoms of overgrazing [9].

Increased animal populations in dry areas lead to overgrazing, which accelerates runoff and soil erosion while reducing infiltration. The development of soil fertility is greatly influenced by soil microorganisms. Soil's water content and capacity for storing water, texture, size, and other factors are the main factors affecting the presence and activity of soil microorganisms. Significant grazing, which is often used to eradicate weeds, may degrade grasslands due to significant defoliation and trampling. Natural vegetation is lost as a result of overgrazing. Because herbivores produce in the environment where evolution developed them, animal grazing is a natural technique of using feed. This is the best, most affordable equipment for meat production on a worldwide scale. The population of cattle uses a significant percentage of grasslands. Although overgrazing harms soil and plants, changes are reversible. Low plant density results from heavy grazing pressure, which often promotes the introduction of undesirable species. But all of these detrimental effects are avoidable with good management techniques.

As you may already be aware, soil erosion is the process through which top soil is removed from the ground. Soil erosion is one of the most detrimental effects of overgrazing. As a result of the animals' grazing on even the tiniest, finest, and smallest new plant shoots, the trampling of many animals on a land will work to accelerate the death of plants and vegetation cover. The ground is left barren and exposed to severe weather, including high temperatures that crumble the rocks and carry the top soil away, as a result of the full destruction of flora. Animals also tend to congregate in certain places, such as those close to water supplies, and these places might deteriorate.

Land degradation may be brought on by overgrazing, which results in soil erosion. The situation is considerably worse in drier regions where a considerable portion of pasture and other land cover is lost, adding to the desertification that has been brought on by overgrazing. The greatest harm is done to the ecosystem when overgrazing and overstocking are coupled. The water cycle is disturbed by excessive or intensive grazing, which also reduces the capacity of ground water supplies to replenish themselves. Overgrazing is linked to pollution with nitrogen and phosphorus in several parts of the world.

Loss of important species:

Overgrazing has an impact on the diversity of plants and their ability for regeneration. The original pasture vegetations are made up of nutrient-dense plants and high-quality pastures. Even the root stocks that carry the reserve food or regeneration capability disintegrate when animals overgraze such pastures. As a result, less desirable plants and weeds that are more adaptive take their place. Due to their great adaptability and poor nutritional value, these secondary plant species supplant native, endemic, and beneficial species, resulting in the loss of important plant diversity. As was previously said, overgrazing is a major cause of desertification since it turns arable or pasture land into unproductive land, which results in food shortages and famine. The loss of vital nutrients makes the overgrazed soil unsuitable for producing food. Food availability is directly impacted by the decline in land productivity. Additionally, overgrazing results in financial loss.

Death of people and animals:

Long-term impacts of overgrazing include a lack of food, which may cause both humans and animals to perish from famine. Cattle lack the essential nutrients for survival when there is insufficient grass available for animals to graze. The animals' inability to grow weight that is healthy for them as a result of dietary deficits reduces their chances of surviving. When there is little food available for consumption, human survival rates and health are also impacted [10].

The disposal of solid waste

Solid waste disposal is another significant factor in the deterioration of the soil. Millions of tons of solid garbage are being dumped in and around the land as a result of the fast expansion of developing activities including urbanization and industrialisation. Almost all towns throughout the globe use the typical garbage disposal technique of dumping solid trash on land. Both biodegradable and non-biodegradable solid waste may exist, however non-biodegradable trash is often thought to be more damaging than biodegradable garbage.

Waste on Land: The following paragraphs provide an overview of the many consequences of solid waste on land.

Pollution: Solid waste, particularly hazardous, industrial, non-biodegradable, and radioactive waste, includes a variety of toxic substances. Any area that has solid trash put on it is seriously polluted. Solid waste disposal on public property contributes to air and water pollution in addition to soil degradation. Dumping locations are progressively becoming wasteland. Bio-magnification is the process by which the concentration of hazardous substances rises at each trophic level of the food chain. When dangerous chemicals are deposited in the soil, they may spread to plants and eventually to animals, where they can lead to a number of illnesses.

Loss of biodiversity: As you are likely aware, biodiversity refers to the variety and variability among all living things. Both on land and in water is biodiversity. One teaspoon of rich soil is said to hold 100 million bacteria.

Agribusiness Methods

As you are aware, agriculture is crucial to the prosperity of any country. India is mostly an agricultural nation. Since the beginning of time, India has used a wide range of agricultural methods, including subsistence farming, shifting cultivation, plantation agriculture, intensive farming, and dry agriculture, mixed and multiple agriculture, crop rotation, and terrace cultivation.

Fertilizers are currently necessary for boosting crop output, but their over usage is leading to an imbalance in the amount of certain nutrients in the soil. The vegetation is negatively impacted by this unevenness. The term "pesticides" refers to any substance that has biocidal effects on any other population and is used to manage undesirable herbaceous plants, woody plants, insects, rodents, molluscs, rodenticides, and herbicides. Additionally, overusing these pesticides causes certain pests to become more resistant and may result in the extinction of beneficial species like earthworms, insects, honeybees, and others. These species undoubtedly benefit terrestrial environments. As a result, using pesticides causes the soil's fertility to deteriorate. Increased soil alkalinity may be brought on by the excessive use of alkaline fertilizers like sodium nitrate and basic slag, which eventually lowers land yield.

Land-related effects of agricultural practices:

Land degradation is caused by a number of agricultural activities, including shifting cultivation, unplanned or unregulated irrigation, and the use of agrochemicals. These techniques have a variety of consequences on the land, and Fig. summarizes some of the more significant ones and farther down:

1. Nutrient deficiency in the soil brought on by intensive cultivation.
2. Imbalance in the soil's nutrient content, notably a lack of micronutrients.
3. Decrease in the soil's organic content.
4. Overgrazing and deforestation.
5. Decrease in subsurface water owing to overuse by crops with high water requirements.
6. Valuable species are lost.

Soil erosion caused by water is divided into the following categories:

Sheet Erosion: In this form of soil erosion, water is used to destroy the rich soil layer. Because a finer, more fertile soil layer is destroyed, it is a severe kind of soil erosion.

Rill erosion: This is the second kind of sheet erosion. Small, finger-like rills start to emerge on the soil in this kind of erosion. These little rills grow in quantity, depth, and width over time, rendering the ground unusable for agriculture or other useful uses.

Gully Erosion: In this kind of soil erosion, water travels along a specific downward route. Land becomes unusable for farming due to gully erosion. Soil erosion along river banks and beds occurs under this form of erosion. The majority of this kind of soil erosion happens in rivers, streams, and tributaries. Shore erosion, also known as coastal erosion, is the wearing away of material from a coastal profile, such as the loss of sand dunes, beaches, or silt by wave action, tidal currents, wave currents, or strong winds.

Negative Effects of Land Degradation

As you are aware, land degradation manifests itself in a variety of ways, including desertification, increased sediment loading of water bodies, and soil erosion. If we analyze the effects of land degradation, we will see that it is a significant problem on a global scale. Land degradation has a number of negative effects and results, some of the more significant of which are listed below:

Human Health Impact

One of the significant effects of land degradation is this. As you are aware, we completely rely on land resources for everything from transportation to forests to food and produce. Different kinds of harmful substances were introduced into the earth by humans. These wastes include metals and hazardous compounds that are harmful to people. For instance, plastic garbage may include phthalates, polyvinyl chloride, polycarbonate, acrylic, and polycarbonate, which are linked to cancer, skin conditions, respiratory issues, and birth problems. Chemical elements including cadmium, arsenic, mercury, cyanide, and chromium that are often found in industrial wastes from pesticides, fertilizers, and pharmaceuticals also have terrible impacts on human health. They include substances that may cause cancer, and they can also wreak havoc on the liver, kidneys, and lungs. Many harmful chemicals that are discharged into terrestrial ecosystems have the potential to bio-magnify their way to higher trophic levels, where they may cause illnesses in humans. Land pollution from industrial and agricultural waste causes a rise in dumping sites. These trash dumps also serve as a breeding ground for disease-carrying rodents, flies, mosquitoes, and birds. Therefore, pandemic illnesses like cholera, typhoid, amoebiasis, etc. may be brought on by land contamination. These waste disposal facilities include harmful compounds of a sort that may enter the human body via vegetables and other foods produced on polluted soils [11], [12].

Pollution

It is moreover one of the most significant effects of land degradation. Land pollution includes polluting of the soil. Soil contamination results from soil degradation caused by excessive fertilizer chemical usage or land degradation brought on by the disposal of hazardous chemicals and solid waste. The main factors that contribute to soil contamination are the impacts of agricultural and chemical wastes. Eventually, the fertility and vegetative cover of the land are lost.

Degradation of the land may result in various sorts of pollution. Air pollution is caused by the revolting aromas and odors that landfills and waste sites produce in the regions where they are situated. Residents have reported intense pungent odors in cities and towns that are close to large landfills and dump sites. The burning of solid trash, on the other hand, pollutes the air. Land pollution has the potential to spread in all directions and have a negative effect on the nearby habitats. It may pollute water and materially lower the quality of it. It occurs when surface rainfall runoff mostly transports chemicals and other harmful material from landfills and solid wastes into rivers. Leaching occurs concurrently, causing the dangerous compounds to seep into water sources and aquifers. Additionally, polluted water evaporates and returns to the atmosphere as contamination-filled precipitation. Coastal areas in marine ecosystems are especially vulnerable to pollution-related effects brought on by land degradation. Large sections of coastline that include reefs and expansive marine ecosystems may be impacted, providing proof of global effects. The major effect connecting land degradation with organic pollutants is the pollution of water, ecosystems, and food chains by agro-chemicals applied to or accumulating in soil.

Decrease in Biodiversity

The biodiversity has suffered greatly over the last several decades as a result of a continuous and significant threat to the loss of their natural environment. As you are aware, a significant danger to biological diversity is habitat loss. As a result of ongoing human economic activity, the land has been progressively degraded, pushing species to disperse and adapt to new environments. As a result, several species have perished while attempting to adapt, others have become extinct, and several more are now in danger of becoming extinct. Numerous organisms, including plants, bacteria, and arthropods, as well as nematodes, earthworms, and bacteria all live in the ecosystems of the land. These biological diversitys undoubtedly benefit the terrestrial ecology. The ecology becomes unfavorable for the survival of plants and animals within their interaction food chain when harmful substances are discharged on land. The toxins pollute the water and plants, which are subsequently eaten by lesser creatures, continuing the food chain up the ecosystem's food chain ladder. Biomagnifications, as the process is often called, are said to pose a severe danger to ecological sustainability. The richness of above- and below-ground biodiversity is irreparably reduced by disruption to terrestrial ecosystem services, which also negatively impacts the aquatic environment.

Nutrient Loss and Reduced Land Productivity

Numerous priceless nutrients are gone permanently along with this degraded substance. 6,000 Mt of soil are estimated to be lost from the Indian subcontinent per year. Both leaching and surface runoff cause the loss of many nutrients. The risk for leaching is very considerable in locations with strong water percolation. Nutrient-leaching losses are definitely influenced by the characteristics of the soil. Due to the higher rate of percolation and lesser nutrient-absorbing capacity of sandy soil compared to clay, there is a larger nutrient loss in sandy soil. Thus, in sandy soil, nutrients in the top soil are lost as a result of wind erosion as well as more quickly occurring leaching. Due to land degradation, a number of other items are lost, and it is difficult to determine their economic worth. Which are:

1. Fall in the output of wood and loss of pasture and feed.
2. Loss of plant and animal species.
3. Drying springs and other natural water sources, as well as a decline in the water level

In wells, are signs of a loss of water resource sites. In addition to physical, chemical, and biological deterioration, there is a loss of economic prospects when land is destroyed due to wind or water erosion. As a result, people move into cities and towns, which results in unplanned urbanization-related societal issues.

Financial loss

As you are aware, land is crucial to the economy. Globally, land deterioration costs millions of dollars. Additionally lowering air quality, landfills and waste sites may pose a risk to human health. Land degradation is also to blame for other things like illness, deforestation, and biodiversity loss in addition to the loss of agriculture. The price of restoring forests, biodiversity, and illnesses is incalculable. Some research revealed a connection between the tourist sector and land degradation. The amount of tourists visiting a place decreases as the land gets degraded. Land degradation thus increased the strain on the nation's economy as well as on local communities.

Natural catastrophes

Natural catastrophes such as earthquakes, floods, landslides, and landslips may be brought on by land degradation. The most common calamity in India is flooding. Water runoff rises as a result of soil degradation, creating flood-like conditions in a region. Floods may primarily be caused by unusually excessive rainfall, but their intensity, frequency, and severity are often worse in areas with degraded ground. However, many human activities have a detrimental impact on the capacity of the soil profile and land surface to absorb, store, and use rainwater. Land degradation also contributes to landslides because it decreases the soil's ability to retain water, which leads to landslips and landslides. The specifics of land-related dangers are covered in this course's unit 7. We have covered a wide range of the causes and effects of land degradation in this unit. You now know that land is a valuable resource that may exist as forest land, crop land, barren land, grass land, range land, snowy land, dry land, and waste land. Land degradation is the process through which a piece of land loses its ability to produce. There are two types of causes of land degradation: anthropogenic, or man-made, causes, and natural ones. Earthquake, landslides, land slips, and flood are a few examples of natural causes of land degradation. Deforestation, desertification, overgrazing, soil erosion, various agricultural methods, urbanization & industrialisation, mining, etc. are examples of anthropogenic causes of land degradation. Deforestation has a number of negative effects, including nitrogen loss in the soil, landslides, a reduction in soil moisture content and water holding capacity, floods, desertification, and more.

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CHAPTER 7

TYPES, AMOUNTS, CONSERVATION, AND MANAGEMENT OF WASTE LAND

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In this course's Unit-5, you learned about many causes and effects of land resources. Land is a terrestrial bio-productive habitat, as you are aware. It is made up of plants, soil, water, and other biotic groups. According to its ecological characteristics, the land may be divided into many types, including farmland, wasteland, desert dry land, wetland, range land, grassland, and snowy land. Land that is routinely planted with and collected from crops is known as cropland. Uncovered bedrock, talus, and other collections of rock without vegetation cones are characteristics of barren terrain. A wetland is a region of land where the soil is continually or seasonally soaked with moisture. Among wetlands are bogs, marshes, and swamps. The origin of wasteland areas may be attributed to a number of natural and human-made factors. Wasteland formation on land may occur naturally or as a result of human activity. Approximately 33% of the land is covered by woods, 26% by grasslands and pastures, 20% is desert, 10% is covered by wetlands, 10% is farmland, and 20% is urban land, according to the Food & Agriculture Organization of the United Nations. Land that has been utilized for production but has since been abandoned and is unsuitable for cultivation is referred to as wasteland. You will study about the definitions, categories, and origins of waste lands in this unit. Additionally, you will study waste land management and conservation.

Examples of Wasteland

Varied workers have given varied definitions of "wasteland." The following list includes some key definitions of wasteland: Wasteland is described as "land that has been used in the past but has since been abandoned and for which no other use has been found." Ministry of Food and Agriculture's Wasteland Survey and Reclamation Committee. Wastelands are "those lands which are either not available for cultivation or left out without being cultivated for some reason or another," according to India.

In other words, wasteland is unproductive or not being used to its full potential. Wasteland is defined as "those diverse lands which are currently not suitable for, or capable of, producing materials or services of value due to some constraints ranging from geo-environmental to socio-economic causes." The definition of a wasteland is a piece of land that has been left unused after being abandoned. Or the area that only generates 20% of its economic potential is called wasteland. Waste lands are those areas of land that are severely eroded, degraded, and environmentally unstable.

Different Waste Lands

Degraded woods, overgrazed land, eroded land, mountainous slopes, waterlogged marshy area, barren terrain, etc. may all be included in the wastelands. The many wastelands are produced as a result of artificial and natural forces. Although wasteland may potentially have value, some significant kinds of wasteland include:

1. Ruined land
2. Salinized terrain
3. flooded ground
4. Desert terrain

Land with degraded soil

There are several elements that contribute to the growth of wastelands. An examination of the variables demonstrates that man, nature, and technology combine in an unhealthy way to create wasteland. The capacity of man to use land via technical advancements also plays a significant part in the formation of wastelands, even if natural forces are important. Some significant physical parameters, including as relative relief, drainage density, slope, and the research area's geological foundation, are taken into account in order to identify and keep track of the causes of wasteland genesis[1], [2].

Wasteland Classifications for Identification

Culturable Wasteland: Land that has the capacity to establish a vegetative cover but is not being exploited as a result of various limitations of varied degrees, such as salinity, waterlogging, erosion, etc. These are cultivable wastelands that are being underutilized or improperly managed for a number of reasons, including State or private occupancy or having been designated as notified forest area. These culturable wastelands include undulating, saline, marshy, gullied, and surface water logged soils. Wastelands based on ecological constraints, such as degraded woods and pastures, changing agriculture zones, sand dunes or mining spoils, etc., are also included in this category.

Uncultivable Wasteland: Land that cannot be farmed for vegetative cover, such as stony glacier regions that are snow- and ice-covered. These are the barren wastelands, which cannot be planted. These include places that are snow- or glacier-covered, rocky, desolate terrain, and steeply sloping terrain. By negatively influencing the many ecosystem components that are either directly or indirectly reliant on that specific area, the formation of wastelands contributes to the degradation of the ecological equilibrium.

Genesis: Waste land development of waste land. There are several factors that contribute to the creation of waste land, including the use of forest products, overgrazing, development projects, abuse, and incorrect land management. Wasteland formation may occur naturally or as a result of manmade activity. The construction of gullied or voracious land, Jhum/shifting cultivation, and barren hill ridges are produced by artificial or human activity, while undulating upland, sandy land, snow-covered ground, and coastal salty land are created by natural processes. Four significant human activities are key factors in the creation of wastelands.

Deforestation, excessive grazing, excessive agriculture, and irrational irrigation are examples of these practices. The creation of waste land may also result from over use of natural resources, industrial and sewage waste, soil erosion, water logging, and other factors. Areas with Water: About 6 million hectares of India have water on them. The usual flow of air through the soil is hampered by water logging. In addition, it causes the soil to be highly salinized and contributes to the creation of waste land[3].

Shifting development: This kind of agriculture entails clearing thick forest to make room for agricultural development. Farmers search for another forest and carry out identical activities elsewhere after utilising the rich soil of that forest. Waste land was also created as a result of this sort of farming technique. This kind of agriculture is mostly practiced in the North-East states of India. Jhuming, also known as shifting cultivation, is a primitive kind of agriculture used in north-eastern Indian states and other areas where land availability is not a concern. On sloped or other types of terrain, the thick forest and other plants are removed, and crops are grown without any maintenance. It is necessary to locate appropriate land for intensive farming in order to manage jhumed land. For each unique location, an intense system of land use and cropping pattern will need to be developed that doesn't harm the environment, taking into account climatic conditions, soil characteristics, and other relevant elements.

Deforestation: A large quantity of land has been turned into waste land as a result of the fast loss of the forest. As you are aware, forests help to preserve the soil's fertility, but because of the increased demand for infrastructure and food, forest area is becoming wasteland. Many different species may be found in forests, and these species contribute to maintain the fertility of the soil. These priceless species cannot last longer due to deforestation. Deforestation is hence a significant contributor to the creation of wasteland. Overuse of agricultural chemicals: Agrochemicals are chemicals used in agriculture. Pesticides and fertilizers may be among these substances. Excessive usage of these agricultural chemicals is to blame for the creation of waste land as well as the extinction of precious species of land.

Industrial activities: A variety of companies discharge their wastewater into the land environment; sometimes, this effluent includes very harmful chemicals that kill the land's total biodiversity. Industrial waste materials render soil infertile and unproductive, resulting in the creation of wasteland.

Landslides: Landslides and landslips are a prevalent concern, particularly in mountainous locations, and they pose a danger to agricultural lands, roadways, and villagers. Weak geological formations, seismic disturbances, inappropriate land use, deforestation, mining, etc. are the primary causes of land slides. The formation of waste land is a result of landslides and landslips, which may alter the landscape's structure[4].

Land Conservation

Preservation, restoration, remediation, and mitigation are all examples of land conservation. In the preservation process, man should refrain from exploiting the land and its associated resources and instead keep them in their original state. Restoration is the process of returning local communities and ecosystems to their pre-restoration state. During the remediation process, we use a number of strategies to clean up the contaminated area. Bacteria, remediation, phyto-remediation, compost remediation, and myco-remediation are a few examples of these methods. Bio-remediation is the term used to refer to all of these methods. The Waste Land Development Board, which seeks to achieve the following goals, is responsible for waste land reclamation and development in our nation.

1. To enhance the marginal soils' quality and physical structure
2. To increase the supply of high-quality water needed to irrigate these locations
3. To avoid landslides, floods, and soil erosion

Some significant reclamation procedures are outlined below in order to preserve the biological resources of the land for sustainable usage.

Controlling Soil Erosion: As you are aware, soil erosion is the main cause of land deterioration and the creation of waste land. We can definitely preserve the land if we can stop the soil from eroding. Numerous agricultural practices, including contour farming, strip cropping, terracing, gully reclamation, and shelter belts, and help reduce soil erosion. Typically, contour farming occurs on the slope. Strip cropping, which divides a field of crops into long, narrow strips to stop soil erosion, is another efficient farming technique. Terracing is used on a sloping surface. Surface runoff and soil erosion are reduced by this technique. Gullies are a symptom of soil being destroyed quickly. If gullies develop on the land, we should plant fast-growing crops there. Plants known as "shatter belts" block the effects of wind and water and lessen the likelihood of soil erosion. Plantation, livestock management, and flood control are further methods for controlling soil erosion.

Controlling landslides: Landslides are also the cause of the creation of wasteland. It is viewed as both a natural catastrophe and a man-made calamity. Landslides may occur naturally owing to high rainfall, geographic factors, and gravity; however, man-made causes of landslides include deforestation, mining, and agricultural activities. The manmade activities that cause landslides may be reduced. We can considerably preserve the land if we can stop landslides. Hillslopes are often where landslides happen. Plantation may prevent slides, thus we should have as much vegetation on slopes as we can. Additionally, in landslide-prone locations, excessive or uncontrolled irrigation must be avoided[5].

Reforestation: Forests are crucial to the preservation of land. The presence of forests helps keep the land fruitful and the soil hydrated. Reforestation also aids in the sustainable use of land. 5 million hectares of waste land need to be recovered by afforestation, according to the Ministry of Environment, Forests, and Climate Change. Enhance agricultural methods: Modern, sustainable, and suitable farming techniques may be used to save land. Farmers utilize bio-fertilizers, bio-insecticides, bio-pesticides, and micro-irrigation methods in these sustainable agricultural practices. Solid Waste Management: It is important to manage solid waste if we want to preserve our land. As is well known, solid waste contributes to the development of wasteland and includes very dangerous compounds that progressively reduce the soil's quality. We can considerably save the land resources if we manage the solid waste generated by cities and businesses[6], [7].

Wasteland Management

Land management is a procedure that enables us to control the land resource and develop it for both the current and future generations. If we take into account the causes of wasteland generics, we can manage the land. There are several techniques that are undoubtedly useful for managing land.

These techniques are explained below:

The greatest method for preserving land resources is forest conservation. Heavy soil erosion is a result of trees, particularly in steep areas, degrading more and more. Due to the deteriorated terrain, it results in a severe scarcity of firewood and productivity loss. The National Forest Policy made explicit the many uses of forests and community rights, including Protection of forest resources without their active involvement is not advisable, because forests are important to the survival strategies of the poor. The primary systems in the division's Wildlife section are dedicated to the preservation, improvement, and development of wildlife and its ecosystems. The primary method for preserving biodiversity is to preserve diverse habitats in representative ecosystems. 103 National Parks, 503 Wildlife Sanctuaries, 30 Tiger Reserves, and 18 Biosphere Reserves make up a vast network that has helped to preserve these species and forest resources as well. Finally, environmental resource management must be viewed as a measure to ensure the best possible use of India's limited natural resources and to protect and preserve the environment in which we live. It is commonly known that a sizable portion of the nation erodes as a result of water eroding soil. The slope, type of soil, amount of rainfall, farming strategy, and land management are the key contributors to this erosion. According to the severity of soil erosion, it may be divided into;

1. Erosion of sheets
2. Erosion in a gully
3. Ravines

Based on these classifications, appropriate actions to prevent runoff and soil loss may be advised. Planting erosive-resistant crops, such legumes and grasses, adopting an appropriate cropping system, management, and the application of mulches are cultural practices designed to reduce runoff and soil loss. By lengthening the duration of concentration and slowing the runoff's velocity, mechanical interventions like bunding, terracing, etc. are shown to be beneficial in preventing runoff and soil loss. For controlling erosion, contour cultivation and graded trenching are also useful. Development of the grassland ecosystem is another crucial component in managing the land's resources. The soil is held together by grass, which also prevents soil erosion. Grasses like Cenchrus ciliaris, Lasiurus sindicus, and others have been proven to be excellent in stopping soil drifting. It implies that eroded lands in locations where wind erosion is likely might be held back beneath the grasses. We can manage the land resources greatly if we create a grassland ecosystem[8], [9].

Strip cropping: This type of land management is very beneficial. A particularly efficient strategy for reducing wind erosion is the field strip cropping of grain legumes or cereals in grass strips, which was developed at the Central Arid Zone Research Institute. Mulching: Research has shown that mulching is particularly good in reducing wind erosion. Agro-horticultural forestry on waste land: This approach combines horticultural crops with food and vegetable crops. This approach is more prevalent in newly established orchards when the trees have not yet begun to bear fruit. These fields and orchards are often used to cultivate oil seeds and legumes. The towering fruit trees are cut to make cultural activities easier, and any seasonal crop, such as wheat or gram, is planted in the area between the rows. By covering the field, these crops manage the land by increasing per unit land revenue.

Agroforestry: Agroforestry is a useful technique for land management. In fact, it is a form of land management in which grazing land is used to produce trees or other vegetation. It is a self-sustaining form of land management that blends the simultaneous or sequential production of agricultural crops with trees, cattle, and plants on the same plot of land. This method improves soil production, biodiversity, and the economy. As was already said, vegetation such as plants, trees, and grasses play a crucial role in the management of land. By putting the land resources under suitable vegetation, most land degradation may be stopped or avoided. The vegetative cover may be used for a variety of purposes, including grazing, silviculture, sustained crop production, fodder and fuel, and other socioeconomic ones. Production of grazing land and fuel: Degraded lands and wastelands are biologically imbalanced, have lost their top fertile soils, have acquired toxicity, and these factors prevent the development of plants, crops, and trees. It has been discovered that it is feasible to cultivate high-yielding grasses, legumes, and trees for fodder and fuel under controlled circumstances with little inputs.

Sustained Land Use: Humans are wholly reliant on the resources of the land for their everyday requirements. Sadly, human beings have overused these resources. We can manage the natural resources if we can lessen human beings' excessive desires and avarice. We should reduce our reliance on things like food, fuel, and fodder. Chemical use that is excessive should be avoided. Technology for pasture management allows us to effectively manage our land resources. It entails a variety of actions, a set of procedures, and a set of materials, such as the reconstruction of degraded rangelands, their restructuring with a mosaic of species or cultivars of grasses and legumes in pure and mixed stands, and the improvement of the soil and plant nutrients through the use of fertilizer. This method maintains a pasture free of undesirable plants, harmful materials, solid waste, etc. Additionally, different kinds of plants are cultivated using pasture management technologies. The ideal species for managing pastures are Conchrussetigerus and C. Ciliaris, Lasiurus sindicu, Antidetab Panicum, etc.

Silvipasture Management: Increased demand for fuel wood, small timber, forage and fodder for livestock and wildlife, as well as for human use, contributes to the deterioration of the environment. The greatest method for economically using damaged or wastelands seems to be silvipasture. The three main components of the Silvipasture system of land management are: In addition to their significance as a source of fuel and lumber, trees are significant in and of themselves as a land steward and as a climate stabilizer, particularly in dry and semi-arid regions. Animals eating off the leaves of nourishing trees and bushes while grazing on the grassland. Trees, shrubs, grasses, and legumes were selected as the plant components in this system[10].

Socio-economic factors in optimal land use: Land management is possible with optimal land use. It is a well-known fact that 33% of the earth's surface has to be covered with forest in order for an ecological system to remain in equilibrium. Large numbers of farmers choose cash crops like wheat and rice to increase their profits, but there is still a difference between the quantity of oilseeds, pulses, and pasture crops produced and what is needed. Growing oilseeds, fodder, and pulses on partly degraded land might balance the social and economic facets of human existence, depending on appropriateness and other geographical criteria including soil, infrastructure, and necessity. While planting trees on unusable property would unquestionably benefit our ecosystem and environment. We have covered waste land kinds, origin, conservation, and management in this unit. As of now, you are aware that land is a beneficial resource and may take the shape of cropland, waste land, desert land, grassland, rangeland, snowland, and so on.

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CHAPTER 8

LAND-RELATED HAZARDS AND THEIR MITIGATION: EARTHQUAKE, DROUGHT, LANDSLIDES, AND LANDSLIPS

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The basic elements needed to sustain life are stored on Earth. Our planet's dynamic processes, which are also the cause of natural catastrophes, are ultimately what give rise to our natural resources and ecosystems. According to predictions, devastating earthquakes, droughts, floods, and landslides will claim thousands of lives in the near future. To reduce losses from these natural calamities as well as from slower continuing processes such ground subsidence, soil and water pollution, and erosion, billions or millions of dollars will be required. To guide these expenditures in protecting infrastructure and human life, fundamental scientific advancements are required. Natural catastrophes are defined as earthquakes, landslides, and droughts. These are natural occurrences that might significantly harm any nation's environment and socioeconomic system. Natural disasters may be broadly divided into two categories. Earthquake, drought, landslides, volcanic eruption, flood, forest fires, and other geophysical disasters fall under the first category. Biological hazards, which might include illnesses and infections, make up the second type of natural hazard. The ecological, social, and economic aspects of the region may be impacted by a variety of land-related risks. You are aware that the natural calamities that affect the land ecosystem include earthquakes, landslides, landslips, and droughts. Land-related dangers have large and many origins and effects. You will study about land-related hazards in this unit, with a focus on landslides, landslips, earthquakes, and drought, as well as how to mitigate them.

Land-Related Risks

Natural disasters that occur on land and disrupt its ecosystems are referred to as land-related disasters. There are many different kinds of dangers that are associated to the land, including landslides, landslips, earthquakes, droughts, floods, and volcanic eruptions. These land-related risks are brought on by both natural and artificial processes. There are many different kinds of land-related hazards, including earthquakes, droughts, and landslides. The following subsections provide descriptions of them.

Land slips / slides

"Landslide is a general term for a wide variety of down slope movements of earth materials that results in downward and outward movement of soil, rock, and vegetation under the influence of gravity," says the definition of landslides and landslips. The phrase "landslide" refers to a broad range of downhill slope motions of earth elements that cause soil, rock, and plant to flow outward and downward as a consequence of gravity. While some landslides happen quickly, in a matter of seconds, others might take hours, weeks, or even longer to occur. Rock, dirt, and other debris are fluidized into debris flows by the presence of water. The characteristics of mudflows or debris flows include steep, sparsely vegetated slopes where heavy rainfall causes movement in a thick layer of weathered material. They form whenever there is a sudden buildup of water in the ground, such as after a strong downpour or a quick snowmelt, turning the land into a river of streaming mud or slurry. Slurry may move quickly along channels or down slopes, and it can hit at avalanche speeds with little to no notice. Landslides may happen in the western Ghat or in the Himalaya's rugged, hilly areas. However, because of their vulnerability, landslides happen more often in the Himalayan area[1], [2].

Landslip Causes

Landslides are caused by a variety of causes, including topography, gravity, weather, and ground water, and wave action, type of soil, wave motion, and human activity. Although landslides often happen on steep slopes, they may also happen in low relief places. Landslides may happen due to slope failures connected to quarries and open pit mines, ground failure of river bluffs, cut and fill failures that may follow highway and construction excavation, and collapse of mine waste heaps. In lakes and reservoirs, offshore marine environments, and other low relief locations, underwater landslides often occur. .Landslides may have artificial or natural origins, such as those listed below:

Natural Causes of Landslides: The following are some examples of natural causes of landslides:

Gravity: Slightly incline slopes are more subject to the effects of gravity than steeper slopes.

Factors related to the geology: Many slides happen in environments where permeable sands and gravel are found above impervious layers of silt and clay or bedrock. Water gathers on top of the underlying units after seeping through the upper layers, creating a weak spot. Rainfall that is both heavy and prolonged: Water is often the main cause of landslides. Slides often happen after heavy rain, when runoff from storms saturates the soils on steep slopes, or when infiltration produces a sharp increase in ground water levels. A lengthy or strong rainstorm may cause the ground water to rise. A few slopes become unstable when water tables rise. Earthquake: Landslides have always primarily been caused by seismic activity across the planet. When tectonic plates shift, the soil follows suit. Landslides often result from soil slips that happen during earthquakes in places with steep slopes. Additionally, earthquake-induced ashen debris flows may cause large-scale soil displacement. Forest Fires: Because natural vegetation is destroyed, forest fires lead to soil erosion, flooding, and landslides.

Volcanoes: Strato volcanoes are susceptible to unexpected collapse, particularly in rainy circumstances. Conditions that destroy large swaths of vegetation and scatter loose volcanic rocks throughout the terrain often persist after a volcanic eruption. Following wet seasons, swelling rivers may dissolve the new deposits and can produce deadly lahars for those downstream. Waves: Wave motion may cut through the slope and prepare the ground for a future avalanche by eroding the beach or the toe of a bluff. Anthropogenic causes of landslides/landslips: Landslides may be caused by human activity, particularly those that have an impact on drainage or groundwater. The following list of significant human-made activities that cause landslides is provided for reference[3]:

Inadequate drainage system: Without adequate provision for surface drainage of excess storm water during high intensity rains, landslide vulnerability increases. Natural drainage lines on slopes are blocked by terracing/contour bounding adopted to prevent soil erosion and enhance percolation during dry season for cultivation. Deep Excavations on Slopes for Buildings, Roads, Canals, and Mining: Construction of buildings, roads, embankments, cut-and-fill constructions, and other development activities alter the natural slopes. Landslides are mostly caused by these kinds of activity. Change in slope/land use pattern, deforestation, and agricultural methods on steep slopes: The change in land use pattern is brought about by deforestation, the cultivation of seasonal crops, and a rise in settlement. Creep and loss of toe support have often been caused by improper land use techniques such intensive tilling, agricultural methods, and settlement patterns.

Consequences of Land Slides

Landslides may have a variety of impacts, some of which are listed below: Landslides have the power to completely alter the landscape's form. The construction of mountains and hilly regions is absolutely abrupt. Due to severe landslides, many magnificent ecosystems, including ponds, lakes, woodlands, etc., may suffer structural damage or loss. Landslides often occur in Uttarakhand, Jammu and Kashmir, including Ladakh, Himachal Pradesh, Manipur, and Mizoram. Hillsides commonly cause landslides. Loss of human life: Landslide is type of natural disaster which may lead to loss of human life. People who are living in the foot of hills and mountainous region are at great risk of death due to landslides.

Landslides may have an effect on aquatic, terrestrial, and woodland ecosystems. Debris may enter natural rivers and springs and obstruct the flow of such bodies of water. Landslides may have an impact on a variety of water quality indicators, including clarity, turbidity, total solids, total dissolved solids, and dissolved oxygen. Economic effects: Landslides may harm the infrastructure of educational facilities, hospitals, businesses, roadways, and other transportation networks. These repairs are exceedingly expensive and have a negative impact on the economies of the states or nations.

Measures to Prevent Landslides and Landslips

A number of different elements may combine to trigger a landslide. .As a result, there are several sorts of precautions that may be implemented to avoid landslides. By taking precautions, land slips may be managed. Prior to the disaster/landslide determine your location and make a note of the frequency of landslides there. Additionally, water lines might be installed to slope so that water can be removed, keeping it from running too high and decreasing the likelihood of a landslide[4].

During a disaster or Landslide

Keep your eyes and ears open; many debris flows happen when people are asleep. For warnings of heavy rain, tune in to a weather radio, portable radio, or television. Be warned that sudden, powerful downpours may be quite hazardous, especially if they follow a prolonged period of heavy rain and moist weather. If it is safe to do so, think about evacuating if you are in a region that is susceptible to landslides and debris flows. Keep in mind that driving in a lot of rain might be dangerous. If you decide to stay in your house, consider moving upstairs.

Keep an ear out for any strange noises that could signal moving debris, such as the breaking of trees or the clashing of boulders. Larger landslides may be preceded by a trickle of mud or debris that is falling or streaming. Debris in motion may move swiftly and sometimes without notice. If you're close to a stream or river, keep an eye out for any rapid changes in water flow, such as a switch from clear to muddy water. These alterations can be a sign of upstream landslides. When driving, pay extra attention. Landslides are especially prone to damage embankments along roadside. Keep an eye out for any signs of a potential debris flow, such as crumbling pavement, mud, falling boulders, and other debris. Examine the building's foundations, the chimney, and the surrounding area for damage. Damage to the chimney, foundations, or nearby land may provide insight into the area's safety.

Earthquakes

Tremor and temblor are other names for earthquake. A seismic wave is produced when there is a rapid release of energy in the lithosphere, causing the earth's surface to shake. .Earthquakes are the most hazardous and destructive kind of natural catastrophe; they may instantly destroy millions of lives, homes, buildings, and infrastructures. As a result, earthquakes are the most terrifying natural events in human history. It is much more so since it might happen at any time and can happen without any prior indications. An earthquake occurs when the earth trembles as a result of the movement of tectonic plates under the crust of the planet. Near the epicenter, where the vibrations start and spread, the most damage often happens. The study of earthquakes and seismic waves that travel through and around the earth is known as seismology. A scientist who investigates earthquakes and seismic waves is known as a seismologist. The Himalayan and Sub-Himalayan regions are home to the majority of India's vulnerable areas, which make up around 50–60% of the country. The North East states, Andaman and Nicobar Islands, western Gujarat, Himalayan foothills of Uttarakhand, Himachal Pradesh, Uttar Pradesh, and Bihar are the states whose areas do lie in the most vulnerable seismic zones. The least susceptible regions are in Rajasthan and the Deccan Peninsula[5], [6].

Various Earthquake Types

Three basic fault types are known to be the main contributors to earthquakes. Here are several earthquake types: Tectonic plates flow past one another horizontally along a strike slip fault, which is vertical. When crustal chunks are moving past one another, this happens. In the moments before an earthquake, dogs often start barking uncontrollably. P-wave velocities in earthquakes typically vary from 5 to 8 km/s. Shear waves, also known as secondary waves or S-waves, are the second form of body wave and are the second wave you experience after an earthquake. The only liquid media through which an S-wave can travel is solid rock, making it slower than a P-wave. Seismologists came to the conclusion that the Earth's outer core is a liquid because of this characteristic of S-waves. Body waves are the P and S waves taken as a whole. .Surface Waves: These waves can be clearly detected on a seismogram since they only pass through the crust and have a lower frequency than body waves. Surface waves are nearly solely to blame for the damage and devastation caused by earthquakes, even when body waves come after them. In deeper earthquakes, less damage is done and the surface waves are weaker.

Two earthen bricks suddenly slipping past one another causes an earthquake. The fault or fault plane is the area where they slide. An earthquake's starting point is known as the hypocenter, and the spot immediately above it on the surface is known as the epicenter. Tectonic faults and magma circulation in volcanoes both contribute to the frequent occurrence of earthquakes in volcanic areas. Geological fault rupture is the main source of earthquakes, although they may also be brought on by volcanic activity, landslides, mine explosions, and nuclear testing.

Measures to Reduce Earthquake Damage

As you are aware, an earthquake is the fastest, quickest, and most unexpected tragedy, and we are unable to use effective ways at the time. Therefore, in order to reduce the effects of an earthquake, it is essential to abide by the laws and regulations before a catastrophe. There are many earthquake mitigation strategies, but the following list of crucial ones is guaranteed to assist reduce the effects of an earthquake:

Before an earthquake: As you are probably aware, earthquakes may happen suddenly and without warning, so if we wait until the ground starts to tremble, it can already be too late. The following should be kept in mind before an earthquake, particularly in locations that are susceptible to them. Find the earthquake zone and frequency for the region where you reside.

Observe the guidelines set out by the authorities. The Indian government has a number of regulations for building development in distinct seismic zones. Regular disaster management training for individuals and communities is required. Keep the contact information for the National Disasters Response Force officials and the media handy. Always store drinking water bottles, dried food, first aid kits, torches, and battery-operated radios in a specific location.

Find a location in the home that will provide protection during an earthquake. Making long distance calls during an earthquake could be simpler. Choose a distant cousin or acquaintance to serve as the family's emergency contact. Family members should get in touch with the selected relative or friend if they get separated after the tragedy and are unable to reach one another. All members of the family should have the contact person's address and phone number. When there is an earthquake, almost no warning is given. There are occasions when a loud rumbling sound may hint at its impending arrival. We could have an opportunity to leave during those few moments and go somewhere safer. .Here are some crucial pointers for staying secure during an earthquake[7]. Get behind cover, sit or remain close to the ground, or crawl beneath a table or other sturdy furniture. For balance, cling to the legs of furniture. If your cover shifts, be ready to move. Once you're outdoors and in the open, keep away from any structures, lamps, or utility lines. Once outside, remain there until the trembling stops. Avoid areas where there are loose wires, and stay away from anything metal that is touching a loose wire. Avoid any severely damaged buildings.

If you are in a car, relocate to an open place away from any structures, trees, or overpasses. Avoid using ramps and bridges that may have been affected by the earthquake. Here are a few things to have in mind after an earthquake. Your own safety may depend on the prudence you use thereafter. To protect your feed from trash and other dangerous materials, wear shoes. Be ready for aftershocks when there is an earthquake. An aftershock may weaken buildings and inflict extra harm. In the first hours, days, weeks, and even months after the earthquakes, aftershocks might happen.

Only go back home after being told it is safe by reliable sources. Immediately clean up any spilled medications, bleach, gasoline, or other flammable substances. If you smell gas or other chemical odors, get out of the area. Open the windows if you smell gas and leave the premises right away. Switch off the gas cylinder's top by depressing it. Turn off the power at the main fuse box and check for electrical system damage if you see sparks, damaged wires, or the burning aroma of amber. Look for damage to the water and sewer pipes. Avoid using the toilets if you think the sewage pipes are compromised. Avoid using the water from the faucet if water pipes are broken.

Only use the phone for emergencies

Create a strategy for reconnecting family members in the event that they get separated during an earthquake. Ensure that everyone in the family is aware of the contact person's name, address, and phone number.

Drought

When precipitation is below normal for an extended period of time, generally longer than a season, a drought ensues. Temperatures are often greater than usual. It may also result from overuse or overpopulation in a region, when the demand for water exceeds the amount of water available. A widespread meteorological phenomenon known as a lengthy period of water shortage is called a drought. .Different Droughts Weather-related drought: it is localized to certain areas. Simple definition of a meteorological drought is "short fall of rain over time." The length and total quantity of precipitation vary by area. Agricultural drought: It takes into consideration the water requirements of crops at various growth stages. The features of both hydrological and meteorological drought are linked in agricultural drought. This kind of drought affects forestry, livestock, and agricultural production. Water levels in streams, rivers, and reservoirs that are consistently low are referred to as a hydrological drought. Hydrological droughts may become worse as a result of a variety of human actions, such reservoir depletion. Weather-related droughts are often associated with hydrological droughts. Changes in surface water sources are a defining characteristic of several kinds of droughts[8].

Socioeconomic Drought: This condition arises when there is an imbalance between water supply and demand. Too much irrigation or low river flow forcing hydroelectric power plant operators to restrict energy output are two examples of socioeconomic drought.

Drought: Natural and Human Causes

Deforestation: As you are aware, trees are important to the water cycle. Trees aid in lowering evaporation, storing enough water, etc. As a result, the region experiences drought-like conditions due to deforestation. Global warming is a phenomenon in which the earth's average temperature increases. More greenhouse gases were introduced into the atmosphere as a result of human activity. The temperature of the earth rises as a consequence. Drought is a consequence of these factors as well. Drought is brought on by hot land and water. More water evaporates as the temperature rises, and severe weather conditions also rise. The total demand for water rises as more water is required to sustain landscapes and crops. Drought is influenced by soil moisture content. When soil moisture levels are low, there is less water evaporation to produce clouds. The cycle of rain is impacted. As the earth's temperatures increase, more water is required but less is accessible, which makes the drought conditions more severe. Drought is also a result of population growth. More people means they need more water to meet their demands.

Maharashtra will lessen the effects of the drought. .Around 16 districts in Odisha are vulnerable to drought. Odisha's Chief Minister, Sh. Farmers who were impacted by the drought would get 100 crore rupees, according to Naveen Patnaik. Except for Adilabad and Kamman, almost all Telangana district has been impacted by the drought. Rajasthan's 19 districts also experienced drought-related issues. 46 of Madhya Pradesh's 52 districts are experiencing drought-related problems. 22 districts in Jharkhand are experiencing drought-like conditions. There is a drought affecting 50 districts in Uttar Pradesh. On the other hand, there is a drought in 27 Karnataka districts. India's states of Gujarat, West Bengal, Haryana, and Bihar are all suffering from drought[9].

Effects of the Drought

Following are some of the different economic, environmental, and social implications of drought:

Financial Effects

If a drought reduces the amount of vegetables, grains, and other crops grown, farmers and individuals may lose money. Farmers may need to invest more on irrigation if water availability is too low. Ranchers could have to spend more money on water and feed for their animals. Industries that rely on agriculture, such as those that produce tractors and food, might see a decline in sales if a drought harms crops or cattle. When wildfires burn down wood stands, it might have an impact on those who work in the forestry sector. Because of the drought, lakes and other aquatic habitats have dried up, making it difficult for businesses who depend on boats and fishing gear to sell part of their products. If the drought dries out too much of the water supply, hydro-power firms that typically depend on hydroelectric electricity may have to spend more money on alternative fuel sources. Companies that use water could have to pay more for new or additional water supply. Due to the limited water supply in rivers, navigation becomes challenging. Low water levels could make it difficult for ships to navigate streams, rivers, and canals, which would have an impact on the economy's reliance on water transportation[10].

Environmental Effects:

Drought has a variety of distinct effects on the environment. As you are aware, water and aquatic habitats are essential for plants and animals. Animals' food supplies may shrink and their habitats may deteriorate during a drought. Sometimes the damage is just temporary, and after the drought is over, their habitat and food levels return to normal. However, the effects of droughts on the ecosystem might sometimes endure a very long period, if not forever. The following list of drought's many environmental effects:

1. Destruction of the environment for animals and fish
2. Lack of wild animals' access to food and water
3. Due to a lack of food and water, wild animals are becoming more ill.
4. Movement of wildlife
5. Highlight the need to protect endangered species
6. Low amounts of water in ponds, lakes, and reservoirs
7. Degradation of wetlands
8. The likelihood of a forest fire is increased by drought.
9. Soil erosion caused by wind and water
10. Poor soil conditions

Drought Mitigation Measures

The effects of drought may be lessened by doing the following actions. Climate studies that employ coupled ocean/atmosphere models, anomalous ocean and atmospheric circulation patterns, soil moisture, and the concept of stored water accessible for residential, livestock, and irrigation applications may be used to predict drought. On the basis of the location's historical records, weather monitoring systems, etc., many scientists and researchers can forecast the drought. Monitoring may be done with the use of vital information such as rainfall, weather, crop conditions, and water availability. Satellite observations supplement data gathered by ground systems, which are equally useful in drought monitoring. .An impact assessment is conducted based on the kind of land use, the population, the infrastructure that is already in place, the intensity and area of the usage, and the impact on agricultural productivity, human health, and the amount and quality of water. Advanced drought monitoring, effective water and crop management, the addition of groundwater to existing water sources, increased public awareness and environmental education, watershed management, rainwater collecting and local planning, a decrease in water demand, and water conservation are all part of the response.

There are several land-related risks that are caused by land and that may have an impact on the region's social, ecological, and economic situations. You are aware that natural catastrophes that affect the land ecosystem include earthquakes, landslides, landslips, and droughts. Land-related dangers have large and many origins and effects. You will study about land-related hazards in this unit, with a focus on landslides, landslips, earthquakes, and drought, as well as how to mitigate them. .The phrase "landslide" refers to a broad range of downhill slope motions of earth elements that cause soil, rock, and plant to flow outward and downward as a consequence of gravity. Some landslides happen quickly, taking just a few seconds, while others might take hours, weeks, or even longer. Rock, dirt, and other debris are fluidized into debris flows by the presence of water.

Landslides may come in a variety of forms, including lateral spreads, mudflows, lahars, and debris flows and avalanches. .Natural forces such as gravity, geological elements, heavy and prolonged rains, earthquakes, forest fires, volcanoes, and waves may be the cause of landslides and landslips. Landslides may be caused by anthropogenic factors such as improper drainage systems, deep excavation for mining, roads, canals, and buildings, changes in land use patterns, and agricultural operations on steep slopes. Landslides may change the way the land is built, result in human fatalities, economic losses, etc.

Earthquake, also known as a tremor or temblor, is defined as the "shaking of the earth's surface caused by the abrupt release of energy in the lithosphere that create seismic wave." Strike slip fault, normal fault, and reverse fault are different types of earthquake faults. Two earthen bricks suddenly slipping past one another causes an earthquake. The fault or fault plane is the area where they slide. Usually lasting longer than a season, a drought is a prolonged period of precipitation that is below normal. The drought may be divided into meteorological, agricultural, hydrological, and socioeconomic categories.

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CHAPTER 9

LAND MANAGEMENT: SOIL IMPROVEMENT, REHABILITATION, AND WASTELAND RESTORATION

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As you are aware, soil erosion has traditionally been seen as the primary factor in land degradation; however, the meager efficacy and low adoption of extensively publicized physical and biological anti-erosive techniques calls into question this perception. As you are aware, both natural and artificial activities contribute to the deterioration of the land. The primary causes of land degradation include overuse of fertilizers, hazardous waste disposal on and near the land, deforestation, and desertification. Low output in terrestrial ecosystems is brought on by these elements. Many dangerous substances, including mercury, arsenic, cadmium, chromium, nickel, and zinc enter the terrestrial environment and may progress via bio-accumulation to higher trophic levels. Both humans and other animals are susceptible to a number of ailments brought on by these poisonous compounds.

As a result, it's important to maintain and preserve the land ecosystems for both the current and future generations. Land husbandry is the active activity of controlling production and land usage in order to maximize productivity. There are several ways to enhance land, soil, and waste land, all of which serve to raise the productivity of the land. Soil agglomeration, soil rehabilitation, and soil restoration are a few examples of land management techniques. Active management of slopes, vegetation, soil, and rain water are all included in land husbandry. The method of land husbandry occurs on a range of sizes, from the field to the landscape and soil. The two primary methods of land husbandry are land improvement and vegetation output. You will study about land management, soil improvement, soil rehabilitation, and soil restoration in this unit. Land Management.

Hugh Hammond Bennett is credited as being the father of soil conservation. Hugh Hammond Bennett's work resulted in a plethora of manuals and recipes for erosion control that describe practical experience, technical principles, mechanical methods to be used, and a variety of useful techniques that have been applied to varying degrees of success in various geographic areas. Bennett's strategy for conserving soil was subsequently deployed, without any testing beforehand, in very different conditions, with the extremely neutral effects that have been seen by all. The degradation of the environment and the rise of civilizations are intimately related. Ecologists, foresters, geographers, hydrologists, as well as social economists, are all equally interested in them. "Every day the land dies silently, only our voices are left," is a well-known proverb.

Land degradation is caused by climatic hazards such as high rainfall intensities, droughts, and excess rainfall quantities, as well as high, low, and fluctuating temperatures. On the other hand, slope may impact the speed of any runoff, which is one of the hazards of the terrain. Effects of past erosion on the quality of the surviving top soil. Deterioration of the soil's physical, chemical, and biological properties may lead to land degradation. Organic matter content, organisms, acidification, loss of porosity, loss of soil particles, nutrients and water in runoff, and erosion are a few examples of these factors. On the other hand, enhancing any, some, or all of these characteristics will help the impacted land be more stable, conserved, and sustainable. The practice of cultivating land or keeping livestock is known as land husbandry.

Techniques for Land Management

Soil compaction is often the consequence of the incorrect handling of soils or the use of large construction equipment. In turn, this causes the soil to have too little oxygen and have pore volumes that are too small for plant development. Low structural stability soils are more susceptible to compaction damage, especially exposures related to adverse soil water content. Physical soil amelioration, which mainly tries to improve the soil's air and water balance, is the initial stage in re-cultivating compacted soils. The phrase chemical soil amelioration refers to soil enhancements that affect the important characteristics of soils. These are basically methods for altering the pH of the soil, maximizing its nutritional value, and minimizing or removing detrimental significant impacts like pollution or salinization. These treatments enhance the fundamental conditions in severely acidic, excessively alkaline, nutrient-deficient, or polluted soils, allowing for sound plant development when reclamation and erosion control techniques are used. In mining regions, on bare soils devoid of humus, in salinated sites, and during the decontamination of polluted hazardous sites, chemical remediation procedures are mostly necessary[1], [2].

Soil Improvement

Using a procedure called soil amelioration, we may raise the soil's quality. The Latin word "melior," which meaning "better," is the source of the term. As you may know, soil is composed of clay, silt, and sand, as well as humus, microbes, and earthworms, which are also important parts of soil. The functions of abiotic and biotic factors are different in land ecosystems; a clay soil is responsible for soil amendments that improve soil aggregation, increase porosity and permeability, and improve aeration, drainage, and rooting depth.

Indicators of Soil Productivity:

There are various indications by which we can determine the soil is polluted, water logged or higher salinity, etc. Drainage of water is indication in which we can observe the amount of water flowing slowly or quickly over soil. This may indicate saturated or unsaturated soil conditions. This can also cause erosion. Water left standing after a rain may also indicate excessive moisture in the soil. Edges of leaves turning brown may be indicator of too much soil moisture. We can identify the roots of plants; decayed roots are also indicator of waterlogged soils. The type of soil at a site influences moisture conditions. Sandy soils generally have a high infiltration rate with water moving quickly through, while clay soils may be likely to retain water. The pH is the scale to determine acidic or basic nature of any solution. It is a measure of the concentration of hydrogen ions in the solution. It is also indicator of soil productivity. The lower the pH of soil, the greater the acidity, pH of 4 has 10 times more acid than a pH of 5 and 100 times more acid than a pH of 6. Acidity caused by natural process, accelerated by agriculture, inefficient use of nitrates, followed by the export of alkalinity in produce. Microbial biodiversity is also indicator of soil productivity. As you know, most of the biological activity in the soil occurs in the top 10 cm. Farmers generally do not realize the amount of life and what type of organisms live in soil, because we do not see their activities. Many farmers do not understand the diversity of organisms present in the soil and their function. Microorganisms play various functions in soil. These functions may include: Nutrient recycling, maintaining soil structure, suppression of plant disease and soil detoxification Techniques for Saline Soil Amelioration: The following list of techniques for saline soil improvement includes a variety of approaches:

Scraping: This method, which consists only of mechanically removing salt content, has had mixed results. Leaching should be done when soil moisture content is low and ground water is deep because stagnation of freshwater may dissolve salt in agricultural fields. Leaching is the most efficient management strategy for eliminating salts from the root zone of soil.

Drainage: Reducing the salt content of the soil by drainage is another beneficial strategy. Crops grown in high salinity need to be watered more often because this minimizes salt formation by maintaining the soil at a higher soil moisture content[3].

Sprinklers, drip irrigation, micro-irrigation, and drop irrigation are effective irrigation techniques for applying tiny amounts of water repeatedly. Leaching of soluble salts is also more effectively completed when water application rates are lower than the soil's capacity for infiltration, which cannot be fulfilled by flood irrigation.

Mulching: When the water table is low and the salt of the ground water is high, soil salinization is especially severe. By reducing soil surface evaporation and promoting downward soil water movement, mulching helps prevent salt buildup on the soil's surface.

Although barren, saline soils have the potential to be fruitful. To maintain the food supply and security for an ever-increasing population, all problematic soils must be fixed and made productive. The aforementioned amelioration process may reduce the soluble salt content of salty soil and make it productive.

There are many reasons to avoid soil compaction, including the fact that it results in nutrient deficiencies, lowers crop productivity, limits root growth, reduces soil aeration, lowers soil availability for water, lowers infiltration rates, increases surface runoff, and damages soil structure. Deep tillage, crop residue, the addition of organic matter, vermin-compost, etc. are all methods for managing soil compaction. Gypsum or any other chemical may be added to a landscape to treat compaction, and a soil analysis can be done to determine the texture, mineral deficiencies, toxicities, etc. of the soil. Gypsum may reduce salt levels in saline soils and enhance the structure of heavy clay soils. On the other hand, adding gypsum to sandy soils may be a waste of money and natural resources and can have a bad effect on the health of the ecosystem, the soil, and the plants that grow there.

Restoration of Wasteland and Soil

The term "rehabilitation" refers to improving ecosystem productivity, services, and processes rather than returning the ecosystem to its original state. The act of restoring the land in a specific region to a portion of its prior condition after harm has been caused by a procedure is known as soil and wasteland rehabilitation. Land degradation is a result of several development initiatives, such as mining, agricultural methods, etc.

An intervention aimed at improving land ecosystems is known as land restoration. In the majority of cases, this involves reducing soil degradation brought on by bad land husbandry techniques, particularly agricultural operations. To what extent the land should be restored to self-sustaining natural control and to what extent to a sustainable economic after-use, where future land quality is preserved by careful management and repair, are the key problems in land rehabilitation. Land rehabilitation projects sometimes entail reversing the visible signs of land degradation, such as soil quality losses brought on by compaction, as well as faster runoff and erosion on hill slopes and in waterways. The reduction of soil erosion and pollution is one of the treatments in different situations.

Rehabilitating the soil

In the restoration of land, the soil is crucial. The soil regulates how quickly crops develop on the land and how much water infiltrates the soil, flows off as surface flow, is kept at the surface in ponds, or is retained in the soil connected to soil particles via evaporation or transpiration of water into the atmosphere. The soil also controls how quickly soil is eroded by water or wind, either directly or indirectly via the vegetation cover. Soil is a living resource, a complex dynamic, developing, biologically modified open system, and a living ecosystem.

As "a biotic build favoring net primary productivity," the soil may be described. As you are aware, soil plays a significant role in bio-geochemical cycles. It is where the key components of the majority of land-based biogeochemical cycles pulsate. The biological processes of the soil control soil density, porosity, aeration, chemical buffering, nutrient delivery, and water holding capacity. Stabilization of soil structure, soil purification, and soil self-creation are all impacted by these variables. The biology of the soil regulates its composition and, in general, improves the environment for living things. Because of this, the condition and vitality of the soil are the main focus of land restoration[4], [5]. As a consequence of the vertical and horizontal motions of organisms, organic materials, water, chemicals, and soil particles, soils change in a variety of ways. The following variables influence the self-development and evolution of soils:

Biological processes, the actions of soil-dwelling organisms, as well as the enzymatic effects of their waste products and secretions. The kind, availability, and quantity of the material from which the soil skeleton is generated are determined by geological circumstances, which via weathering. The location of the soil within the terrestrial ecosystem influences the amount of erosion, drainage, or deposition it has undergone, which in turn influences geomorphological and hydrological processes. Climate and microclimate processes that regulate biological system activity and promote physical processes via soaking and drying. Because most soils have been altered by land use, human effects often result from disruptive activities like grazing, forest farming, and agriculture that have been going on for decades or centuries. The majority of the soils on property slated for restoration have been harmed by unsuitable land use and inadequate land management. Changing how they are handled is often the only option to solve their issues, and hence, land degradation.

Evaporation causes the soil to lose water.

Rhizosphere of soil

Enhance Soil Depth: To restore a self-sustaining soil, which is necessary for land rehabilitation, there must be a balance between soil growth and soil loss. This may be done in one of two ways: either by slowing down soil erosion, which is the conventional method of conserving soil, or by promoting soil formation. The role of organic acids in speeding up the weathering of bedrock as plants mine for the minerals they need and, in the process, speeding up soil formation, is stressed by scientists. Mucuna beans have been successfully used recently to rejuvenate soils in tropical, rocky terrain. Mucuna has been utilized to restore fields that were almost barren of cultivable soil and is capable of producing 100 tonnes ha of green manure annually. However, in addition to incorporating organic matter, there are several more techniques to increase effective soil depth. On the other hand, the actual collection of soils, such as during the construction of agricultural terraces by cut and fill from slopes, may alter soil depth. Many areas used for industrial land reclamation are completed using top soil brought from other locations. Making a location, such as a dam, that gathers material that has been moved by wind and soil erosion and transforms it into a level depositional terrace that can be utilized for agriculture is the agricultural counterpart[6].

Reclaiming Abandoned Land

As you are aware, waste land is land that was formerly used for agriculture but was abandoned owing to poor productivity. It is also land that has been utilized in the past but has since been abandoned. According to estimates, 5 million tonnes of NPK and 6000 million tons of rich soil are shifted each year. Waste land is being created as a result of several developmental activities, including industries, urbanizations, agricultural operations, etc. Reduce siltation and increase water output in catchment regions by rehabilitating wasteland via the management of soil and vegetation. It depends on the kind of soil, the climate, and the type of plant. Waste land is mostly the result of deforestation. Plants are crucial to the restoration of abandoned land. However, choosing the right plant species is the most crucial factor. The choice of plant species is made based on the local climate, adaptation, production, and survival.

"Restoration" in the context of an ecosystem refers to the process of regenerating an ecosystem that has been harmed, degraded, or destroyed, sometimes as a result of soil erosion or human intervention. An ecosystem is being restored in an effort to put it back on its previous course. the process of returning a piece of land to its original condition after disturbance or destruction. Toxins and other harmful compounds must be removed, along with other buildings, and the soil must be improved. This procedure is often used to fix problems brought on by procedures like coal mining, oil drilling, and other operations, as well as to improve the land after a natural catastrophe.

The earth is the source of many of our valuable resources, including some that are necessary, like coal or bricks. As a consequence, even for the most fundamental aspects of existence, land is destroyed. Since the dawn of civilisation, this has been the case. However, the rate of this destruction has been influenced by the way people live and by the variety and intensity of the activities that have helped people lead civilized lives. The process of returning a place to its original ecology and the habitat of microbes, plants, and animals is known as land restoration. As you are likely aware, pollution, deforestation, and other human activities often result in ecological degradation[7].

The potential of a damaged soil to generate crops, food, and a place for living things to live in its surrounds is often lost. This condition has a detrimental influence on the local socioeconomic system and ecosystem. As a result, efforts are undertaken to return the soil to its original condition. High salinity, a reduction in fertility and organic matter, increased erodibility, and a rise in alkalinity and acidity are all characteristics of degraded soil. Man is capable of causing soil deterioration. For instance, chemical usage may raise soil salinity or alkalinity while agricultural operations might affect the soil's drainage capacity and structure. There are several techniques to restore damaged soil, some of which include:

Utilization of organic farming methods:

This entails the use of natural resources in agricultural production to minimize adverse environmental effects. Utilizing green manure, cover crops, crop rotation, and organic compost are some organic farming practices that aid in soil restoration. One of the finest methods for restoring waste land is this. Since chemical fertilizers, as you are aware, cause soil degradation, organic farming is beneficial for restoring waste land.

Green manure and cover crops act as mulch for the soil, protecting it from erosive processes and moisture loss. As they break down in the soil, they also increase the amount of organic matter there. Green manure and cover crops have the capacity to fix nitrogen. Their root nodules' nitrogen-fixing bacteria aid in absorbing nitrogen from the atmosphere. These crops and manure prevent weed development. It is a cheap and environmentally friendly way to eradicate weeds and restore degraded land.

Compared to inorganic fertilizers, organic compost is often a more affordable way to fertilize soil. Animal and plant waste that has decomposed are combined to create compost. Composting increases the amount of organic matter in the soil, which is its principal advantage. As you are aware, organic matter increases soil fertility, soil structure, and soil's ability to store water. It is also a crucial feature of soil carbon. Compost lessens the need for chemical fertilizers, which, if used improperly, may harm groundwater, tributaries, streams, and rivers. Crop rotation is an agricultural method that entails cultivating several crops in succession in one site. This agricultural method lowers soil erosion, boosts soil fertility, and hence enhances crop output[8]. The greatest method for restoring wasteland is soil remediation. It entails the elimination of pollutants from soils, including heavy metals, sewage sludge, carcinogenic hydrocarbons, alcoholic beverages, and petroleum. Biological methods may be used to remediate soil. Bio-remediation is another name for this technique.

Using microorganisms to break down dangerous compounds in soil, sediments, water, or other polluted materials is a process known as bio-remediation. For bio-remediation, certain types of bacteria, fungus, algae, and plants are employed. Microorganisms are brought to contaminated sites as part of the bio-augmentation process to speed up the breakdown of hazardous materials. The following forms of bio-remediation may be used, depending on the process of degradation:

Compost bio-remediation: In this procedure, compost tea is brewed in order to introduce several helpful bacteria into the soil. In order to bio-remediate toxins, compost tea is a water-based, oxygen-rich culture that contains a significant population of beneficial aerobic bacteria, nematodes, fungus, and protozoa. This concoction is used to clean up polluted areas where microbial activity breaks down the dangerous compounds.

In situ bioremediation: "Bioremediation applied to soil or water at the site with minimum disturbances" is the definition of in situ bioremediation procedures. Technologies are applied "in place" rather than removing the polluted matrix. These methods are the best because they are less expensive and cause less disruption since they deliver treatment where it is needed without excavating or moving toxins.

Ex Situ Bio-remediation: These bio-remediation techniques include excavating the contaminated matrix in order to modify it using slurry reactors, compositing, biopiles, etc. The location of the polluted area was deteriorated in this method.

Positive aspects of bioremediation

Bio-remediation is a natural process with no negative effects on the surrounding people or communities. The following list of benefits of bio-remediation includes:

A broad range of harmful compounds may be completely destroyed via bio-remediation. Many chemicals that are designated as harmful by law may be converted into innocuous compounds utilizing this technology.

Both on and off site bioremediation is an option

Compared to other methods, bio-remediation is less costly for cleaning up hazardous waste. Because bio-remediation is entirely dependent on natural bacteria, it has no negative effects on humans, animals, or other living things.

Negative effects of bio-remediation

Compared to other approaches, bio-remediation often takes longer. It's conceivable that the bio-remediation product will be more harmful than the parent substance. Only biodegradable substances can be cleaned up using bio-remediation. Introducing genetically altered microorganisms into polluted soils with the intention of pollutant degradation is known as bio-augmentation. The physico-chemical characteristics of the soil and the capacity of the newly introduced microorganisms to effectively compete with the native soil microflora are two elements that affect this technique's effectiveness.

We have covered a variety of topics related to land management, soil improvement, soil rehabilitation, and restoration of unused land in this unit. As of now, you know that: The management of production and land use systems in a manner that will enhance productivity is referred to as land husbandry. The productivity of land may be increased by a variety of strategies for enhancing land, soil, and waste land. Soil agglomeration, soil rehabilitation, and soil restoration are a few examples of land management techniques. Active management of slopes, vegetation, soil, and rain water are all included in land husbandry.

Hugh Hammond Bennett, known as the "Father of Soil Conservation," is credited with creating a number of manuals on erosion control that detail practical knowledge, technical principles, mechanical techniques to be used, and a number of useful recipes that have been implemented with varying degrees of success in various geographical areas. "Land husbandry is the active process of putting preferred production methods in place and managing them such that there will be a gain in - or at worst, no loss of - productivity, stability, or usefulness. for the selected objective; moreover, in some circumstances, it could be necessary to modify current usage or management to stop fast deterioration and bring the land back to a state where good husbandry can have the greatest impact. Using a procedure called soil amelioration, we may raise the soil's quality. The Latin word "melior," which means "better," was used to create the term.

We can tell if the soil is contaminated, saturated with water, or more salinized, among other things, by a number of indicators. Water drainage is a sign that allows us to see how much water is moving slowly or fast across soil. This might mean that the soil is either saturated or unsaturated. Scraping, leaching, drainage, irrigation techniques, irrigation used correctly, mulching, and other amelioration treatments for saline soil are included. In the restoration of land, the soil is crucial. The soil regulates how quickly crops develop on the land and how much water infiltrates the soil, flows off as surface flow, is kept at the surface in ponds, or is retained in the soil connected to soil particles via evaporation or transpiration of water into the atmosphere. The soil also controls how quickly soil is eroded by water or wind, either directly or indirectly via the vegetation cover. Soil is a living resource, a complex dynamic, developing, biologically modified open system, and a living ecosystem[9].

The fundamental requirements for plant species in waste land rehabilitation are that they should be able to survive at the nursery and growth stage on waste land, have a high reproductive fertility, a high establishment rate, a good capacity for regeneration, and meet local requirements for fuel, food, and fodder. "Restoration" in the context of an ecosystem refers to the process of restoring an ecosystem that has been harmed, degraded, or destroyed, sometimes as a result of soil erosion or human intervention. An ecosystem is being restored in an effort to put it back on its previous course.

Use of organic agricultural methods, Green manure and cover crops, organic compost, crop rotation, and soil remediation are a few methods for repairing damaged soil. Utilizing microorganisms to break down dangerous compounds found in soil, sediments, water, or other polluted materials is known as bio-remediation. For bio-remediation, certain types of bacteria, fungus, algae, and plants are employed. Microorganisms are brought to contaminated sites as part of the bio-augmentation process to speed up the breakdown of hazardous materials[10].

Compost bioremediation and Remediation

Bio-remediation has a number of benefits, including the ability to completely destroy a broad range of harmful compounds. Many substances that are regarded as hazardous by law can be converted into harmless compounds using this technique. Bio-remediation can be used on or off site, and it is less expensive than other technologies for cleaning up hazardous waste. Because it is entirely based on natural microbes, it has no negative effects on people, animals, or plants. Bio-remediation has a number of drawbacks, including the fact that it typically takes longer than other technologies, that the final product may be more toxic than the original one, and that it is only permitted for bio-degradable substances. Control manuals are available that describe practical experience, technical principles, mechanical methods to be used, and a number of real-world recipes that have been adopted with varying degrees of success.

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CHAPTER 10

INTRODUCTION, STATUS, FEATURES, AND UTILIZATION OF WATER AND WATER RESOURCES

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One of the most significant natural resources and sometimes referred to as the "elixir of life," is water. This statement, "Water is the Driving Force of all Nature," helps us to grasp the significance of water. It implies that water is responsible for all of nature's processes. It is often believed that the best medicine is pure water. More than 97.5% of the water on Earth is seawater found in the oceans. Due of its low salt concentration, the remaining water is known as freshwater. The majority of freshwater is solidly frozen in Greenland's and Antarctica's massive glaciers. Nearly all of the fresh water that is accessible to humans is either surface water which is found in lakes, rivers, and streams or groundwater, which is found beneath the surface in rocks and soil. Without water, life on this planet is unimaginable, making water the most valuable gift that nature has to offer. As you are aware, human beings utilize water resources for environmental, agricultural, industrial, domestic, and recreational purposes. Fresh water makes up only 2.5% of the total amount of water on Earth, and more than two thirds of it is frozen in glaciers and polar ice caps.

According to estimates, irrigation in agriculture accounts for 70% of all water usage worldwide. Due to the close relationship between the climate and hydrologic cycle, climate change will have a significant impact on water resources all over the world. The average runoff in India's river system is about 1869 km3, and of that, it is predicted that about 690 km3 will be usable. This priceless resource is rapidly being depleted and contaminated as a result of various anthropogenic or man-made activities. a number of anthropogenic or man-made activities, such as domestic sewage, industrial effluent, excessive use of chemical fertilizers, and improper solid waste management, can seriously harm water resources. As you are aware, we commemorate World Water Day on March 22nd each year in an effort to protect this priceless natural resource. You will learn about the characteristics and use of water resources, as well as their availability on a national and global scale.

Resources for Water

Among all of the natural resources, water is the most valuable. On our planet, water is the substance that is most evenly distributed. Without it, human life itself is impossible because there is nothing that can replace it. Fresh water has always been consumed by men for a variety of reasons. Water resources are generally freshwater sources that are useful to humans or may be useful to them, such as for domestic, agricultural, and industrial purposes.

Water resources are so heavily polluted in many parts of the world that they are already unable to keep up with demand. This is now the main issue impeding both population growth and economic development. There are three different forms of water: liquid, solid, and gas. It creates the surface waters found in the top layers of the Earth's crust and soil, as well as the underground waters, lakes, rivers, and oceans, seas, and lakes. In the Polar Regions, it exists as ice and snow cover in a solid state. Water is present in the biosphere, as well as in the air as ice crystals, water droplets, and water vapor [1], [2].

Water is incredibly dynamic, making it difficult to reliably monitor the total amount of water stored on Earth. It is constantly shifting between the liquid and solid or gaseous phases, or vice versa. Estimating the amount of water present in the hydrosphere is crucial. It is estimated that the hydrosphere contains 1386 million cubic kilometers of water, which is a significant amount. However, only 2.5% of this total is fresh water, making up 97.5% of the total saline waters. Only 0.26% of the total amount of fresh water at the global level is concentrated in lakes, reservoirs, and river systems where it is most easily accessible for our economic needs and essential for water ecosystems. The majority of this fresh water is in the form of ice and permanent snow cover in the Antarctic, the Arctic, and in the mountainous regions. Another 29.9% is present as fresh groundwater.

That water, as was mentioned earlier, is dynamic and changes phases frequently. Water on the earth's surface evaporates due to the sun's heat and enters the atmosphere. A constant stream of water vapor is released from the land, lakes, rivers, and oceans; this vapor spreads across the planet's surface before returning as precipitation or rain. The primary cause of the formation of land-based waters, such as rivers, lakes, groundwater, and glaciers, is precipitation that falls on the surface of the earth. A portion of atmospheric precipitation evaporates, some seeps into the ground and recharges it, and the remainder flows downstream as rivers and returns to the oceans, where it evaporates again. However, some groundwater bypasses river systems entirely and may flow straight into the ocean or evaporate in the atmosphere.

These are the primary sources of fresh water needed for both life support and economic activity. The hydrological cycle and the human water supply both greatly depend on river water. Deep groundwater and mountainous glaciers recharge completely in about 1500 years, permafrost and ice in about 10,000 years, and seawater in about 2500 years. Over the course of 17 years, lakes' water reserves are completely replenished and about 16 days in rivers. Two ideas that are frequently used in hydrology are the static storage component and renewable water, both of which are based on the characteristics of water exchange. Normally the static storage includes groundwater and large lakes that undergo a period of complete renewal over many years or decades. Inevitably, intensive usage of this component depletes the store, which has negative effects.

Water inside May occasionally revert to its original purity if man suddenly stops polluting rivers. The most crucial part of the hydrological cycle is therefore river runoff, which represents renewable water resources. It significantly influences both human economic progress and the earth's ecosystem. River runoff supplies the majority of the world's water usage and is dispersed across the land surface most broadly [3].

State of the World's Water Resources

In a literal sense, water is what gives life to the planet. It is a key component of the hydrosphere, which also includes the shallow groundwater bodies that interact with the surface water and the oceans, seas, rivers, streams, glaciers, lakes, and reservoirs. Water, mostly in the form of oceans, covers around 70.8% of the surface of the world. A rough estimate 1,386 million cubic kilometers of water make up the hydrosphere, of which 97.5% are found in the oceans and inland seas, where the high salt content prevents human usage. The glaciers, ice caps, rivers, streams, lakes, reservoirs, and ground water sources all contain around 2.5% of the world's total freshwater supply.

Freshwater and saltwater supplies have remained mostly stable throughout time. However, the little area where freshwater and seawater meet has always altered in response to climate conditions. In the hydrological cycle, temperature is a crucial factor. By paying attention to the example, you may comprehend this phenomena. When the temperature is very cold, glaciers and ice caps absorb a large amount of seawater, causing freshwater levels to rise at the cost of the sea. However, in warm climates, glaciers and ice caps melt and sea levels rise at the expense of freshwater. Observations of sea level over the last 100 years show that the sea is rising, which suggests that the global climate is continually warming [4].

Freshwater

Ice caps, ponds, lakes, rivers, streams, and groundwater are all examples of places where fresh water may be found naturally. The amount of dissolved salts and TDS is minimal. Freshwater makes up around 2.5% of the planet's water. Another name for it is "Sweet Water." Precipitation/rainfall is the primary source of freshwater. Fresh water is a renewable and flexible, yet finite natural resource. Fresh water alone is replenished by the process of the hydrological cycle, in which water from oceans, lakes, forests, land, rivers, etc. evaporates, produces clouds, and returns as precipitation. Freshwater may classed as surface water and Ground water.

Salt-Water

Saline water is one which includes a significant concentration of salts. About 97.5 % of the total water in the globe is salt water. On the basis of salt content, saltwater may be classed as follows. Slightly salty water: In this group salinity is roughly 1,000 to 3,000 ppm or 0.1–0.3%.

1. **Moderately saline water:** In this sort of salt water, salinity is roughly 3,000 to 10,000 ppm or 0.4–1%.
2. **Highly salty water:** In this sort of salt water, salinity is roughly 10,000 to 35,000 ppm or 1.1–3.5%.
3. **Importance of Water:** Water is necessary for life not just human life, but all natural processes of our planet.

It is part of life itself, as it is the medium in which all living activities occur. It dissolves nutrients and distributes them to cells, regulates body temperature, maintains structure and eliminates wastes products. Even, roughly 60% of human body is made out of water. As you know that we start our everyday activities with water. Any individual may live for week without food, but cannot survive more than few days without water. Since the earliest days of history, the availability of water has controlled where human settlements were formed and what food human being could raise. Many human civilizations were developed around the water bodies. Without water neither the individual neither the society can exist. The earth is only a planet where liquid water occurs in adequate amounts. Water bodies cover more than 70% of world surface. Unfortunately, most of the water on earth is salt water, which is not appropriate for drinking and other uses.

As you know every activity of man involves some use of water, and he needs water not only for drinking purpose, but also for bathing, washing, heating, air conditioning, agriculture, livestock, industrial activities, hydropower generations, steam power, navigation, recreation, aquaculture, and for disposal of waste. A community with a restricted water supply is a community with a limited growth, since the total food production and large scale generation of electrical energy still very much rely on the availability of water resources and also there is a rising demand of water by industry. There are considerable variances in present per capita water availability for each continent. Oceania has over 70,000 cubic meters per person per year, the Africa has under 7000 m3/person/year on the other side Asia has just 3400 m3/person/year. If the overall quantity of water is largely stable, greater and larger number of people will diminish total per capita water availability over time [5].

Fresh Water Crisis:

Water is consumed in enormous amounts compared to all other natural resources. The total volume of water utilized on Earth annually has recently been about 1000 times the entire amount of minerals produced worldwide, including coal, oil, metal ores, and non-metals. Total water quantity is not the issue on a global basis. Water availability at the appropriate location, at the appropriate time, and in the appropriate form is the issue. As you are aware, rainfall/precipitation is seasonal, and as a result, the volume of inland water varies. Floods and droughts are often brought on by irregularities in the timing and intensity of rainfall. As you are aware, freshwater resources are restricted on a worldwide scale. Each year, 12.5 to 14 billion cubic meters of water are thought to be accessible for human consumption. On the other hand, freshwater is also enough for the entire world's population, but equitable distribution is impossible due to two factors: first, the fact that two thirds of people on earth live in regions that receive only a quarter of the world's annual rainfall; and second, the lack of consistent rainfall throughout the seasons or from year to year.

Freshwater resources are dispersed unevenly, with a large portion of the water being placed distant from people. The majority of the world's biggest river basins pass through sparsely inhabited regions. By 2025, it is predicted that two out of every three people would live in water-stressed regions. A 20% of the world's population does not have access to clean drinking water. In underdeveloped nations, fecal contamination of surface waterways continues to be a leading source of sickness due to water-borne illnesses. According to estimates, 1.2 billion people's health are negatively impacted by pollution, and 15 million children die each year as a result. The oceans' levels may significantly increase as a result of climate change. This might make some coastal regions entirely flooded and make other locations more vulnerable to human exploitation. Because marine resources are very important to human populations. Due to the consequences of both sea level rise and changes in marine ecosystems, small island developing states are particularly susceptible [6].

A 10% of the water left flows into inner basins and undeveloped lakes. Most Indian rivers are cesspools of filth poured from different urban and industrial areas, in addition to the floods and droughts. 18 significant rivers are seriously contaminated, according to the Central Pollution Control Board. Through deforestation, sand mining, riverside brick manufacturing, and pollution, 44 rivers in the State of Kerala are losing quality. As you probably already know, rivers provide irrigation, raw water for industry, and drinking water for both urban and rural regions. Many rivers in India have silt buildup in their beds, which decreases flow and disrupts the environment. Deforestation in the river's riparian area causes soil erosion, landslides, floods, silt accumulation, and other problems. The siltation rate in Indian rivers is one of the highest in the world. About 32 million tonnes of soluble matter and 135 million million metric tonnes of sediment load are expected to reach the ocean via several rivers. On these rivers, several major dams and barrages have been constructed. Unit 10 of this course covers the different dams in India and their effects.

The most beautiful lakes in the world are found in India. They may be found in the northeast, Rajasthan's semi-arid deserts, coastal areas, small cities, and villages, as well as the high Himalayan regions under the ice sheath. Lakes are a significant supply of water for drinking, farming, and industry in India. These lakes serve as groundwater recharge zones, sewage absorbers, and flood controllers. These are significant ecosystems where many birds and other creatures live. Additionally, lakes support pisciculture and aquaculture, both of which are successful and offer a source of income for people. There are urban and rural lakes in India that fall within the Ramsar Convention on Wetlands classification. These lakes are significant primarily for their ecological sustainability and as a means of subsistence for many populations. Lack of water in these lakes, whose sources of replenishment have been severely harmed by human activity. However, surface water and ground water make up the majority of India's water resources [7], [8].

Resources for surface water: Surface water is the kind of water that naturally appears on the earth's surface. This water is found in rivers, lakes, marshes, and even the ocean. Rainfall or other precipitation is the principal source of surface water. After the rain, a considerable percentage is either temporarily retained in surface depressions or caught by the plants. The remaining water starts to flow after the soil is completely saturated. Rivers, streams, lakes, surface reservoirs, and other water bodies get this water. Surface water resources are the major source of agriculture's needs. Reservoirs are used to hold runoff from streams and rivers, while canal systems are used to redirect it for irrigation. In India, the amount of surface run-off caused by precipitation and snowmelt is estimated to be about 1869 billion cubic meters. Only roughly 690 billion cubic meters, or 37%, of the surface water resources are thought to be really mobilizable. Because over 90% of the Himalayan Rivers' yearly flow occurs over a four-month period and because there aren't many places with sufficient storage reservoirs, the possibility to use such resources is challenging.

Indian river systems are characterized by their capacity to erode and convey silt. Numerous things have an impact on this. The essential characteristics of a river are its flow, gradient, speed of water, and form. The distance that water in a river flows in a certain length of time is known as its velocity. Water energy has a direct relationship with water velocity in rivers. As you are aware, a fast-moving river may transport heavier particles and degrade things more quickly than a slow-moving river. The slope's steepness, the volume of water flowing downstream, and the nature of the water's course all have an impact on a velocity. The gradient of a stream or river refers to how steep the slope. The quantity of water that flows through a certain location in a specified period of time is known as a river's discharge. A river's discharge is not necessarily steady over its whole course. Because numerous tributaries keep adding water to the river, discharge rises downstream in the majority of rivers. More water enters rivers when there is greater precipitation during the monsoon or when snow is melting. The river widens and deepens as the water's velocity rises, causing a flood.

Lakes:

India is also home to a number of lakes. Lakes are created by obstructed rivers, the retreat of glaciers, etc. In lakes, the earth is quite wet and there are a few spots where the water is stagnant or flowing slowly. Lakes have lentic ecosystems because the water is still and not moving. Lake water is stratified based on temperature, oxygen content, and biological elements. Lakes are inland depressions that continuously store standing waters. Lakes are regarded as a significant source of freshwater supply since they are typically bigger than ponds and have more accessible water than groundwater or glaciers. In terms of equality and quality, the water from these sources is superior to that from rivers and streams. Because lakes are motionless compared to streams and rivers, they are often stratified. If you swim in a lake where the top water is warm, the deeper side of the lake will seem colder to you. The lowest layers are often the ones that are the coolest. Spring and autumn stratification is prevented by temperature changes, and nutrients are stirred up by bottom waters coming to the surface during those seasons.

India has five states with glaciers, and various rivers get their water from these glaciers. The capacity to flow is a glacier's primary distinguishing trait. When enough ice is accumulated, it puts significant pressure on the ice in the lower layers and develops flexible qualities that allow the ice-mass to move outward or downward, resulting in the formation of an active glacier. When there is a significant buildup of ice on a slope, the glacier will gently flow down a valley under the pull of gravity until it reaches a point where the rate of melting precisely balances the accumulation of ice. Far below the snowline, a glacier may exist. As you are aware, the glacier's center is where snow accumulates the most, and its margins are where ice thickness is at its thinnest. The thickness of the glacier, the gradient of the slope it covers, the ice's temperature, the rate of evaporation and melting, and the level of friction that slows the glacier's movement are just a few of the variables that affect how quickly it moves [9].

Resources for Ground Water:

As you are probably aware, ground water is water that is found underground. Ground water is the second greatest source of fresh water after glaciers, ice caps, and snowfields. When runoff from the surface or rain that does not evaporate back into the atmosphere percolates through the soil and either collects in or below the ground. The creation of a groundwater supply may be rather straightforward. Groundwater is often transparent and colorless, but it is also harder than surface water. Groundwater has a usually consistent quality. In many parts of the globe, especially when surface water supplies are limited, groundwater serves as the primary supply of freshwater for home and agricultural use.

Rainfall/Precipitation is the primary source of ground water. However, additional sources such as seepage from canals and field channels, ponds, tanks, deep percolation from irrigated fields, etc., complement ground water recharge. Any portion of these water sources that seeps into the soil's top layer may continue to migrate laterally at a short depth. The stream channel may ultimately be reached by the water that is present below the soil's surface. Melted snow, surface run-off, subsurface run-off, and ground water run-off all contribute to the rivers' overall run-off. The contribution given to ground water from nearby basins, effluent rivers, natural lakes, ponds, and constructed storage reservoirs is included in ground water resources together with a portion of run-off water that, after infiltration, reaches the ground water.

The following three categories best describe the ground water in India based on geological considerations: Unconsolidated rocks: Between the Himalayan foothills in the north and the peninsula in the south, this area encompasses the enormous alluvial plains of North India. The Indus, Ganga, and Brahmaputra rivers are the most significant sources of unconsolidated rock deposits.

The Central Ground Water Board and the State Ground Water Departments now calculate ground water resources using the rules and regulations established by the Ground Water Estimation Committee. The country's yearly replenishable ground water resources come out to be 45.33 m based on the committee's recommendations. The amount of groundwater that might be used for irrigation after allowing 15% for industrial, drinking, and other purposes was calculated at 38.34 m. hectare m annually. According to the Planning Commission, there are 178 million hectare meters of water resources in total, but only a tiny percentage of them may be utilised due to physiography, geology, reliability, quality, and current technological advancements. Due to the population boom, there is an increased need for water for irrigation, which necessitates the adoption of new technologies that will be necessary to make efficient use of the water resources.

Irrigation

As was already indicated, the agricultural sector uses around 70% of the water resources available. In 1950–1951, India had an irrigated area of around 22.6 million hectares. Due consideration was given to increasing irrigation since the country's food output was far below what was needed. India's total potential for irrigation is estimated to be 140Mha, of which 64Mha would come from groundwater sources and 76Mha from surface water. A total of 428 km3 of water 300 km3 of surface water and 128 km3 of groundwater was utilized for irrigation throughout the 20th century. According to the estimations, the water needed for irrigation by 2025 will be 611 km3 for a high-demand scenario and 561 km3 for a low-demand scenario. By 2050, these needs are probably going to be 628 km3 for a low-demand scenario and 807 km3 for a high-demand scenario.

Since India's economy has traditionally been centered on agriculture, the expansion of irrigation to boost agricultural productivity and help the nation become self-sufficient has been of utmost significance to planners. As a result, the 5-year plans gave the irrigation sector a very high priority. To improve irrigation capacity and optimize agricultural output, projects like the Bhakra Nangal, Hirakud, Damodar Valley, Nagarjuna Sagar, Rajasthan Canal Project, etc. were undertaken. Population increase must be taken into consideration in long-term planning. The output of food grains has expanded, from around 50 million tonnes in the 1950s to nearly 203 million tonnes in the years 1999-2000, according to National Water Policy. By 2025, the population is predicted to reach 1286 million in the low growth scenario and 133 million in the high growth scenario, according to the National Commission on Integrated Water Resources Development. Approximately 1581 million people are projected to live on Earth in 2050 under high population growth scenarios, compared to 1346 million under low growth scenarios.

Power from Water

Since ancient times, water resources have been exploited to produce hydroelectric power. At a 60% load factor, India's hydropower potential has been calculated at 84,044 MW. The installed capacity of hydropower plants was 508MW at the time of independence. The installed hydropower capacity was roughly 22,000 MW in 1998. In important basins, hydropower development is at a very unequal stage [10].

For use in industries

Additionally, water is employed in many industrial operations, such as fabrication, cleaning, processing, dilution, cooling, etc. In India, the agricultural sector consumes the majority of the country's water supplies nearly 90% for farming and raising cattle. Around 19% of the world's water resources are used industrially on average. In the United States, 5% of the water supply is used for industrial purposes. Following ground water and municipal water as key sources for industrial use is surface water. The biggest consumers of water resources are the industries that make metals, wood, paper goods, chemicals, oil, etc. Rough calculations show that the industrial sector now uses about 15 km3 of water per year. With installed capacity of 40,000 MW and 1500 MW, respectively, thermal and nuclear power facilities are anticipated to utilize around 19 km3 of water each. The water needed by enterprises in 2050, given the current pace of water usage, would be 103 km3; but, if water-saving technologies are widely implemented, this number is anticipated to drop to about 81 km3.

Aquaculture

As you are aware, aquaculture is the raising of aquatic creatures, particularly fish, for human consumption. Aqua-farming is another name for aquaculture. Fish, crustaceans, mollusks, aquatic plants, algae, etc. are all farmed by aquaculture. Aquaculture thus needed access to water resources like ponds, rivers, and lakes. About 9.6 million tons of aquaculture are produced annually in India. India comes ranked second to China in terms of aquaculture output. Since India is endowed with abundant water resources, aquaculture is widely practiced there. Water resources are the only basis for all water-based industries, including fishing, prawn culture, integrated fish farming, mariculture, pearl culture, mussel culture, seaweed culture, etc.

Recreational

Recreation is a vital and expanding activity on a worldwide scale. People engage in this sport for leisure to typically refresh their bodies and minds. Numerous research revealed that among the most popular activities are those that include water, including swimming, bathing, and river rafting. There are several areas of land near water bodies that are available for outdoor activities like hiking, hunting, snow skiing, etc. Swimming, water skiing, and fishing are some activities that involve water resources.

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CHAPTER 11

DAMS: THE NECESSARY EVIL IN THE DEVELOPMENT OF WATER RESOURCES

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As we discussed in Unit 9 of this course, where we discussed how to use water resources, you already know about the water resources. The greatest resource in the planet is water. But regrettably, this resource is not evenly distributed, and the majority of the water is found as salt water in seas and oceans. 2.5% of the world's freshwater supply is available, however the majority of that 2.5% is trapped in glaciers and ice caps. As a result, groundwater and surface water are essential to human life. River basins undoubtedly have played and will continue to play a crucial role. Water resources have been evolved in accordance with how man utilizes them. Development of water resources may be seen as a series of efforts aimed at enhancing the beneficial use of water for human civilization. Water applications may be divided into consumptive and non-consumptive categories.

For environmentalists who are interested in sustainable development, habitat loss, pollution, deforestation, and wetland destruction, for lawyers who are interested in water rights and legislation, and for economists who focus on economic growth, poverty alleviation, etc., water development may be of interest. Engineers manipulated water by building dams, canals, hydropower plants, and other structures in order to generate a certain water potential. Since the beginning of time, man has utilised water resources for a variety of reasons. As we learned in unit 9 of this course, there are many ways to use water, including for residential purposes, irrigation, aquaculture, and the production of hydroelectric power. Dams are a prime illustration of how human beings have developed water resources. Humans have altered water resources in many different ways. We should develop the water in sustainable ways if we wish to utilize it properly and sustainably. You will study about the notion of a dam, dams at the national and international levels, the beneficial and bad effects of dams, and the reasons why dams are seen as a necessary evil in this unit.

Resource Development for Water

The development of water resources has been seen in many places of the globe as a means of fostering social and economic progress. Ecologists, environmentalists, hydrologists, sociologists, and economics are interested in water development. Development of water resources may include leisure activities, construction of dams, and irrigation techniques. According to one definition, "the set of activities of planning, developing, distributing, and managing the best utilization of water resources" refers to the development of water resources. Planning for the development of water resources should ideally take into account all water demands and aim to allocate water in an equitable manner to meet all human needs[1]. As you are aware, India is a historically rural, agricultural nation that is fast becoming urban. With significant inter-annual changes, the country gets a significant portion of its yearly precipitation during monsoon season.

In many areas of the nation, a significant percentage of the yearly runoff must be stored in reservoirs between monsoon seasons for a variety of purposes. Per capita reservoir storage in the nation is quite low, and water usage efficiency is still inefficient. Water needed for scientifically producing crops in regions with little rainfall. River navigation may be improved by increasing the flow and the depth of water needed to accommodate bigger boats. Water development in India has a long history, although large-scale water development only began in the 19th century. Near first, several "run of the river" kinds of irrigation diversion projects were constructed near the foothills of the Himalaya. A significant ground water development occurred after 1975. Approximately 220 km3 of live storage have been established in different locations, excluding minor, small, and medium storages, according to statistics from the Central Water Commission of India. Water resources may be developed locally using a variety of techniques. The water resources have undergone numerous human modifications a some of the traditional techniques for developing water resources.

Seasonal check bunds are excellent water sources. Water may be found in rivulets and gullies, which transport it for 4-6 months during and after the rainy season. The construction of checkbunds over rivulets using soil or cement is typically not advised since the rivulets are prone to high flooding and the watershed experiences considerable siltation. Instead, in the last stages of the rainy season, temporary checkbunds are built by laying sandbags over rivulets. The water is utilized to irrigate fruit orchards and grow rabi crops. Local communities may construct temporary check bunds or dams. Farmers have constructed bunds without financial assistance in several places. Water that is kept behind check bunds may be directed to plots at lower elevations by gravity. Farmers often pump water and utilize it for their purposes. During monsoon season, the building is often destroyed and has to be reconstructed. Gully plugging may be done using earthen dams that utilize the catchment area as a percolation tank.

Beneficiary farmers must be in charge of and have ownership over the catchment area as a necessary condition. Water gathered in percolation tanks, behind check dams, and water flowing via rivers are all distributed using lift irrigation. Farmers build agricultural tanks and ponds, which are filled with raised and transported water. The growth of natural springs and rivers is another crucial approach for the production of water. Development of natural springs or rivers is mostly done to provide drinking water, agriculture, etc. Natural springs are widespread in regions with dense forest cover. To collect water from these springs, utilize it for drinking, irrigate farmland and nursery plants, and prevent deforestation in the watershed region, special efforts are undertaken. Trapezoidal agricultural ponds of different sizes are dug to retain rainwater on plots where percolation of rainfall is poor. The water is utilized to irrigate vegetables, fruit trees, and food crops. Pond dimensions may range from 5 m x 5 m to 10 m x 10 m[2], [3].

Dams on a National Scale

India is well-endowed with a variety of natural resources, including several rivers that run across the nation. Numerous rivers, including the Godavari, Krishna, Damodar, Ganga, Yamuna, Tapti, and Indus, run across the nation. The National Water Resource Council of India established the country's national water policy in 1987. This strategy places a strong emphasis on an all-encompassing, basin-focused approach to water development and encouraging water usage. The conservation, management, and development of water as a national resource are within the purview of the Government of India's Ministry of Water Resources, River Development, and Ganga Rejuvenation. Additionally, it is in charge of general policy, technical support, training, research and development, multipurpose projects, flood control, including flood-proofing, water logging, marine erosion, and dam safety, from a national viewpoint. The regulation and development of interstate rivers, the operation of tribunals, the evaluation of water quality, bilateral and international assistance and cooperation programs for water resources, and issues pertaining to rivers shared by India and its neighbors have all been assigned to the Ministry of Water Resource.

Advantages of a Dam

Water is a valuable resource that is becoming harder to get everywhere. There is increasing need to harness and use surface water sources in order to alleviate shortages. The application could be for aquaculture, irrigation, hydroelectricity, water transportation to deficient regions, etc. People have been moving water around for a long time; this is not a new trend. Large-scale irrigation systems that delivered river water to agricultural fields were the foundation of some of the greatest ancient civilizations. Canals were created by the Romans and Native Americans 2000 years ago to move water from remote rivers to where it was required. However, it's unlikely that those early water engineers had even considered transporting water on the scale that is now being planned and, in some instances, achieved. Any country's economy, wherever in the world, depends heavily on dams. Numerous dams have been built for a variety of objectives, including navigation, aquaculture, flood control, water supply, and irrigation. While hydropower is a significant source of energy on a worldwide scale, agriculture also needs appropriate water supplies, which are supplied by dams. Dams are thus essential to the nation's overall growth. In the past, dams were only ever built for one purpose: either to control flooding or for agriculture. But today's dams serve a variety of purposes and have several uses[4].

Provide Clean Energy: Dams are essential for harnessing the power of flowing water to generate electricity. In this procedure, the river's kinetic energy is turned into mechanical energy and used to spin the wheel. The Three Gorges dam, built in China across the Yangtze River, is the biggest dam in the world. The dam is 185 meters tall and 2.3 kilometers broad. The Grand Coulee Dam on the Columbia River is home to the largest hydroelectric facility in the country. Hydroelectric plants in Washington State generate more than 70% of the power used there. Currently, hydropower is the most affordable method of producing energy. Because the energy source flowing water is free after a dam has been constructed and the machinery installed. It is a clean, renewable fuel source.

One of the most significant advantages of the dams is irrigation. Since the majority of the rivers in India cross state lines, irrigation is a contentious topic there. But in India, the development of large and medium-sized projects has predominated in the irrigation sector. Water shortage is now a widespread issue for farmers everywhere in the world. Dams provide sufficient water for agriculture. Typically, during the dry season, this water is utilised. As you are aware, dams hold a lot of water, which may be released during the summer or dry months and spread across various channels and canals on agricultural area. As you are probably aware, 70% of water resources are utilized for irrigation. India has undertaken a number of irrigation projects, including the Bargi Project, Beas Project, and Bhadra Project.

Aquaculture is the practice of raising aquatic creatures, particularly fish. Since dams provide fish with a sufficient volume of water, a diverse assortment of plankton, enough water depth, and other favorable circumstances. Dams thus provide communities the chance to engage in aquaculture. Many studies have determined the suitability of these dams for usage in both net cage and multi-purpose irrigation systems for aquaculture. However, engaging in extensive fish farming in already-existing open water bodies may raise the water's nutrition levels via organic loading, which results from fish metabolic wastes and uneaten feeds[5].

Navigation: The world's governments are searching for alternatives as a result of the population boom, which undoubtedly puts a lot of strain on the world's highways. As you are aware, rivers are in highly hazardous situations as a result of erosion, sedimentation, etc. The rivers that have been dammed as they have grown provide navigable conditions. Dams provide a reliable river transportation system.

Flood control: Dams are also useful for preventing flooding since they may be used to efficiently control river levels and stop flooding downstream. For many of the current dams, flood management is their primary function.

Water supply: A prevalent issue facing the whole planet is water scarcity. Dams serve local populations with an appropriate quantity of water. For irrigation during the summer and dry months, dams store water. Due to water supply from dams and canals, many desert areas can now support agriculture. Dams are necessary to store water and subsequently supply it to communities during water shortages. They also offer drinking water to local stakeholders to balance the hydrological cycle and water cycle.

Land Improvement: Dams are useful for improving the land. Benefits from land improvement are the additional advantages that follow an increase in soil productivity as a result of drainage and land improvement practices.

Economy and employment: Top states and nations benefit economically from dams. Dams also provide engineers, labourers, farmers, fishers, etc. a job. Although dam building has a large upfront cost, it is incredibly cheap to maintain them. The least expensive energy is produced in hydroelectric power facilities.

Adverse effects of Dams

Despite the fact that dams have been helpful for millennia, Current River taming via large dams has led to several environmental, social, and cultural problems. They often diminish water supplies and undermine both natural and human values. Dams also have a number of negative effects, particularly on the environment, in addition to the good ones[6]. The biodiversity and water of the riverine environment are maintained via ecological flow. Construction of dams on rivers may alter the river's species mix and water quality.

Increase the likelihood of a catastrophic flood: The massive amount of water behind the dam may cause seismic activity, which may break the structure of the dam and result in catastrophic floods. As you are aware, catastrophic flooding is more deadly than alluvial, coastal, and other types of flooding. Cities may be flooded catastrophically in a few of hours.

Preventing sediment feeding of downstream channels or coastline beaches is accomplished by building dams and storing silt in reservoirs. The egg-laying zone of fish living in the riverine environment is also damaged as a result of this method of preventing the movement of sediments. Since the dam serves as a barrier, territorial animals' normal passageways are hampered. Fish may sustain harm when navigating high-bodied dam floodgates, turbines, and pumps. When drainage water from irrigation that was carried out in accordance with the irrigation projects returns, there will be significant changes in the water quality. The species may alter in tandem with erosion brought on by human activity or a long-term rise in water turbidity as a result of dam building. Some migratory fish have the characteristic trait of migrating, which involves the fish moving from one location to another for various reasons, most notably for breeding. Dam building has prevented many diadromous fish from migrating. Fish migration may be halted or delayed as a result of dam building. Fish cannot migrate between feeding and spawning areas because of the dam. The extinction of species may result from this kind of prevention.

Climate Change: The growth and building of dams may have an impact on local climate. Dam building may cause microclimate and even local climate changes.

Change in Water Quality: Some dams squander more water than they produce because so much of the water evaporates and seeps into porous rock beds. Evaporation-related salt deposits raise the river's salinity, rendering its water unsuitable downstream. In addition to rendering dams ineffective, silt buildup in storage reservoirs results in nutrient losses to agricultural fields downstream. Schistosomiasis outbreaks might be caused by snail population growth in shallow, permanent canals that provide water to fields. When dams are erected and reservoirs are created, a variety of water-related illnesses have been loosely linked to these events. The main cause for worry has been the sharp rise in the spread of schistosomiasis and malaria, particularly where water impoundments serve as hatching grounds for the disease's vectors. It has also been shown that onchocerciasis is spreading among people living downstream and close to dam spillways. The temperature of the water, the amount of salt, and the distribution of oxygen may alter vertically as a result of the construction of a dam, according to International River Network and Canadian Dam Association, 2001. This might result in the emergence of unwanted new species[7].

When soil is saturated with water, it is said to be "water logged." Due to the high water level, the soil may be waterlogged. Water logging may cause a loss of important biological communities, a decrease in soil air, an increase in soil salinity, etc. According to the Indian Institute of Science, the Sardar Sarovar Dam's command center would be submerged to a depth of around 40%. Dams have a significant negative influence on the social and cultural features of the area under consideration, particularly by forcing people to leave their homes and communities because of persistent flooding. Their mind is badly impacted by dams. Globally, 400–800 million people are said to have been impacted by dams. Dams enable us to store our limited freshwater supply for use when necessary. We are unable to compete with other nations throughout the world without dams. Dams are thus unavoidably needed. But why are dams so evilly necessary? Pt. Dams were seen as the "Temple of India" by Jawaharlal Nehru. But as you are aware, dams have both advantages and disadvantages. Dams were an essential component of the infrastructure at the time and have played a significant role in the history of urban expansion.

Due to the heavy reservoirs, big dams even contribute to earthquakes. They also produce greenhouse gases, decimate marine fisheries, and cause coastal erosion. The dam-related accident that received the greatest attention occurred in China, when over 2, 30,000 people perished as a result of dam destruction. According to the World Commission on Dams, between 40 and 80 million people have been uprooted because of dams. According to the statistics, dams have destroyed at least some of the lengths of the world's major river systems, if not all of them. On the other side, the enhanced availability to groundwater for family use, farm animals, and crops helped almost 7, 00,000 people in Alwar and adjoining districts of Rajasthan state alone. No family has been uprooted in order to do this. Rainfall may be collected on roofs and directed into tanks in urban settings, where rainwater collection is also effective. Although there are various alternatives to hydroelectricity, dams are still significant. Simply using power more effectively comes first[8].

This list may be expanded to include several more effects. The most crucial thing is to make a clear distinction between short-term advantages and long-term hazards. Engineers, hydrologists, social scientists, and other professional groups must be required to attend environmental impact assessments, and alternative solutions must perform their duties in the calculation of environmental consequences[9], [10].

Dams are crucial for the national economy in a variety of ways, including irrigation, clean drinking water, flood control, energy production, fishing, and tourism. In the meanwhile, the dams' altered habitat has helped a variety of species move into the region. Dams are crucial for both economic development and general moral and ethical advancement. Dams have played a significant part in the development of the undeveloped areas in many industrialized nations.

We need energy, aquaculture, agriculture, recreation, and flood control, but at the expense of negative environmental and societal effects, dams are now seen as a necessary evil. On the one hand, we should concentrate on the economics, but we also need to consider the detrimental effects of the Dam. Large Dams definitely injure people more than they help them. As a result, we need to build little dams that may be just as effective and do less harm. We've covered a variety of topics related to the development of water resources, including the pros and cons of dams. You now know that water development is a series of actions for organizing, creating, allocating, and managing the optimal use of water resources. Common techniques for developing water resources include seasonal check bunds, temporary check bunds/dams, earthen dams, lift irrigation, farm ponds, Jalkunds, and group wells.

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CHAPTER 12

WATERSHED MANAGEMENT, RAINWATER HARVESTING, MICRO-IRRIGATION, AND WATER RESOURCE CONSERVATION

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At a global level, protecting our natural resources is crucial. As you are aware, water is the most precious resource on planet and a need for maintaining life. We are all familiar with the significance of water resources, their use, and their development. First and foremost, it is the duty of mankind to conserve water supplies for future generations. Additionally, because water management uses a significant amount of power, it aids in lowering the quantity of energy utilized. In conclusion, various wildlife use water as a habitat. The international community thus works to stop the total depletion of water supplies. In units 9 and 10, you studied about water resources, their significance, and how to develop them. In these units, we spoke about a variety of water resources-related topics. Water supplies are running out more quickly than normal. Water demand also rises in tandem with population growth.

Deforestation, solid waste disposal, excessive pesticide usage, urbanization, industrialisation, mining, etc. are only a few human activities that contribute to the depletion of water resources. The water quality data from several rivers throughout the world demonstrated that human-made activities are undoubtedly to blame for the loss of water supplies. Due to the discharge of solid waste, even our ocean is being depleted. Water bodies are severely polluted by industries that discharge their effluents straight into them. One of India's biggest causes of water contamination is domestic sewage. Only 8 towns and cities in India have complete sewage treatment facilities, whereas there are 3,119 municipalities in the country with incomplete sewage treatment systems, according to the World Health Organization.

The water cannot be used because of human activity. In addition to being helpful to humans, water is also the habitat of millions of species. Due to the depletion of water supplies, many aquatic species are either extinct or on the brink of becoming extinct. As a result, it is our responsibility to safeguard this valuable resource at all costs. Conserving water resources may contribute to water preservation for future generations. As the population grows, there will be a greater strain on water resources to meet the needs of people, agriculture, industry, and leisure. We should keep in mind that water is the most important and finite resource while thinking about water conservation. You will study about a variety of methods for conserving water resources in this course, including watershed management, rainwater harvesting, micro-irrigation, and the Pani Panchayat idea [1], [2].

Saving Water Resources

The production foundation of the land and soil depends heavily on water. There are several ways to manage and save water, including micro-irrigation, watershed management, and rainwater collection. As you are aware, water is crucial for maintaining life as well as supporting ecosystems, economic growth, social cohesion, and cultural values. As a result, water supplies must be preserved for future generations. As you are aware, freshwater is scarce and dispersed inequitably around the planet. The water that is available for usage in every location is not equal and changes significantly over time as a result of human and natural processes.

Using the metric, any rise in population would result in a reduction in the amount of water available per person, which is often implicitly considered to be undesirable. The preservation of a targeted flow of benefits to a specific population throughout time without diminishing is a better definition of sustainable water usage.

It is neither necessary nor probable that the intended sets of advantages brought about by water will be the same for every user throughout the course of time. Given the disparities in politics, religion, culture, and technology, these advantages do vary significantly. But any genuine debate of sustainability must openly analyze the advantages that will be offered. According to the definition, water consumption is unsustainable since it depletes the water resources that society needs and wants over time. Even if other users are able to retain the intended services, an equity criterion would call for a decline in services to one user group over time to be deemed "unsustainable." Rainwater collection, better agricultural practices, the use of geothermal water, increasing forest cover, repair of traditional water resources, micro-irrigation, and other conservation tactics are just a few examples of the many conservation measures that may be taken to protect water resources. Because water is becoming scarcer, water conservation has become a major concern on a global scale. Rainwater harvesting, better agricultural techniques, the use of geothermal water, a rise in forest cover, the repair of traditional water resources, micro-irrigation, watershed management, etc. are some examples of conservation measures for protecting water resources. Due to the rising demand for water, one of the most significant concerns facing the world today is water resource conservation. We can all do our part to protect the water supply. Because a significant portion of water is used to meet our daily demands. Excessive water consumption in the kitchen, restrooms, and other areas. To minimize water use at our homes, there are many eco-friendly gadgets available, such toilet dams, water-saving showers, faucet aerators, etc. Additionally, our way of living contributes to excessive water usage; as a result, we should modify our way of life to use less water. We are able to preserve a significant quantity of water resources locally by engaging in these little actions by modifications to water flows and stocks that modify the water's spatial or temporal availability

by modifying the demand for a resource's advantages as a result of changes in the quality of life, technology, population size, or cultural norms. Sustainability is the foundation for water resource conservation. Water sustainability must meet a number of standards. The criteria and goals were developed after extensive discussion and analysis with academic, governmental, and non-governmental interests working on regional, national, and international water problems; they are not, on their own, recommendations for action, but rather, points of policies that lay out specific societal goals that could, or should, be addressed. These parameters, in particular, may serve as the foundation for alternative "viscous" for improved water management and conservation. The various sustainability criteria are listed below. To maintain human health, a minimal water need shall be provided to all people. Water allocations will be sufficient to restore and safeguard ecological health. The exact numbers will change according on the weather and other factors. Flexible and dynamic management will be necessary to determine these quantities. A specific minimal level for water quality will be maintained. These requirements will change based on geography and water use [3].

The long-term renewability of freshwater supplies and flows will not be harmed by human activity. Data on the availability, usage, and quality of water resources will be gathered and made available to all stakeholders. There will be institutional measures put in place to stop and settle disputes over water. Water planning and decision-making shall be democratic, ensuring that all parties with impacted interests are represented.

Watershed Administration

Watershed literally means Boundary. Every body of water has a watershed. The geographical region from which water flows into bodies of water is known as the watershed. In 1920, the word "watershed" was first used to describe borders. A region of the ground surrounded by drainage is called a watershed. The method for managing watersheds is often used in regions with heavy rainfall.

Watershed management is crucial because, as you are probably aware, runoff is the removal of water. Aquatic pollution may be caused by a variety of runoff types, including runoff from rain, agricultural land, and glaciers, in lakes, rivers, ponds, and other bodies of water. The management of watersheds aids in reducing aquatic body pollution. Watershed management has found a number of practices that have an impact on the water quality of a watershed, including gardening, septic tank discharge, and agricultural runoff. The bad effects or negative effects of pollution may be reduced by following the advice of watershed management to address these activities' negative effects on the watershed. Where there are little available water resources, watershed management is nevertheless beneficial. Land, water, and plants may all be protected via watershed management.

Watershed management has four basic stages: recognition, restoration, protection, and improvement. These steps are listed in that order. Following is a description of these four stages:

Phase of recognition: The phase of recognition consists of three crucial processes, including

Problems are recognized at this period, which may also include the inflow of pollutants from industry or the entry of pesticides from agricultural runoff. Monitoring of the issue at hand and its effects is stressed in this phase, along with monitoring of the watershed analysis. Monitoring allows us to determine if harmful substances are present in and around a watershed.

Using various methods in diverse resources for various objectives, rain water harvesting is a technique for gathering and storing rainwater. Rainwater may be gathered and stored in artificial tanks. Rainwater collection techniques also include rooftop harvesting. The communities in low-rainfall regions benefit from RWH. Due to a lack of water, they may continue harvesting seasonal crops by utilizing rainwater that has been gathered.

The act of collecting and storing rainwater so that it may be used is often referred to as rainwater harvesting. Water is directed toward a suitable gathering place when it rains. The technique of collecting rainwater has been around for a very long time. The difference is that there is now such a strong demand for water that rainwater collection is necessary to maintain the supply, particularly during the dry months. The procedure has been developed and is now being made simpler and more effective by modern technology.

Surface Water Collection Systems: Surface water is located above the surface of the planet, as you are aware. Rain often travels down slopes as it goes toward a point of depression as it falls on the surface. Rainwater may be collected using surface water collecting systems before it is dispersed to other regions. Water collecting structures like rivers, ponds, and wells are examples. Water may be sent into these systems via pipes. There are several uses for this water.

Rooftop System: This system is crucial because it allows every home to collect rainwater. The rooftop system technique of collecting rainwater is popular since the water that is collected is clean, pure, and doesn't need any further processing to be appropriate for human use. In this approach, a tank made of cement is built onto the roof of a home, a school, or any other structure, and rainwater is collected in a second tank via the use of pipes. The second tank should be constructed underground to provide for enough rainwater storage [4].

Dams: As you may already be aware, dams are obstacles built to store water. These dams have the ability to directly catch rainwater. Most often utilized for agriculture, treated rainwater that is collected and kept in dams may also be used for home uses. Because of the manner they are built, dams may also be utilized to collect a significant amount of rainwater.

Underground Tanks: For collecting and storing rainwater, underground tanks are also vital and crucial. To minimize water penetration, these tanks are constructed by excavating into the earth and then cementing them. Where the roof top is not appropriate or available, the top part of tanks may instead be used. The rain discs resemble umbrellas. Rainwater is often collected in these saucers that are hooked to pipes. As opposed to roof top approaches, these rain saucers cover a larger area.

Reservoirs for collecting water: This approach is not entirely secure, as rainwater may get contaminated. However, irrigation could be done using the water that was gathered in this way. This technique collects rainwater from sidewalks or highways.

Barrage: This technique uses a dam with several apertures that can be closed or opened to regulate the amount of water that flows through it. It may be used to gather enough water since it is typically big.

Slopes: When rainfall is applied using this manner, it tends to flow off the ground and gather at the bottom of slopes. When it rains a lot, the water level may climb to the top of the hill. This technique is the most straightforward and organic approach to collect rainwater.

Trenches: In this technique, trenches are used to channel rainfall toward the agricultural field. This is one of the greatest old-fashioned rainwater collection techniques that is still widely used today.

Rain barrels: Rainwater is also collected using rain barrels. They may be bought from shops and are made specifically for collecting water. These rain buckets are used for collecting rooftop rainfall.

Benefits of Rainwater Harvesting: Since rainwater contains few contaminants, it may be utilized for a variety of tasks. Rainwater collection has a number of benefits, which are listed in Fig. 4 and further addressed below:

Domestic Water: The RWH is useful since it offers a supply of water for usage in the home. Water that has been collected and kept may be utilized for food preparation, washing, and cleaning. Rainwater may also be utilized for drinking after treatment. It is the simplest method of obtaining water for domestic usage. Instead of using clean water in the toilets, you may utilize rainwater. The RWH conserves potable water that would only be utilized for drinking and cooking [5].

Water for Industrial Use: A number of firms may place more emphasis on collecting rainwater for use in various industrial procedures. Usually, rainwater intended for industrial use is captured on a massive scale. These businesses may build their own underground reservoirs or dams to collect rainwater. Rainwater collection should normally be done on a big scale for industrial purposes.

Supplemental Water Source: As you are aware, owing to improper rain and high rates of evaporation, many locations have water shortages, particularly during dry or hot months. During dry spells, finding a source of water could be challenging. With an increase in water consumption, water costs likewise rise. As a result, collecting rainwater is thought of as a means to be ready for dry spells.

Irrigation: As you are likely aware, India's agriculture is largely dependent on rainfall. poor rainfall results in poor crop productivity when it occurs often. Harvesting rainwater is essential to agriculture and farming. Once rainwater has been collected, it might be used, particularly during dry spells. Harvesting rainwater allows farmers to achieve high rates of output.

Cost-effective: Rain falls on every continent. You are aware that it is a natural process and a gift from nature to the planet. We could never have to pay for water again if we have adequate water supplies throughout the summer if we stockpile enough water during the rainy season. We spend less on water thanks to the RWH.

Reliable Flow of Harvested Water: Although the ability to collect rainwater relies on rainfall, once rainwater has been collected and stored, the supply of water is assured. As long as there is still harvestable water, the RWH can provide a steady flow of water from the storage location.

Impacts of Floods are Mitigated or Reduced: Rainwater collecting is crucial in minimizing the effects of floods. We may manage the flow of rainwater whenever it floods agricultural land via trenches by using a technology called rain water harvesting. The RWH prevents flooding in a specific region. As you are aware, floods have too many harmful, expensive, and significant negative effects. Therefore, using a rainwater collecting technology to lessen the effects of flooding in a region is a suitable and effective method. Building a dam and an underground tank requires significant resources and labor. We will need to use a lot of resources when we start collecting rainwater. Although there are a number of inexpensive ways available, they are insufficient to retain enough rainwater.

Depend on Rainfall: As you are aware, rain is the only factor that influences rainwater gathering. This approach is thus unreliable and only practical under wet conditions.

restricted Storage: Even if it rains for three months, we still won't be able to extract all that water, no matter how much we would want to, since the reservoirs' storage capacity is restricted [6].

Risk of Contamination: If rainwater is not carefully collected and kept, it may become polluted. Numerous illnesses may be brought on by contaminated water, particularly if it is utilized untreated. As you are aware, the expense of treating water-borne illnesses is high. Contrarily, certain roofs of homes may contain toxins and chemicals that might combine with rainwater, posing a health risk to those who consume it. Additionally, it has been noted that a variety of industrial processes are to blame for the development of acid rain. Low pH rainwater collection may result in a number of health issues for both people and plants. Because acidic rainfall corrodes the soil and creates adverse circumstances for plant development, it may also result in the death of crops when used for irrigation.

Lack of Water for Wildlife: As you may already be aware, wild animals utilize natural water bodies, such as rivers, streams, ponds, and the like, to cool themselves in hot and arid climates. RWH decreases the volume of water in certain bodies of water. As a result, a lack of water may cause many wild creatures to perish.

Rainfall is a significant weather occurrence, as you are aware. It is a source of both surface and ground water and is crucial for the development of crops, ground water recharge, and other processes. The RWH is a procedure that has been in use for some time. This technique for water storage and conservation was used in many of communities. As you are aware, climate change and human activity both contribute to a worldwide shortage of water. A good strategy to be ready for a time when the traditional water sources run dry is to collect rainwater. We can then utilize the water that has been collected for a variety of uses. The practice of storing water via rainwater collecting is the finest. However, there are certain crucial safety measures that we should follow while collecting rainwater. When we use innovation and technology, scientists and researchers may develop better techniques for collecting rainwater and enhance the conservation approach [7].

Micro-Irrigation

As you are aware, the majority of freshwater resources are utilized for irrigation. If we can create new methods for saving water in the agricultural sector, we can protect or conserve this natural resource. Micro-irrigation is the regular distribution of tiny amounts of water, often in the form of discrete drops, continuous drips, and small streams via emitters positioned along a water supply line, immediately above and below the soil. Localized irrigation, low volume irrigation, low-flow irrigation, and trickle irrigation are other names for microirrigation. This irrigation technique uses less pressure and flow than a conventional technique. In agriculture, micro-irrigation is often utilized for row crops, orchards, vineyards, etc. Additionally, this method is used in horticulture, including nurseries, public and private gardens, etc. It is an irrigation technique that uses less fertilizer and water. In this method, nutrients and water are softly injected into plant roots. This method uses a network of pipelines as well as tubes, drippers, and regulating valves. Sometimes you may see the area covered with water, and other times you can see it entirely dry. The agriculture is really challenging because of this kind of unpredictability. Crops suffer severe damage as a result of this water distribution imbalance. Therefore, farmers urgently need a suitable approach that would allow them to adopt sustainable water consumption for irrigation [8], [9].

Municipally treated water is used in microirrigation systems. Spraying untreated water in the air is normally prohibited by laws and rules imposed by the government. Fertigation and chemigation are terms used by farmers to describe the application of fertilizers with water. Different injectors, including aspirators, piston pumps, and diaphragm pumps, may be utilized with fertilization. Any time the irrigation system is running, the chemicals may be applied. Comparing micro-irrigation to standard techniques, around 90% of fertilizers may be saved. By lowering evaporation and deep drainage, micro-irrigation may aid in water conservation.

Additionally, micro-irrigation may get rid of a number of illnesses that are acquired by coming into touch with the leaves and water. By using micro-irrigation, we can boost agricultural productivity in areas with limited water supplies.

You have learned the following so far: There are two ways that unsustainable water use can develop: first, through alteration in the stocks and flow of water that change its availability in space or time; and second, through alteration in the demand for the benefits provided by a resource, because of the resource's benefits being in high demand. In this unit, we have discussed various aspects of water resource conservation, watershed management, rain water harvesting, micro-irrigation, and about the Pani Panchayat.

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CHAPTER 13

LAND, WATER, AND BIORESOURCES INTEGRATED MANAGEMENT FOR SUSTAINABLE AGRICULTURE

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Climate change, widespread rural poverty, depleting natural resources from agricultural land usage, and global economic and population growth issues are requiring ecological sustainability components to be included into agricultural production intensification. Chemo-centric technical development during the Green Revolution era increased the country's food security and production capacity. However, as seen by the output plateau in the green revolution belt, this industrial system has gradually begun to show signs of reaching its carrying capacity. This kind of agriculture is no longer sufficient to satisfy the requirements and expectations of agricultural and rural resource management in the 21st century since the soil structure, soil life, and organic matter are mechanically destroyed every season and the soil has no organic cover. Future farming must be multifunctional and simultaneously environmentally, commercially, and socially viable in order to provide farmers with a means of subsistence as well as ecosystem products and services. The issues facing agriculture on a local, national, and worldwide level must be appropriately addressed. These issues include climate change, widespread rural poverty, insecurity regarding food, water, and energy, and depletion of natural resources. By implementing integrated management of land, water, and bioresources, all these issues may be resolved.

The ecosystem approach is a method for managing land, water, and biological resources in an equitable manner while fostering conservation and sustainable usage. It is based on the use of proper scientific procedures that are concentrated on levels of biological organization, which includes the interactions between organisms and their environment as well as the fundamental structure, processes, and functions of those organisms. It acknowledges that people, with their wide variety of cultures, are an essential part of many ecosystems. The Convention on Biological Diversity acknowledged the need for a practical definition and further development of the ecosystem approach during its fourth Conference of the Parties meeting in Bratislava in May 1998, and it asked the Subsidiary Body on Scientific, Technical and Technological Advice to create guidelines and other principles on the ecosystem approach. The fifth meeting of the Conference of the Parties adopted a definition of the ecosystem approach and proposed 12 principles for its implementation, both of which were based on the work of SBSTTA, which was tasked with operationalizing the ecosystem approach. Additionally, it provided five operational advice points for the ecosystem approach.

You have learned what makes up your surroundings and how the ecosystem sustains a wide variety of living things, including humans, in earlier courses. Additionally, you are aware of the significance of the ecosystem and how energy flows from the sun to producers, then to herbivores, and finally to other types of life eaters, such as predators. We will talk about the richness that nature has bestowed upon us in this unit since it is vital for all living forms to survive and flourish. Using our natural resources prudently and responsibly is our top priority. Our need for natural resources is rising quickly. However, it's thought that the resources are being used carelessly. This is due in part to the enormous growth in the human population as well as our failure to recognize that these resources are finite and will eventually run out. The plant communities and their composition, as well as their ability for regeneration, have been negatively impacted by the intensive and uncontrolled use of land surface for agriculture, grazing, or the exploitation of plant material. The degradation of water resources, both quantitatively and qualitatively, is another of mining and pollution's most notable and pervasive repercussions. Industries pollute water bodies with poisonous waste, rendering them useless. The fact that our water and land resources are finite gives us additional motivation to protect and preserve them. The demand for natural resources is growing, therefore we need to utilize them more effectively while simultaneously looking for alternatives or other sources. We can only do this once we are aware of their capabilities and restrictions[1], [2].

The two main categories of our resources are renewable and nonrenewable. Let's examine what this implies. Any beneficial knowledge, product, or service may be referred to as a resource. In general, we may distinguish between human-made resources, such as cities, buildings, institutions, and other artifacts, and natural resources, such as the commodities and services provided by the environment. Human resources also include knowledge, experience, skill, and initiative. Two categories of natural resources exist. Some of the earth's natural resources are sometimes replenished through natural reproduction, like plants. To put it another way, these resources are regenerable, which is why they are referred to as renewable resources. Examples of renewable resources include vegetation including forests, pastures, wildlife, and aquatic life. Because it is recycled, water is a renewable resource as well. Other resources, like minerals and fossil fuels, are gone forever after they are used up. They are not regenerable. It took millions of years for mineral deposits to slowly develop. A deposit cannot be renewed after it has been utilized. For instance, once they are used, fossil fuels cannot be retrieved. These resources are categorized as nonrenewable. Similar to this, soil formation is an extremely gradual process, and the development of a top soil layer may take thousands of years. It follows that it is a non-renewable resource. Let's look at land and water separately as renewable and non-renewable resources.

Resource for Recyclable Water

One of the most crucial elements of existence is water. Although water seems to be abundantly accessible, our water supplies are restricted. In many regions of the globe, there is a lack of water that is sufficient for human use. The interaction that cultures had with land and water resources was essential to human existence throughout history. Since the first human settlements were impacted by riverbanks and river valleys, this connection has been developing. Numerous ancient civilizations have thrived beside rivers and died in floods, some possibly as a result of poor watershed/river basin management. However, through time, humans had developed an understanding of the cyclical nature of the link between water and land. This knowledge inspired the development of tanks employing cutting-edge technical methods. One of the most crucial elements for maintaining human existence is freshwater. As one of the five elements earth, fire, air, space, and water considered to be the most significant, it was adored, venerated, and treated with respect by everyone.

Aquatic Cycle:

On the ground, water is always moving and creates a variety of intricate, interconnected loops. The whole living biota, including the atmosphere, sea, and earth, participate in the cycle of water. Water is constantly moving and has a large worldwide circulation. However, it is separated into other categories for convenience's sake:

Rain, snow, hail, sleet, and dew are all types of precipitation that atmospheric moisture takes on before falling to the ground. Figure 1 shows that before falling, the water vapor that is released into the atmosphere condenses into either a liquid or a solid. Through condensation, deposition, and precipitation, water from the atmosphere returns to the land and the sea. The process through which water transforms from a vapour phase to a liquid state is known as condensation. Water moves from a vapour to a solid phase without any intermediate steps via a process called deposition. Clouds are made up of the minuscule water and ice crystal droplets that form during condensation and deposition in the atmosphere. Rainfall is how most of the water on Earth is delivered. In nature, the sun's energy powers the water cycle. Water from the sea and the land evaporates thanks to solar energy. Clouds are created when water vapor condenses in the atmosphere and is carried great distances by wind currents. Snowmelt and rain refill rivers with water, which they then transport back to the sea[3].

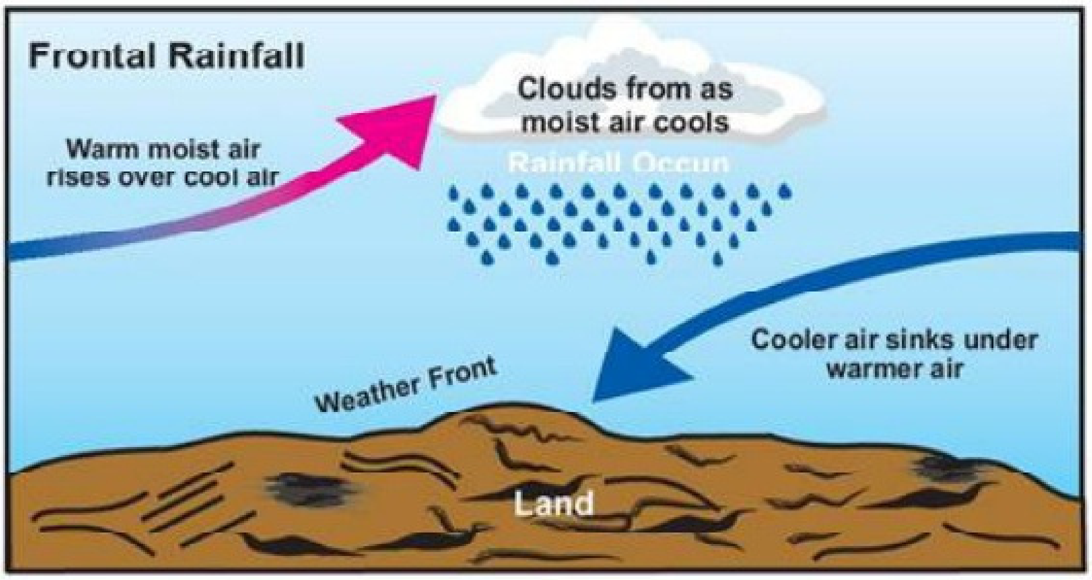

Figure 1: Temperature affects the relative humidity for a particular parcel of wet air.

1. **Run off:** Some of the rainwater soaks into the ground, and any surplus water runs off along the terrain's natural slope. The major source of water for lakes and rivers that eventually flow into the sea is run off. The underlying rock is weathered and the soil is eroded by the running water. In many areas of our nation, flooding during the rainy season is caused by excessive runoff.
2. **Sublimation:** Without first going through the liquid phase, sublimation is the process by which solid water transforms into vapour. Sublimation is shown by the slow

melting of ice crystals during times when the temperature is much below freezing.

3. **Evaporation:** At room temperature, evaporation is the process by which liquid water transforms into vapour. Every aquatic body of water evaporates, as do moist surfaces. The biggest source of atmospheric water vapor is by far evaporation from the ocean's surface.
4. **Transpiration:** This term describes the loss of water from plant leaves in the form of vapour. Transpiration occurs a lot on land. For instance, a hectare of maize loses over 35,000 litres of water each day via the process of transpiration alone. After studying about the water's natural cycle, you may be interested in learning about the many forms of water that exist on the planet.

Three different types of water occur on land: fresh water, brackish water, and marine water. Fresh Water Fresh water, a universal solvent, always has a lot of soluble salts in it. The overall salt level in fresh water is still less than 1.5%. Different kinds of soluble salts that are produced by soil erosion, rock weathering, and organic matter degradation easily dissolve in water. Salts that have been dissolved have special relevance for phytoplankton and floatable aquatic plants. Brackish Water There are between 0.5 to 3.5% more dissolved salts in brackish water than in fresh water. These waters, which fall within the intermediate salinity range, are not similar to freshwater or saltwater. When freshwater and saltwater mingle in an estuary, which is the last section of a river, brackish water is produced[4].

Groundwater and surface water overuse

Precipitation-related water travels through rocks and into the earth before accumulating as ground water. Water may be accessed by creating wells in the aquifer, a layer of rock through which it percolates down. Two layers of the earth contain ground water. The area of aeration, where air and water are injected into soil gaps. The spaces are entirely filled with water farther down in a zone of saturation. The water table, which separates the saturated zone from the unsaturated zone in rocks, rises and falls depending on the level of ground water. We always have access to ground water for a variety of uses, and this supply is unlikely to run out under normal circumstances.

Streams, ponds, lakes, man-made reservoirs and canals, and freshwater wetlands are all examples of surface water. Although they rely on other components of the water cycle, surface water bodies are nevertheless regarded as renewable resources as part of the water cycle. Water use in agriculture is by far the highest. Worldwide, agriculture consumes over 70% of the water supply each year. The overall annual water extraction in Asia is 86%, compared to 49% in North and Central America and 38% in Europe. An age of resource- and energy-intensive agriculture was inaugurated in India with the Green Revolution. Through irrigation, flood management, and drainage, water was a crucial component of the Green Revolution and has been primarily responsible for the increase in wheat and rice output over the last 40 years. Future agricultural output will be affected by the need to develop water-efficient techniques that increase productivity per unit of water intake. This would need the effective functioning of irrigation systems, water-saving technology, suitable soil and water conservation measures, and adjustments to cropping patterns and crop-growing practices in order to utilize water more effectively. For enterprises to reduce water usage and avoid dumping polluted effluents into water bodies, similar regulations would need to be established and implemented[5], [6].

Sources of Water are Degrading

The depletion and pollution of water resources, which renders them unusable as a supply of water for human use. It is now a serious issue. Due to intense agriculture, urbanization, industrialization, and deforestation, the majority of our water bodies, including rivers, lakes, seas, estuaries, and groundwater bodies, are suffering from severe pollution. Siltation of rivers and lakes as a consequence of soil erosion gradually lowers their ability to retain water, resulting in destructive floods every year. The contradictory absence of clean drinking water in locations with above-average rainfall and regions with a lot of water bodies is a problem we now confront. In addition to polluting water, the discharge of sewage and industrial effluents into water bodies often causes an increase in the development of aquatic plants and algal blooms, which eventually causes the water bodies to vanish. Additionally, this might lead to the demise and deterioration of a variety of aquatic creatures, including fish.

The development of science and technology has made it possible to foresee or forecast the commencement of floods in advance. If only the involved authorities coordinate their efforts and respond to the disaster in a timely manner, the damage to property, the loss of life, and the displacement of people may be mitigated. In a place where rain is often anticipated, a "drought" is described as an extended period of exceptionally dry weather with minimal rainfall. A place that is typically or seasonally dry is often linked with a dry climate, which is different from a drought. Years may frequently pass during droughts. Due to its gradual onset and protracted duration, drought is a creeping disaster. Droughts are not limited to any one tectonic or geographical location, and their effects often cover wide swaths of land. The effects of drought are more severe in underdeveloped nations than in industrialized nations. Crop losses, hunger, and malnutrition cause the impoverished people great suffering.

Water resource conservation and Management

A limited resource, water is becoming harder to get by. Its shortage poses a threat to all of us, imperiling our livelihoods and even putting our lives in risk. Freshwater shortage is characterized for many millions of people as much by bad quality as it is by inadequate quantity. One-third of the world's population would face acute water shortages over the next 25 years, according to a 2001 assessment by the United Nations Population Fund. Currently, 3 billion people lack access to basic sewage facilities, and more than 1 billion people lack access to clean drinking water. More than 90% of the sewage generated in underdeveloped nations is released into the environment untreated. We will continue to see paradoxical circumstances like a scarcity of drinking water owing to pollution even in places with above-average rainfall if water resources are not managed appropriately. Long-term policy choices regarding water resource regeneration, regulation, allocation, and use would need to be made as populations grow and economic growth accelerates.

Future demands for clean drinking water, sanitary conditions, and industrial and agricultural operations will progressively clash with one another. Water resource management refers to a plan to deliver a sufficient amount of high-quality water for a variety of purposes without harming the source's or the water reserve's longevity. In other words, efforts should be taken to ensure that water of the proper quality is accessible for all types of usage and that this priceless resource is neither misused nor wasted. Recharging groundwater reserves and moving supplies from a zone of excess to a place of shortage are both parts of water management. The most crucial part of water management is groundwater recharge. The watersheds are lushly vegetated in the mountains and hills. Rainwater may seep through the watershed's litter-covered soil and eventually reach the aquifers. Storm water, used water, or home drains may be poured into pits, trenches, or any other depressions in both urban and rural regions so that it can filter underground. Flood water may either be dispersed over the fields by a system of ditches or pumped into aquifers by a series of deep holes[7].

Water-scarce locations may benefit from the diversion of surplus flows of both normal and floodwater. This would not only reduce the risk of flooding-related harm but also help areas with little resources. One may get a supply suitable for various industrial and agricultural uses by properly treating home and municipal waste water. As you previously learned in the previous part, the treatment of waste water includes the removal of contaminants, pathogens, and hazardous substances. The waste water or sewage is treated in a tank or in ponds for a number of days in order to get rid of bacteria and hazardous substances. As a result, the heavier particles naturally sink to the bottom while the finer particles are forced to do so by the addition of alum and caustic soda. After allowing the clear liquid to flow through filters, sand, or soil, air is then forced through it. In addition to purifying the water by removing the carbon dioxide and hydrogen sulfide that are often dissolved in waste water, this treatment also provides oxygen to the filtered water. Chlorination, the process of treating water with the right amounts of chlorine to eliminate all hazardous microorganisms and make it safe to drink. It serves two purposes to develop algae or water hyacinth, a natural plant that grows in floating masses in rivers and lakes. Pollutants like phosphates and nitrates that function as fertilizers for these plants are removed from the water, and these plants may also be used to generate biogas.

Land Resource Not Renewable

You may be curious in our non-renewable resources, such as land and mineral oceanic resources, after learning about renewable resources like water and trees. These resources cannot be increased or renewed. Resources related to land for humans, land is a fundamental resource. It is, in reality, the foundation upon which the whole ecological system depends, and it is the living ground for all terrestrial plants and animals, as you have learned in the previous section. The capacity of the land to sustain life and diverse human and animal activities depends on both its biological production and the ability of the soil and rocks to support loads. The demand on the land is increasing as the population grows. More than 1200 million people today live on our land mass, which was occupied by 238 million people in 1901. The quality of the soil and landscapes have suffered significantly due to improper management of the land resource as a consequence of careless tree cutting or deforestation[8], [9].

Sources of Soil

Because it sustains the whole living system, produces food and fodder in the form of flora, and stores water that is necessary for life, soil, which makes up the top layer of the ground, is the most valuable of all resources. Sand, silt, and clays are combined with moisture and air in this mixture. Rich organic and mineral nutrients may be found in it.

In eastern Bihar, Madhya Pradesh, Jharkand, Chhatisgarh, Odisha, Kerala, Karnataka, and Andhra Pradesh, red soil is found in plateaux and lowland regions where temperatures are consistently over 22°C and rainfall ranges from 100 to 300 cm annually. The soil is suitable for growing potatoes, bananas, pineapples, rubber, and rain forests and grasslands.

1. The soil is loamy, dark, and covered with clay over the Deccan and Malwa plateaux in western and central India. It is exceptionally fertile and sustains mixed grasslands, woods, and rice, cotton, soyabean, groundnut, and sugarcane crops.

2. Western and northwestern India's desert soils contain low levels of organic matter and are often regarded as being of poor fertility. They may be made quite fruitful, however, if water is given.
3. The Indo-Gangetic lowlands, which stretch in the delta areas along the coastlines of Bengal, Odisha, Andhra Pradesh, Tamil Nadu, Kerala, and Gujarat, include a different kind of soil. This soil is distinguished by its loamy texture, dry content, and variable thickness. The soil supports many types of crops and is quite productive.
4. The soil is rich in organic content, such as decomposed farmyard manure and plant debris, and as such is particularly productive. This soil is part of the low-lying wetlands or marshy area in the deltas of the Ganga, Godavari, Krishna, Kaveri, and in the river basins of Kerala.
5. The ash grey to light yellow-brown colored soil in the hilly Himalayan area is poor in fertility and supports oak and coniferous trees like pine and deodar[10].

Processes Associated with the Formation of Soil

The following categories may be used to study the processes that contribute to soil formation: Weathering of Rocks the processes that contribute to soil formation are slow, continuous, and progressive. Weathering is the collective term for all natural processes that cause parent rocks to break down. This process incorporates physical, chemical, and biological forces. Physical weathering is brought on by mechanical forces that are applied to the rocks. Temperature variations cause the surface of the rock to expand and contract, which results in the development of cracks and fissures. Water that is present in rock fissures freezes in cold weather, which causes ice to develop and expand. Rock breaks apart due to expansion's force. Rock particles that have already broken into smaller pieces tumble down the hillsides. Hail, rain, and swift-moving streams are significant physical weathering agents. Another physical weathering factor is wind, especially when it brings sand particles that abrade the surface of rocks because of friction. In the forests of the Vindhyan hills, it is common to see that tree roots often encroach into rock cracks, and over time, with the radial expansion of the roots, the rocks dissolve.

Weathering by Chemical

The disintegration of rocks may also include chemical changes. When one or more components of rock materials dissolve or react, water plays a significant role in causing chemical changes. Chemical weathering is favored by the presence of dissolved materials and warm temperatures. Hydrolysis, in which water splits into H+ and OHions, acts on silicates like orthoclase to generate silicate clays, is another crucial component of chemical weathering. Other significant methods of chemical weathering include carbonation, oxidation, and reduction processes.

Humification and Mineralization

The physical weathering reduces the rocks' size into tiny fragments. However, the crumbled rock debris alone cannot support plant growth since it is not genuine soil. However, the deteriorated material experiences further alterations, which you will learn about in this section. You may have noted that mostly physical and chemical variables are involved in weathering. The biological agents are primarily engaged in the future development of soil, which includes mineralization and humification. As the plants and soil flora are still developing in the early phases of soil formation, the amount of organic matter in the soil is not particularly high. Algae, lichens, mosses, and other tiny plants flourish in such soils and provide organic matter via their decomposition. Such soils eventually become home to a variety of plants, animals, and microbes. Additionally, they provide organic material to the soil in the form of feces or their decomposing bodies. Then, these organic remains degrade into simpler goods. Different types of microbes including bacteria and fungus cause this breakdown process, commonly referred to as decomposition. The organic materials are broken down into a variety of chemicals, including polysaccharides, proteins, lipids, lignins, waxes, resins, and their derivatives. Further breakdown of these molecules yields straightforward byproducts such carbon dioxide, water, and minerals. The latter is referred to as mineralisation. Humus is the term used to describe the remaining, incompletely digested organic matter that remains after mineralization. Humification is the process through which humus is created. The majority of soil microbes get their energy and nutrients from the amorphous, colloidal, and black material known as humus. Humus plays a crucial role in soil aeration by giving the soil a loose texture. Due to its colloidal form, it has a strong ability to absorb and retain nutrients and water. Humus significantly increases soil fertility[11].

Overgrazing and Agriculture's Impacts

For the purpose of simplicity, the environmental changes brought about by man via his agro-pastoral activities may be classified into two categories: those brought about by traditional agriculture and those brought about by modern agriculture. Traditional agriculture is characterized by land degradation, deforestation combined with loss of soil structure, soil erosion, and soil nutrient depletion. Overgrazing is another unintended consequence of attempts to maximize livestock output on the land. But contemporary. Traditional agriculture's disruptive impacts on the environment are still present in agriculture. Additionally, it influences several environmental modifications that are unique to modern agricultural operations. For instance, excessive irrigation depletes ground water supplies while also contributing to the dual issues of salinization and water logging brought on by an increase in the water table. Similar to this, the use of chemical fertilizers speeds up the loss of soil micronutrients, causes eutrophication in waterways, and causes nitrosoamyemia in children. The application of plant protection agents taints food items and sometimes causes the death of organisms that are not favorable to the goal. The adoption of high yielding cultivars also supports monoculture, which leads to epidemic outbreaks and the loss of genetic diversity while making agriculture market-oriented.

Our own existence is actually supported by soil. It is the substance that underpins all we erect, manages our waste, and cleans our water. Any use of soil results in changes; some of these changes may be beneficial, but many are not. Soil erosion, soil salinity, soil pollution, and soil fertility management are some of the toughest issues facing farmers today. The process of soil erosion involves the removal of the top soil layers, which are then transferred from one location to another by wind or water. This procedure thins the soil and decreases its ability to retain water by removing minerals, organic matter, and nutrients from the soil. Soil that has been eroded may later contaminate streams and reservoirs. Since it takes so long for new soil to develop, any soil lost to erosion is irretrievably gone from a human perspective. To stop soil erosion, a variety of techniques including bunding, mulching, and soil moisture conservation must be widely used. Applying organic material in the form of straw, green manures, or manure that has already experienced a high level of fermentation is one technique to create and maintain healthy soil. This supports a stable aggregate structure, boosts the soil's ability to retain water, and strengthens the soil's cohesion. In dry and semi-arid areas, excessive or insufficient irrigation may increase the amountof soluble salts in the soil, making it salty or alkaline and unsuitable for plant development. Salts such chlorides, sulfates, and bicarbonates of sodium, calcium, and magnesium build up in the soil when water evaporates from it. Applying "gypsum" is the most efficient treatment for alkaline soils. To help wash the salt from saline soils, a reliable drainage system must also be constructed. Only the species that can withstand the highest levels of soil salinity may be planted there.

Planning and Management of Land Use

Land is a finite resource that is very susceptible to climatic and physical process changes. According to its appropriateness and capacity, land should be exploited. As you have seen in previous sections, the fertility and load-bearing capacity of land are used to determine its appropriateness and capability. The invasion of productive agricultural areas for non-agricultural uses like the construction of roads and buildings should be minimized since food for a growing population needs more space for agriculture. The ecological and socioeconomic situations of the local population should not be harmed while choosing locations for the growth of industries, the building of dams and water reservoirs, and mining. As much as feasible, hill regions should be covered with forests since they provide a source of fuel, food, and lumber as well as a place to raise animals. Additionally, as they prevent free surface run-off and enable water to be absorbed by the earth, forests aid in boosting ground water levels. Flooding may be prevented and soil erosion is minimized by this procedure.

We have attempted to examine the principles of managing and conserving the natural resources of land and water in this unit. While land is a non-renewable resource, water is a renewable one. Physical resources like land and water degrade mostly as a consequence of human activity that is exploitative in the areas of agriculture, industry, and urbanization. Changes in land use patterns, irrigation water conservation, reducing the use of pesticides and fertilizers, and the adoption of cutting-edge, environmentally friendly agricultural practices may all have an impact on conservation in agriculture.

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CHAPTER 14

BIORESOURCES AND THEIR IMPORTANCE: OPPORTUNITIES AND CHALLENGES

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Any resource that has a biological or natural origin is referred to as a bioresource. In other terms, bioresources are defined as naturally renewable and biodegradable materials and processes that are produced by living things. Since the beginning of time, humans have had a tight relationship with bioresources, which is where the history of human progress begins. Primitive humans have lived in the deep forest since the dawn of civilization and have been generously fostered by the abundance of resources there. Such close connections between people and environment are said to represent the transition from a rural to an urban culture. Bioresources are thus considered to be a substantial part of the natural resource and have a vital role in human culture and the economy. Compared to other resources, notably fossil resources, a large range of bioresources are found on planet earth. In addition to a large variety of plants and animals that man has tamed for his needs, bioresources also include agricultural crops, timber from logging, marine resources, by-products and wastes from agriculture, industry, and society, as well as common and aquatic weeds. The relevance of studying the interdependence of man and environment is now recognized by researchers all over the world, and as a result, these studies have garnered a lot of interest on a global scale. In the global context for the sustainable use of bioresources, the regions with greater forest cover and biodiversity have emerged as a key subject of study.

All of these bioresources are an intrinsic aspect of the bioeconomy, which primarily consists of food, feed, bioactive compounds, fuel, housing, fiber, and other high-value goods. They all play a key role in meeting the basic and necessary requirements of people. In general, the bioeconomy includes all industries that use and process bioresources, including those in the food and feed, pulp and paper, chemical, biotechnological, and energy sectors, as well as primary production through various sectors like agriculture, forestry, fisheries, and aquaculture. Bioresources are thus seen to be one of the elements contributing, either directly or indirectly, to current and future socioeconomic evolutions. A variety of bioresources are continually employed for the manufacture of the many necessary and value-added goods stated above because bioresources play a significant role in the manufacturing of a broad range of products important for human welfare. Extreme caution must be used while using and treating these bioresources, however, since their overexploitation may be one of the major hindrances to a country's development and economic activity . The ecosystem may be destroyed if bioresources are overused, in addition to having negative effects . Because of the significance of all the aforementioned factors, we have chosen to concentrate on a general review of bioresources in this chapter, including their kinds, characteristics, and composition. Additionally, the value of bioresources in terms of numerous products and effects as a result of their use is also covered [1].

Types, characteristics, and composition of bioresources Bioresources are non-fossil biogenic resources that may be utilized by people to meet their basic needs, such as those for food, durable goods, and energy. Agricultural crops and waste, timber from forestry, marine resources, common and aquatic weeds, organic leftovers from industry, residues from society, etc. are some examples of several significant bioresources. All of these bioresources may be generally divided into two groups:

Fundamental Bioresources

In order to provide food, useful goods, and energy, these bioresources are produced for a particular application-oriented purpose in forestry, agriculture, and aquaculture.

Agribusiness Crops

One of the most important categories of bioresources utilized to satisfy several basic requirements of both humans and animals are agricultural crops or plants. All such plants are capable of being directly cultivated, or their products may be widely gathered for revenue or sustenance. Six major categories may be used to classify various agricultural crops: food crops, which are typically grown for human use; feed crops, which are grown for animal consumption.

Typically, agricultural plants planted just for food or animal feed are not also grown for their tastes, vitamins, or aesthetic value. According to proper climatic circumstances, the aforementioned number of crops, including vegetables, fruits, cereal crops, etc., have been grown all over the world and enjoyed by humans. The Food and Agriculture Organization estimates that in 2016, agriculture covered nearly one-third of the world's land surface. Among the most widely farmed plants are sugarcane, maize, wheat, rice, potatoes, and others. In addition to producing food, certain agricultural crop plants may also be utilized to produce bioenergy. For instance, in small settlements, the crop plant remains can be used as a direct source of energy. They may also often be used in the creation of first-generation biofuels. The phrase "energy crop" refers to crops grown only for the production of energy, which may include both annual and perennial plants. These facilities are effective in absorbing solar energy and storing it as thermochemical energy. Herbaceous plants in general may be utilized as energy crops. The synthesis of bioethanol uses a variety of significant herbaceous energy crops as feedstocks, including switchgrass, alfalfa, miscanthus canary grass, and giant reed. Only when a crop displays quick growth, high biomass yields per hectare, does not compete with food production, is able to thrive in difficult environments, and is resistant to pests and diseases can it be said to be excellent for producing biofuels [2].

Backup Bioresources

Secondary bioresources are a different category of bioresources that largely consists of wastes or leftovers from social, industrial, or agricultural operations. In general, their usage does not conflict with the use of land, which allows for various uses of the land. Some of the significant secondary bioresources are briefly covered in the following sections. Typically, these bioresources may be utilized either in a cascade or parallel to a profitable crop.

Agricultural Byproducts

Agricultural wastes or residues are primarily divided into two groups: "field residues," which often comprise plant stems, stalks, leaves, and seedpods, and "process residues," which include significant components like husks, seeds, roots, bagasse, molasses, etc. These waste materials are mostly produced during the cultivation and processing of agricultural products. These leftovers may be slurries, liquids, solids, or both. Animal waste is furthermore regarded as agricultural in addition to these [3].

Typically, lignocellulosic or starchy agricultural wastes consist of around 40% cellulose, 30% hemicellulose, and 25% lignin. In a dry substance, cellulose and hemicellulose polysaccharides make up up to two-thirds of the plant cell wall. As was previously mentioned, cellulose is a complex and linear polymer of glucose, while hemicellulose is mostly made up of pentose sugars, but it also contains hexoses and uronic acid. The makeup of each kind of plant will determine how these components are distributed. Due to its composition, lignocellulosic biomass is heavily researched as a feedstock for the manufacture of bio-based goods and biofuels, but starchy wastes have shown promise as a substrate for biotechnological activities. Because starchy residues also include proteins, minerals, and fibers in addition to starch, it is often collected from grain producers and frequently utilized as animal feed.

Waste from various small and large scale industries includes a variety of residues, such as those from slaughterhouses, waste from the flower industry and other related industries, waste from the food and food processing industries, waste from the production of black liquor from pulping, sugar beet chips, etc. Additionally, a variety of agro-based food and food processing enterprises, including those in the juice, chips, meat, confectionary, and fruit sectors, create significant quantities of wastes such peels of potatoes, oranges, cassava, pineapple, etc., as well as oil cakes from groundnut, soybean, and coconut. These wastes are often made up of a variety of substances that are high in minerals, sugar, moisture, and proteins. However, because of their physiological, enzymological, and biochemical characteristics, filamentous fungi constitute the most significant category of microorganisms utilized in the solid-state fermentation process.

Because they may be employed as solid supports and sources of nutrients and carbon in solid-state fermentation processes to create a variety of chemicals with value-added, such wastes cannot be regarded as wastes. The creation of biofuels from agro-industrial wastes such rice straw, sweet potato waste, sawdust, potato waste, maize stalks, sugarcane bagasse, and sugar beet waste has also been shown in a number of earlier papers. Different oil cakes, among other agro-industrial wastes, may be used as a possible substrate for the creation of a variety of goods. Similar to how they are often utilized in many other sectors, e.g. industries for food, beverage, textiles, cosmetics, and fragrances. The discharge of flower waste from these companies into rivers, lakes, seas, and other bodies of water causes water pollution and has an impact on the aquatic life there, making it one of the major issues. Therefore, in order to address these issues, it must be managed [4], [5].

Waste created by society and municipal entities, such as food waste, market garbage, yard waste, plastic containers, etc., and are referred to as municipal or urban waste. These wastes are also often referred to as rubbish or trash. Here, however, the topic is limited to biowastes, such as common home wastes including food and kitchen waste, trash paper, organic municipal waste, used vegetable oil, wastewater, etc. Around the world, there is a lot of worry about municipal solid waste management. To deal with MSW and reduce the remaining quantity that has to be disposed of in landfills, a number of alternate waste management techniques are suggested. Advanced biological solutions like in-vessel composting and anaerobic digestion are the ones that are most often employed among the available choices. ABT techniques are created and built to regulate and improve organic biological processes.

Particularly, these techniques exclusively affect biodegradable organic compounds. Both source-segregated materials and those that have been mechanically separated from a mixed waste stream may be converted by ABT methods into a biodegradable, organic-rich fraction. These processes include the biodegradation of waste by live microorganisms, whether or not oxygen is present. In this case, the bacteria engaged in the process utilize the waste as a food source for their development and proliferation. Biodegradable material is broken down into carbon dioxide and water during the aerobic decomposition process, which is similar to composting. In addition, the heat produced by microbial respiration while oxygen is present transforms this material into compost, which is an excellent fertilizer for plant growth. Anaerobic digestion produces water, methane, carbon dioxide, and other gases from biodegradable material. Methane and biogas created in this way may serve as significant energy sources.

Waste from the fishing business currently, a big issue is how to dispose of by-products from fishing, such as crab leftovers, which in many instances clog rivers and mangroves and cause serious ecological imbalances in these ecosystems by producing the slurry in soils. Crayfish, shrimp, and crab carapaces which are often discarded contain 15%–20% chitin, 25%–40% protein, and 40%–55% calcium carbonate, as well as trace levels of colors and lipids. The by-products of the fishing industry, such as crab exoskeletons, are of enormous relevance for biotechnology as green technologies evolve in the pursuit of a sustainable society because they may be utilized to create goods with additional value. With a projected 4.5% market increase in 2017, the value of the worldwide crustacean market was close to 147 billion dollars. The need for healthy meals among consumers and population growth are the key causes of this market expansion. Based on this expanding market and the necessity to find a suitable use for the byproducts produced by the fishing industry, biotechnology has recently concentrated on using crab exoskeletons to create chitin and chitosan, biopolymers that are very significant for contemporary civilization. Chitin is the second most prevalent polymer in nature after cellulose. Henri Braconnot initially isolated this polymer from the fungal cell wall. Odier discovered this polysaccharide from the insect exoskeleton in 1823 and gave it the name "chitin."

Lassaigne established the existence of nitrogen in this polymer in 1843. Chitin is a linear polysaccharide that contains 6%–7% nitrogen and is structurally described as being created by the union of b-2-acetamide-2-deoxy-D-glucose or b-N-acetylglucosamine residues by b-glycosidic links. It appears as a yellow or white powder with crystalline and amorphous forms that is insoluble in water, organic solvents, diluted acids, and alkaline solutions. It also has minimal chemical reactivity and is hard and inelastic. This biopolymer dissolves swiftly in concentrated mineral acids while simultaneously degrading the polymer chain in dimethylacetamide solution with 5% lithium chloride. Its biodegradability, toxicity, and biocompatibility all play a role in its significance. Demineralization, deproteinization, and depigmentation/deodorization are the three steps often used to remove chitin from shrimp and crab carapaces. It should be emphasized that the physicochemical conditions used in these procedures have a direct impact on the features of the chitin that is produced, including its purity and crystallinity [6].

The deacetylation of chitin produces chitosan. It is also a linear polymer created by the b-glycosidic bond union of b-D-glucosamine residues. This polysaccharide is soluble in diluted aqueous solutions of organic and inorganic acid and displays a three-dimensional helical shape supported by intramolecular hydrogen bonds. Similar to chitin, chitosan is a yellowish-white powder that has excellent biocompatibility, is non-toxic to humans and animals, and demonstrates high bioactivity, biodegradability, selective permeability, polyelectrolyte action, antimicrobial activity, ability to form gel and film, chelating ability, and adsorptive capacity. The primary raw materials for the industrial manufacture of chitin and chitosan, as previously mentioned, are the carapaces of crustaceans obtained from the commercial processing of seafood. The biggest manufacturers of chitin are China, the United States, and Japan, although the biopolymer is also made in India, Norway, Canada, Italy, Poland, Chile, and Brazil, albeit to a smaller amount. Chitin and chitosan have several uses, including those in biopharmaceuticals, food processing, water treatment, agriculture, and the cosmetics sector. However, its primary field of use is in biomedicine. Chitin and chitosan have lately been extensively employed in the production of biocomposites and biofilms in tissue engineering, which is thought to be a significant medical sector. The regeneration of cartilage, bone, tendons, and the proliferation and differentiation of stem cells have all been accomplished using chitin and chitosan.

Despite being invasive, several weed species are utilized as food by humans. Dandelion, barnyard grass, purslane, and other weeds may be eaten raw, cooked, or parched. It is thought to be one of the most significant noncompetitive renewable resources for the development of biofuels and other bio-based products, apart from its usage as food and feed. Due to its chemical components, such as ursolic acid, a pentacyclic triterpenoid contained in the plants is responsible for numerous pharmacological effects, lantana camera, a widespread weed, is often used to treat specific health issues. Weeds have a high calorific value, are readily available, and are less costly than processed wood, such as briquettes and pellets, making them ideal feedstocks for the generation of biofuels. These plants may be used to make biobutanol and other bio-based goods in addition to biofuels. After a pretreatment that typically consists of acid hydrolysis, alkaline delignification, and enzymatic hydrolysis, a hydrolysate that is rich in both pentose and hexose sugars and may be fermented by certain microbes is obtained.

Aquatic Weeds

Aquatic weeds, also known as macrophytes, are an essential component of the aquatic environment that naturally exist in all kinds of water. However, their accelerated development has detrimental ecological and human implications. These are categorized into three categories based on their development patterns: submerged, emergent, and floating. Macrophytes are regarded as invasive plants that often thrive in water owing to the availability of nutrients like phosphorus and nitrogen produced as a result of various human activities. Their rapid expansion may result in significant ecological and economic harm. These non-native plants are widespread across the planet, have no natural enemies, and reproduce quickly. Their rapid development after introduction may have detrimental impacts on biodiversity and the loss of aquatic animals, including channel obstruction and worsening of water quality. Aquatic weeds are useful for biotechnological applications, despite the fact that they represent a significant environmental problem.

These plants may be utilized as a possible renewable feedstock for the manufacture of biofuels and bio-based goods since they are often found to be high in cellulose and hemicellulose and have very little lignin content. Aquatic weeds produce better feedstocks when compared to other lignocellulosic biomass due to their low lignin concentration and a few additional benefits, such as the lack of a need for cultivation area or other inputs. The development and performance of fish depend on polyunsaturated fatty acids, which are found in larger concentrations in particular species of aquatic weeds including Ipomoea reptans and Trapa natans. Additionally, these plants are being researched for their capacity for bioremediation, which involves eliminating heavy metals and other hazardous substances from water. Due to its many potential uses in biofuel generation, biogas, animal feed, fertilizer, bio-based products, bioremediation, etc., water hyacinth is one of the most researched aquatic plants. Lists some of the most important aquatic weeds and their possible uses [7].

Grasses and Bamboo

Another significant source of biomass that may be employed as innovative feedstocks for the creation of different biorefining products is bamboo and a variety of grasses. Important grasses and bamboo have been covered in this section. Bamboo: Bamboo is a rapidly expanding plant that serves as a rich source of biomass. It is extensively spread around the world, particularly in Asia with countries like China and India. The estimated 1200 species of bamboo may be used to estimate the presence of the amazing genetic diversity of bamboo. Bamboo has been used as a feedstock for many commercial items for many years, including flooring, furniture, plywood, construction materials, etc. Additionally, throughout the years, bamboo has been a key feedstock in the production of paper and paper goods in the paper and pulp sector. In addition to these, despite its high silica content, which is a significant problem for bamboo processing, it has the potential to be utilized for the generation of cellulosic ethanol. There are several publications that show bamboo to be a potential source of lignocellulosic biomass for biorefineries. Investigated the generation of ethanol from Phyllostachys heterocycle using sequential cofermentation as well as separate hydrolysis and fermentation.

Perennial grass known as switchgrass is also referred to as an energy crop. It is a native of North America, most specifically the United States, and is often seen in regions with warm climates. From 55oN latitude to central Mexico, it naturally occurs. Because of its quick growth, large yields, cheap inputs, exceptional adaptation to a variety of climates, and resilience to several diseases and pests, it is regarded as one of the most promising feedstocks for the generation of ethanol. Additionally, it has a high water usage efficiency, can be cultivated in poor soils, and requires less fertilizer than other crops like maize. It also has a good tolerance for a variety of environmental situations. Therefore, switchgrass may be grown in marginal pastures and croplands to prevent soil erosion.

Switchgrass was recently employed in a promising way by Dien et al. to produce bioethanol, and the amount of bioethanol produced was quite high. Switchgrass may be utilized as a feedstock for the creation of several other valued goods in addition to bioethanol. Switchgrass has drawn a lot of interest from the scientific community as a desirable raw material for pulping because of its low lignin content and harvesting without yearly reestablishment. Due to their short fibers and acceptable slenderness ratio, which are the most crucial characteristics from a pulping point of view, nonwoody plants, like switchgrass, are now receiving the majority of attention in the pulp and paper industry. Miscanthus: A perennial grass native to warm-season regions of Asia, miscanthus also requires little maintenance. It is now grown throughout a large geographic area in temperate climates; nevertheless, the climate in desert regions is inhospitable to its growth.

Miscanthus, unlike switchgrass, can grow up to 13 feet tall on poor soils, including marginal land, and can be kept for extended periods of time with very little to no fertilizer. With careful management and weed control, it is feasible to utilize the same crop for around 15 to 20 years without reestablishment. Miscanthus species have been utilized for thatching and fodder in Japan for countless years, dating back thousands of years. Miscanthus has many other uses as well, but one of the most significant is that it may be utilized as a potential lignocellulosic feedstock for the creation of significant goods, including bioenergy and biofuels. Ibeto et al. reported that when comparing the land required for the cultivation of a specific amount of feedstock using miscanthus and other crops like corn and switchgrass, it was reported that 2.5 times more land is required [8].

Utilizing biorefinery technology to produce High-Value Goods

The idea of a biorefinery is not brand-new. Biomass conversion technology have been used since the 19th century. Examples include the sugar/ethanol and pulp and paper sectors. Energy is a well-known important societal pillar for the creation of new sustainability models. Creating new circular economy policy models based on the bioeconomy might be beneficial. However, in order to properly implement the bioeconomy and biorefineries and meet the demands of society, it is essential to comprehend the advantages and difficulties of this model.

Utilization of feedstock in Biorefineries

The goal of the biorefinery is to combine the aforementioned bioresources with industrial processes to produce a range of products that may meet human requirements. It is possible to use bioresources derived from aquaculture, lignocellulosic starch crops, or even human waste. Their uses may change depending on the model of the biorefinery. Energy and goods are separated into two sections. The primary conversion processes used in biorefineries are biochemical, thermochemical, chemical, and mechanical processes. A biorefinery's many platforms must be linked to a particular feedstock and employed in accordance with each product creation. For the production of bio-based goods and bioenergy, biomass must first be fractionated into its composites utilizing biological or thermochemical processes. Platforms, products, feedstocks, and processes are the four major structural categories for biorefineries. These four components are in charge of creating various biorefinery setups. The production of C5 and C6 sugars, ethanol, and other important products from sugarcane bagasse is an excellent example from the sugarcane sector. According to the need for the goods, the demand for them, and the physical constraints of the biorefinery, the production of coproducts like biogas, fertilizer, and power may or may not take place.

Applications in sustainability and Regulation

The main tenet of the deployment of biorefineries is sustainability, and all processes must work together harmoniously. It is necessary to fully use the biomass in order to generate goods that are optimized and maximized in terms of their economic, environmental, and social advantages. The whole life cycle analysis must adhere to the accepted international standards, including those for greenhouse gas emissions, social life cycle assessment, life cycle costing, and life cycle assessment. The use of bioproducts in place of conventional chemicals has been proposed by regulatory bodies across the globe. According to the Renewable Energy Directive, which proposes that until 2020, transport fuels must include at least 10% renewable fuels, there is a general strategy for the production and marketing of energy from renewable sources in the EU. Up to that time, 20% of energy requirements are anticipated to be met by renewable sources, increasing to 32% by 2030.

Prospects for biorefineries in the Future

Numerous energy-driven biorefinery models are now being researched in various nations. In addition, there are still a large number of ideas in the R&D and pilot-scale phases, with the expectation that they will be commercialized by 2030. In order to produce many products, the assembly of biorefineries must take into account the demands of the local and regional markets. Future conversion technologies that use biomass as a feedstock must be developed and used in accordance with sustainable biorefinery models. The variety of options in a focused biorefinery platform is expanded by the need that current supply chains employ biomass to manufacture new bio-based goods. The biorefining technologies need to be particularly effective in order to fully use biomass for the production of both commodities and specialized products, encouraging the reduction of GHG emissions and having a smaller negative environmental impact than present industries.

Important byproducts of Biorefineries

Since ancient times, humans have struggled to survive and relied on bioresources to do so. Humanity was able to settle down because to advancements in agriculture and cattle, and procuring bioresources grew simpler and less difficult. The exchange of items across various societies met the need for a completed commodity and gave rise to the earliest market-based models. Additionally, as civilizations advanced, feedstocks were used more effectively and the usage of refined resources for future uses was encouraged. This advancement also paved the way for the creation of the modern industries we see today, where goods are created with precise nutritional values, a wealth of drugs are discovered for various illnesses, and vast quantities of chemicals are produced to serve a variety of industries. The following sections address the uses of numerous industrially significant products, the revenue, and potential market trends of specific biomolecules [9].

Biofuels

Various biofuels, such as bioethanol, biodiesel, biogas, butanol, methane, hydrogen, and bio-jet fuels, among others, are significant energy substitutes created utilizing various biorefining processes. As a clean and renewable alternative to the rapidly dwindling fossil fuels, all bio-based energy sources have seen tremendous growth in recent years. These non-GHG emitting fuels are considered to be eco-friendly due to their additional advantages. Additionally, these energy sources will be employed as clean fuel in all nations where GHG emissions are a big problem. For the manufacture of bioethanol, biobutanol, and other biofuels, a variety of bioresources, such as agricultural and forestry leftovers, are crucial, especially lignocellulosic biomasses. Similar to this, the main feedstocks for the manufacturing of biodiesel include bioresources such different oil-seeds like jatropha, soybean, etc., as well as microorganisms like algae. Additionally, a variety of industrial, municipal, and household wastes may be employed as possible raw materials for the production of biogas, along with a few additional bioresources.

It is suggested that one key strategy for reducing both fossil fuel usage and environmental pollution is the production of bioethanol from a variety of biomass. Because of its high octane and low cetane numbers, respectively, bioethanol is proven to be appropriate for use in both gasoline and diesel engines. Given its widespread availability and inexpensive price, lignocellulosic biomass, i.e. The most potential feedstock for the manufacturing of bioethanol is thought to be garbage from cities, farms, and forests. The commercial synthesis of bioethanol in considerable quantities from lignocellulosic bioresources has not yet been realized, despite the fact that the production and consumption of bioethanol are gaining pace. Therefore, it is vital to design bioethanol production processes correctly and evaluate how well the various feedstocks indicated above are used in order to build commercially viable solutions. The distinctive physicochemical features of biobutanol are said to provide it several benefits over other fuels as an effective biofuel.

With simple manufacturing techniques, it may be made from industrial waste and agricultural waste as feedstock. Similar to bioethanol, biodiesel is seen as a significant biofuel substitute for diesel. Typically, it comes from bioresources like animal and vegetable fat. Soybean oil, palm oil, sunflower oil, and rapeseed oil are the four primary types of vegetable oils. Most edible oilseeds have an oil content that varies from 30% to 50%. For the generation of biodiesel, certain algae species with greater lipid or oil concentrations are also often utilized.

Due to its CO2 free nature, biogas, like biomethane generated from different biomasses, has the potential to replace natural gas. This is because during the manufacturing process, some of the carbon in the biomass is removed as CO2. Normally, different biomass is gasified or digested anaerobically to generate biomethane. Due to a large organic content, a variety of bioresources, including municipal solid waste, are most often employed to produce biomethane. In terms of hydrogen production, it has been claimed that there is a danger of GHG emission since, at the moment, fossil fuels are used to manufacture hydrogen all over the globe. In this context, renewable biomass produced from a variety of bioresources is seen to be the optimal feedstock and is garnering a lot of interest on a worldwide scale.

Only 1% of hydrogen is now produced from such renewable biomass, demonstrating the enormous potential for expanded use of this resource. The prospect of using specialized biofuels as an aviation fuel to power aircraft has been stated in publications, in addition to the biofuels previously mentioned that are often used for road transportation. However, bio-jet fuel may be utilized as a viable replacement when taking into account the serious issues like environmental pollution and global warming produced by the widespread burning of fossil fuels. It may be made from a variety of renewable biomass feedstocks, including lignocellulosic biomass, which includes forestry and agricultural residuals, sugar or starch, and oil or lipid-containing biomass, which includes vegetable oil, used cooking oil, and microbial oils.

The most prevalent macromolecules in the biosphere that are found naturally are polysaccharides. These polymers, like starch, cellulose, and hemicellulose in plants, glycogen in animals, and cyanobacteria, play a role in the construction of the biomass of living things. Similar to what is seen in plants, bacteria, fungi, and microalgae produce polysaccharides through microbiological means, resulting in products with significant biotechnological applications for a variety of industries, including food, pharmaceuticals, and chemical-industrial, as well as improving human and animal health. Exopolysaccharides may be used as a flavoring and seasoning ingredient, a hydrocolloid agent, a food coating, an edible film, a starch substitute in low-calorie food compositions, and more in the food business. EPS may be applied to food as coatings or edible films to act as a mechanical barrier against invaders. The usage of edible films and food coatings has grown, mostly as a result of new business possibilities and improvements in environmental requirements that permit the substitution of biodegradable materials for synthetic ones.

These modifications will make it possible to commercialize fruits and vegetables that have edible barriers in order to produce goods with a longer shelf life. The use of EPS must adhere to a number of requirements in order to be used in food, including low production costs, the presentation of sensorial characteristics, good mechanical properties, and the presentation of adequate barriers for gases, liquids, and microorganisms, in addition to physicochemical stability and biochemical stability. EPS should be able to transport antioxidants, smells, colors, as well as antibacterial and/or nutritional additives, while still being health-safe. Due to their anticoagulant, anticancer, antioxidant, and immunomodulatory effects, certain EPS, such lasiodiplodan, provide prospective uses. The creation of goods from EPS is of tremendous interest to the pharmaceutical sector.

In addition to delivering a bio-adhesive, emulsifying, foaming, and solubilizing activity for creams and sunscreen lotions, the hydrocolloid capabilities of EPS have several uses in the production of diverse skin care products. Due to its great compatibility with biological tissues, this hydrogel enables the creation of a structure that, when in contact with water, prevents dryness and functions as an antiaging agent. Since the consumption of dietary fibers like b-glucans is linked to a decrease in chronic diseases, the fungal EPS can also help to control blood glucose, insulin, and lipid levels and reduce risks related to the cardiovascular system, cancers of the colon and breast, obesity, and gastrointestinal tract. Biopolymers may also be used in agriculture, heavy metal adsorption, nanotechnology, and other fields.

Biosurfactants

The biosurfactants are emulsifying, antibacterial, and tensoactive microbial metabolites having amphipathic structures. These are regarded as versatile compounds due to their wide range of uses. Other sectors, including the pharmaceutical and food industries, have also been investigating and employing the biosurfactants extensively. Although biosurfactants are more often utilized in the oil business owing to their impact on the bioremediation processes of polluted regions in oil spills, they are also used widely in other industries. Biosurfactants, in accordance with Gharaei-Fathabad, are used in the pharmaceutical industry for a variety of functions, including gene delivery, drug delivery, immunological adjuvants, antiadherents of pathogenic microorganisms on solid surfaces, recovery of intracellular products, antimicrobials, and in cosmetic formulations. In the food business, they are already used as stabilizers and emulsifiers. In agriculture, biosurfactants may be employed for the biological control of pests and phytopathogens. Studies by Geetha and Manonmani and Geetha et al. and others have shown how these substances may be used to control mosquito eggs, larvae, and adult mosquitoes that serve as vectors for tropical illnesses like dengue caused by Aedes aegypti.

Societal Effects

Any technology's ability to live up to societal challenges that are either connected to it or brought about by it will determine how successful it is. The creation of employment, upholding equality, and the sustainable use of land and water are the key social concerns connected to biofuel technology. At this time, no regulatory agency in the world has established any explicit standards for the social sustainability of this industry.

Therefore, public backing is crucial to the strength of this technology. It is common knowledge that diverse bioresources may be used as inexpensive feedstock in a wide range of businesses to produce a wide range of goods. It encourages the development of enterprises reliant on bioresources. However, the construction of such enterprises has led to an increase in large-scale land acquisition in emerging nations. Africa accounted for 30% of all land acquisition worldwide in 2016.

The local population, who depend on the agricultural land, is severely impacted by this process. Numerous investigations that have been published to date opine that such massive property acquisition has had a detrimental effect on social constructs including class, gender, and ethnicity. Such purchase restricts ordinary people's access to natural resources including water, land, and forests. On the other hand, it was disputed that the introduction of the crop for the production of biofuel may boost productivity and perhaps provide up work prospects for the locals. Despite the fact that it may lead to a lot of employment prospects, there are a lot of potential for unfair labor practices, such as paying employees poor salaries or exploiting them for carrying out tasks that are part of their job description. Land purchase has an impact on people all around the world, including 10% of Sierra Leone's population. A similar scenario might result in significant profits for investors rather than the project's intended beneficiaries. As a result, it encourages friction and disparities between the locals and the relevant authorities in terms of their social and financial standing.

Environmental Consequences

The usage of numerous goods made from different bioresources is very beneficial for human development, but it will be difficult to commercialize this technology without harming the environment and its constituent parts. Because they don't produce greenhouse gases, the biofuels made from different lignocellulosic biomasses are regarded as clean and environmentally friendly fuels and aid in environmental preservation. Similar to this, using leftover materials or waste from various industries, domestic businesses, and municipal corporations to produce the aforementioned value-added goods effectively aids in waste management; perhaps the disposal of these materials is a major concern on a global scale. Such technologies have shown to offer a number of advantages, but they may also have harmful consequences on the environment and human health. Any usage of bioresources has a significant negative influence on the ecosystem and may cause significant environmental losses.

Therefore, it is important to determine the intensity of the technology before using it. The biodiversity, water body quality, soil quality, etc. will all be impacted by the utilization of bioresources. By 2020, 10% of all gasoline used in the EU must be biofuel, according to the Renewable Energy Directive from 2009. Since biofuels have a minimal carbon footprint, their usage should be prioritized. However, in nations like Brazil, the USA, and several Southeast Asian nations, undisturbed land in the rainforest, peat lands, savannas, or grasslands has been transformed for the production of biofuel. The "biofuel carbon debt" that results from this circumstance releases 17 to 420 times more carbon dioxide into the atmosphere than the yearly GHG reductions brought on by the usage of biofuels. The increased use of biofuels poses a concern to the environment since it significantly increases air pollution. Additionally, it will result in a wasteful use of water, natural resources, and more GHG being produced. The costs of food and food items are also rising as a result of the excessive commercial exploitation of agricultural resources.

Additionally, it has been noted that a significant number of natural resources are needed for the manufacturing of biofuels. For instance, 30 Mha of land is required for less than 1% of all biofuel production. It is common knowledge that several microbes, chemicals, and enzymes will be used in the biorefinery industries. The kind and amount of waste created will depend on which reagent is used. Such companies may emit a variety of poisons, pathogens, allergenic substances, and pathogenic microbes as waste products. Therefore, the natural plants, animals, and microorganism of the adjacent water bodies and environment may be impacted by the waste products emitted from such companies. Toxins may be produced by algae utilized as a bioresource for the generation of biofuel [10], [11].

The poisons may cause neurotoxicity, hepatotoxicity, and dermatitis. Such elements may accumulate in water bodies as a result of their introduction into waste disposal systems, which lowers the quantity of dissolved oxygen and has a detrimental effect on biodiversity. The discussion in this part suggests that, in order to utilize biorefinery technologies more safely, an impact assessment of such technologies' potential negative impacts on biodiversity, water quantity and quality, land resources, and industry best practices for managing production should be carried out. Furthermore, the detrimental effects of this technology on the environment and ecology may be lessened with better agricultural technology and careful landscape design. A collaborative scientific community must be established in order to come to consensus on common technical and economic approaches, which can assess the environmental effects of producing biofuels and also offer solutions to the problems that stand in the way of making this technology more environmentally friendly and sustainable.

Financial Effects

A large or small portion of the economies of many nations are reliant on agriculture. Agriculture has a significant role in the creation of jobs and the contribution to the national economy. Additionally, a variety of individuals in various industries rely heavily on their particular bioresources for their economies. The many crops that are often grown by those who work in agriculture are a major factor in their economic situation. Overall, a variety of bioresources with agricultural roots play a significant role in the economy of those who are connected to them. Additionally, a wide range of agricultural commodities, such as oil seeds and many others, are used as raw materials by a number of companies, including those that produce and process food, oil, and other goods, creating a large number of jobs both directly and indirectly.

In addition, a few bioresources with a forest origin are significant economic drivers for indigenous people. Tribes have a close relationship with the natural resources they use; the gathering of diverse forest bioresources and their other products serves as the main source of their additional revenue in addition to their food supply. It has also been shown that different agricultural or forestry wastes may serve as significant renewable resources for the manufacturing of the numerous biorefinery goods listed above, which in turn produce income and support a nation's and individuals' economies. For instance, Brazil is the world's top producer of bioethanol and biodiesel made from sugarcane, and as a result, Brazil is gaining worldwide recognition through bolstering the global economy. When food security is impacted by competition between the resources used to produce food and biofuels, substantial usage of food crops may have minor negative economic effects. For instance, the development of biofuel from sugarcane is to blame for higher food costs.

In the pursuit of financial gain, farmers may sacrifice the genuine food crop for the commercial product crop. Less pay or poor prices, however, gradually worsen farmers' financial circumstances. Fish and other aquatic creatures are regarded as key economic resources when it comes to marine bioresources. Few people's diets would be complete without seafood, such as fish, prawns, and other creatures of the sea. Other aquatic bioresources, such as seaweeds, are also very significant since they are a rich source of numerous bioactive substances and may be used to produce a range of commercially viable goods. As a result, these bioresources generate the economy and provide individuals lucrative work opportunities. The same is true for all other bioresources, which provide income for many individuals connected to them directly or indirectly via a variety of mechanisms.

Bioresources are vital biological materials derived from nature that are biodegradable and sustainably renewed. Numerous bioresources have been important to human growth ever since the dawn of humanity. Crops are one kind of bioresource that comes from agriculture and meets a basic human requirement. Similar to these, other bioresources derived from the forest and/or from different sectors are prospective resources and commercially feasible feedstocks for the creation of high-value goods. Different bioresources may be used to make a variety of products, including biofuels, biopolymers, biosurfactants, enzymes, antibiotics, organic acids, etc. Biofuels stood out among all of these goods since they are clean and environmentally beneficial fuels. Other products with potential uses in the chemical, food, and pharmaceutical sectors include biopolymers, biosurfactants, enzymes, organic acids, antibiotics, etc. Although bioresources take on a prominent role in the bioeconomy and contribute significantly to the development of a country's economy, utmost caution is required to prevent their overexploitation. Therefore, it is crucial to utilize all bioresources in a manner that does not disrupt the variety of genes and species found across the planet or degrade crucial habitats and ecosystems if biodiversity is to be conserved. Additionally, it is vital to preserve the balance between various bioresources since a concentration of a particular bioresource or its exclusive usage for commercial gain may have an adverse impact on food security and raise food costs. Therefore, wise use of bioresources may turn waste into riches. Since bioresources are the primary drivers of the bioeconomy, significant steps should be made to raise awareness of the value and constraints of bioresources. This might be done through eliciting responses, igniting debate, and prompting discussions across all spheres of society. If required, rigorous laws and regulations should be put in place to provide a framework for the protection of biodiversity.

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CHAPTER 15

AGRICULTURE AND BIOLOGICAL RESOURCES

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The term "biological resources" refers to the living landscape, which includes the plants, animals, and other elements of nature. They are significant to civilization for the numerous benefits they provide as well as any potential issues they may bring about. Biological resources can be divided into three categories: those that have an impact on agriculture, like cultivated plants, pollinators, and pests; those that are sources of scientific inputs, like agricultural plant varieties that provide genetic resources; and those that provide natural goods and services, like wildlife, fish, and scenic beauty. Traditional agricultural production measurements may not fully account for the advantages of protecting biological resources on private farms. Private landowners may not be sufficiently motivated as a result to take into account the complete spectrum of commodities and services supplied by the biological resources under their control. In instance, adopting techniques that produce the amount and quality of animal habitat and genetic variety demanded by the American people may not be financially advantageous for farmers. Similar to this, while making judgments about their land usage, farmers could not take into account the whole range of indirect advantages.

Biological resources are often understood to be the living landscape, which includes the plants, animals, and other natural elements that exist on farming, woods, and other natural regions. The impact of private rural lands on biological resources is covered in this chapter, along with the significance of these impacts. For the many benefits they provide and the potential issues they might cause, biological resources are crucial to civilization. The three main categories of biological resources are those that impact agriculture, those that serve as sources of scientific data, and those that provide natural products and services [1].

Agro-resources that have an Impact

These resources might be cultivated plants, pollinators, pests, or pest predators, for instance. Several biological resources directly influence agriculture. The roots of agriculture are really resources like soil microorganisms, agricultural cultivars, and domesticated animals since they directly influence the amount and quality of food and fiber produced. Some biological resources affect agriculture less directly, for better or ill. For instance, a farm's profitability may suffer if there are a lot of noxious weeds in the area since doing weed management after the fact would cost the farmer more money. In a similar vein, nuisance animals and insects may live in non-agricultural grounds.

Sources of Scientific Information

Native plants and animals that may give genetic resources for plant breeding and biotechnology are a few examples of such resources. The macro- and micro-structural knowledge of biological systems can only be obtained from the natural environment. The genetic resources and natural evolutionary processes are protected by maintaining natural landscapes. Alternatives include preserving certain resources in gene banks, which house substantial collections of various genetic resources and are especially valuable to breeders. Together, these strategies save plants and animals as well as material that might be valuable in the development of future industrial and medicinal goods [2], [3].

Natural resources that produce products and Services

Examples include the fish, animals, and scenic beauty found in both natural and agricultural environments. People appreciate the ecological riches of a rural setting, especially the creatures and plants that make up a natural community. On the basis of the kinds of advantages they provide, natural products and services may be grouped into three groups. Utilizing animals actively for pursuits like fishing and hunting necessitates the consumption of biological resources. Wildlife watching and other non-consumptive activities do not directly impact plant and animal populations. And last, a lot of individuals may enjoy a resource without having any direct physical contact with it. Simply knowing that an environment is healthy and will be there for them or their offspring to enjoy gives them happiness. Resources' influence on agriculture may be seen in part via improvements to commodities that are easy to measure, such higher crop yields or lower production costs.

However, farmers and landowners do not get a lot of additional advantages from biological resources. Particularly, changes in the quantity or quality of conventional agricultural commodities are a rare way to quantify the advantages from scientific inputs and natural goods and services. Due to this, standard agricultural production measurements do not fully account for the advantages of protecting biological resources on private farms. What's more, private landowners may not have sufficient incentives to take into account the complete spectrum of products and services supplied by the biological resources they are in charge of. In instance, adopting techniques that produce the amount and quality of animal habitat and genetic variety demanded by the American people may not be financially advantageous for farmers. When making choices on how to utilize their property, farmers may not take into account the entire range of indirect advantages, such as pollination services provided to other farms or possible upgrades to plant breeds. Although it might be difficult to quantify the worth of genetic resources and animal habitat, their preservation raises economic concerns. We address how designing public policies and programs may guarantee that biological resources are properly taken into account, evaluate concerns surrounding the preservation of genetic information both on-site and off-site, and assess the significance of wildlife to the American population.

Wildlife and Agriculture

The American people and the American economy place great value on wildlife. The majority of wildlife-based leisure activities saw increases in participation during the 1980s and a leveling off in the 1990s, indicating that they are still quite popular. The overall number of days spent hunting and fishing has greatly grown, despite the fact that participation rates for these activities have recently plateaued or even decreased somewhat. Despite certain activities increasing, fewer people are now watching wildlife. For instance, between 1982 and 1994, the number of people participating in bird watching climbed by 155%. Spending on commoditized goods and days engaged in outdoor leisure do not provide a whole picture. Consider the whooping crane, which is an endangered species. Only a very tiny portion of individuals will ever get to view such an uncommon bird.

However, many more individuals could be eager to contribute at least a modest sum to the species' preservation. In this approach, a resource's presence may be enjoyed by both users and nonusers. The worth of wildlife resources is difficult to quantify in terms of absolute dollars. Many of the advantages brought about by wildlife lack market data. Instead, studies of individual hunting, fishing, and wildlife watching participation are needed to determine the consumptive and nonconsumptive value of wildlife resources. The worth of many less well-known species has not been researched since these surveys may be costly to execute. In addition, respondents may find it difficult to express values for nonuse benefits, especially for little known or enigmatic species.

Despite these quantitative difficulties, a number of variables that influence how much enjoyment individuals get from a natural resource may be discussed. A few non-use, hunting, and watching values for several animal species. The existence of a consumptive use for the resource and the laws governing that use are two factors that influence these values. For instance, the typical deer hunter is ready to spend $623 per year for the chance to hunt under the present circumstances. Whooping cranes are an example of a nongame bird that may have passive usage or existence values. While many people may care about these species, they may not be ready to spend a lot of money to protect them. Therefore, the overall value from society may be rather high when a lot of individuals have low existence values for the whooping crane [4], [5].

Genetic Resources and Agriculture

The genes that are present in all living organisms are genetic resources. Even while all biological resources include genes, talks regarding genetic resources often center on domesticated plants, animal breeds, and the wild relatives of these species. All agricultural products are descended from a variety of developed and wild genetic resources. The development of biotechnology has made it possible to use genetic resources from unrelated, non-agricultural species to enhance agricultural crops and animals. These genetic resources are an essential input that improves local and global food security by boosting productivity and providing defense against yield variability brought on by maladies, pests, and environmental stress. Farmers created their own crop or livestock variations before contemporary kinds were created. The adoption of contemporary breeding methods has produced genetic advancements that have enhanced yields for farmers. Breeders are continuously looking for resistance qualities to make high-yielding cultivars less susceptible since agricultural producers must contend with pests and illnesses that are constantly evolving. Thus, genetic resources are constantly required to sustain and raise present yields. Genetic resource collection, preservation, and long-term usage are now essential for maintaining agricultural output. It is possible to retain genetic resources in their natural habitats or to deposit them in genebanks.

The majority of the genetic resources in the world may be found in their natural habitat. At the same time, breeders often exploit materials that have previously been gathered and conserved outside of their natural settings. Each conservation strategy has unique costs and advantages, and the two strategies work best together. Finding the right balance of preservation tactics is a challenging undertaking made more difficult by a lack of funding and the destruction of natural environment, especially in emerging nations where a wealth of resources may be discovered. The pool of genetic resources employed in agriculture may potentially be impacted by two related concerns. First, according to some experts, the genetic base has shrunk and crop genetic diversity has increased. Genetic homogeneity may make it more likely for pests and illnesses to infect a range of crops or animals, as was the case with the Irish potato famine in the 19th century and the southern maize leaf blight in the United States in 1970.

Second, preserving the pool of genetic resources has depended on having access to resources available in other nations. Almost all plant species with significant commercial value to the United States have benefited from the introduction of foreign germplasm. The capacity of the United States to get new germplasm from overseas sources has been hampered by disputes over ownership of genetic resources. Genetic resources are being employed more and more in a wide range of different businesses in addition to helping to produce conventional crops. These industries include those that are developing biologically based agrochemicals, innovative foods and cosmetics, new lubricants, and other industrial applications. The need for biologically based agrochemicals is rising as society looks for ways to increase productivity via pest control while reducing environmental harm. One instance of a naturally occurring substance that is used as an agricultural chemical is the pesticide/fungicide neem. Other industrial applications for natural chemicals include lubricants and biological pollution management [6].

Wildlife and Genetic Resources Are Comparable

Genetic variety and wildlife habitat have something in common: both contribute to society in ways that are often unrelated to the sale of tangible goods. As a result, it is sometimes challenging for rural landowners to reap financial benefits from the preservation and conservation of these biological resources. This does not imply that genetic variety and animal habitat are worthless. In fact, a lot of people recognize that wildlife inhabits agricultural regions and that genetic diversity significantly increases agricultural output. However, society lacks the ability to codify its values for genetic diversity and wildlife in a manner that would encourage farmers to take these advantages into account when deciding how to manage their properties. Therefore, animal habitat and genetic variety tend to be underprovided; the country would benefit if rural landowners gave these resources' conservation and maintenance more thought. This "market failure"'s presence implies that the government may play a role. Government initiatives may directly boost the availability of biological resources, such as the upkeep of gene banks.

Government initiatives that collaborate with the private sector, like the Conservation Reserve Program, which restores environmentally sensitive land, and the Environmental Quality Incentives Program, which offers subsidies for environmentally friendly production practices, can both help increase the availability of wildlife habitat. There are limited chances for off-site wildlife preservation, despite the fact that maintaining wildlife habitat and genetic variety are shared objectives for onsite preservation. The major method of safeguarding wildlife populations is to safeguard their habitats, even if there are other initiatives that conserve wildlife off-site, such as captive breeding of endangered species in zoos. In contrast, rather than via the preservation of plant habitat, the United States' genetic diversity is mostly conserved through the upkeep of seed collections. There aren't many domestic locations where "wild" types of significant crops may be maintained in place, which is one of the primary reasons why the United States places such great focus on ex situ preservation [7]–[9].

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CHAPTER 16

MANAGEMENT OF BIOLOGICAL RESOURCES

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The crucial role that biological resources play in maintaining human existence has gained a great deal of, though delayed, attention in the recent two decades. The United Nations Conference on Environment and Development adopted the Convention on Biological Diversity in 1992 as a comprehensive framework for the protection and exploitation of the world's biological resources. The world's biological resources are still being lost at an alarming pace, despite growing awareness, especially in emerging nations where the majority of the remaining resources are concentrated. The causes of loss are many and regionally distinct, but they typically have to do with the processes of agricultural intensification and habitat modification brought on by market and population pressures. The 'public good' qualities of biological resources and the challenges of internalizing values in land-use management increase pressures.

Many millions of farmers, livestock keepers, forest dwellers, and other groups of rural people, both men and women, who rely heavily on the availability and productivity of biological and other natural resources for their livelihoods typically serve as the immediate landmanagers in developing countries. However, their circumstances could not be the same, and various stakeholder groups have varying interests in the use and management of the resources. While some are motivated by commercial possibilities and investments in the conversion of natural systems to productive agriculture, others are driven by tight linkages to conservation and the ongoing use of wild resources. Thus, the management of biological resources and the livelihood systems of humans are intimately and tightly intertwined. In this paper, we develop the claim that opportunities for intervention intended to promote rural development must begin with knowledge and comprehension of the contributions that these resources make to various groups of people, the institutional and economic factors influencing the process, and the costs and advantages of change. We contend that failing to account for micro-level economic-environmental interactions and the cost-benefit ratios of project or program impacts may substantially jeopardize their effectiveness, provide less economic value than expected, and unnecessarily degrade biological resources.

How to more effectively take into account ecological considerations in rural development projects and programs when the primary goals are poverty reduction and economic development, notably enhancing the living standards of impoverished rural people, is a key problem confronting development organizations. This is related to the idea of sustainability and the guarantee that today's "short-termist" choices and deeds won't harm future generations. There are many overlaps between development and conservation, thus it is crucial to look for them whenever feasible. But occasionally there are trade-offs between development and conservation, maybe more often as a result of population expansion and other change-related pressures. Regrettably, these tradeoffs are seldom taken into account and costed in development planning and are often overlooked or minimized. The research focuses on rural development in landscapes that have already undergone human-induced changes or conversions, where local residents and development planners are more concerned with socioeconomic growth than with ecological protection.

It is important to remember that few, if any, landscapes remain unaffected by human activity and that much of the world—perhaps 80% or more—is primarily a result of it. Modified landscapes, in contrast to national parks and other protected places, are maintained mainly for productive goals like agriculture in all of its forms, livestock husbandry, or commercial forestry. These regions are not often seen as being biologically varied or wealthy by global standards, and biological resource management is prioritized elsewhere. The significance of biological resources in these regions should not be understated, either, since they play a crucial role in the diets and livelihoods of many of the world's poorest citizens [1], [2].

Techniques and Methods for Conservation

Since the middle of the 1980s, the term "biodiversity" has gained widespread use; previous to that, the majority of bioresource conservation strategies made reference to the preservation of the natural world or to animals. Although many of the problems and difficulties are still present, the concerns go well beyond the purview of prior strategies. This chapter analyzes the factors that inform modern conservation practice while briefly reviewing historical trends that led to the present state of affairs. 3.1 Historical trends Environmental deterioration dates back to Egyptian and Grecian times, as evidenced by Plato's description of an overgrazed landscape in Attica as being "like the skeleton of a sick man," with only the bare framework of the land remaining. Early initiatives to safeguard the environment by the government were often made for utilitarian or recreational purposes, especially for the benefit of the wealthy.

For instance, the Pharaohs of Lower Egypt preserved hunting and hawking grounds, while William the Conqueror of England expanded the scope of the forest rule to include vast expanses of land "to protect and provide for sport and the provision of game" for his entourage. With urbanization and the loss of wildlands in the late 19th century, contemporary conservation awareness in Britain began to grow. In the 1860s, legislation was established to increase public access to common lands, which marked the beginning of state engagement in the control of natural regions for the benefit of the public. An increasing romantic and scientific interest in nature developed together with this. J. S. Mill, a philosopher and economist, put out arguments in 1869 in favor of protecting species for their own sake, apart from their potential economic use. Out of this, the idea of a nature reserve maintained for its varied and wild species emerged. On a far larger scale, conservation groups emerged in the United States under the leadership of spiritualists and romantics like John Muir, who founded the Sierra Club.

The endeavor to protect nature for its own sake and apart from humanity was the main focus. The economic interests of local populations were completely ignored, despite the fact that most landscapes are affected by human activity. In order to protect the pristine environment, Yellowstone, the first of many national parks, was founded in 1872, forcing the local Shoshone, Crow, and Blackfoot Indians to leave. Conflicts that were eventually revealed publicly included those between forest logging interests and preservationists. During the Roosevelt administration, disputes occurred over proposals to flood a valley in Yosemite National Park in order to provide water to San Francisco. Following World War II, a number of water disputes emerged. Later, as the animal rights and deep ecology groups emerged, the rift became wider [3].

Human-Centered Approach

There are two diverse perspectives on the worth of biological resources and the rationale for their preservation, and these perspectives may result in significant knowledge gaps. According to the ecocentric worldview, every living thing has a morally valid and equal right to exist. All species are considered to have inherent worth in this argument, regardless of any value that humans may extract from or attach to them. On the other side, the anthropocentric paradigm sees biological resources as a collection of products and services that support the preservation and improvement of human existence. When their loss lowers the amount of natural capital and resource base that is available for use now or in the future, conservation is required. A hazard to local and global life support systems as well as the survival of humanity might result from their removal.

Values of Bioresources

The anthropocentric arguments for conservation are based on the fact that both biodiversity and bioabundance provide a variety of products and services that are valuable to people. This was hinted at before. We have used a variety of analytical frameworks for the economic value of the environment to bioresources. Although this approach is useful for conceptualizing the whole economic worth of bioresources, its use faces several theoretical and practical challenges. These values, especially contingency valuation methodologies that determine people's willingness to pay for conservation, are often very difficult to evaluate and use. Furthermore, the given values are not "socially neutral" and may be seen differently by various stakeholder groups. Comparing different countries presents a unique conundrum; for instance, it would not seem morally appropriate for hazy assessments of the existence value of the North to dominate the direct-use values of underprivileged locals in remote areas of emerging nations.

As was already established, some of the benefits of bioresources are related to the resource's quantity, while others come from variety itself. The usefulness of fuelwood gathered by rural residents is probably more reliant on its volume and availability than its variety. However, individuals will also be aware of significant variations in the burning and heating properties of various species. In some circumstances, diversity has a direct benefit. For instance, a farmer may grow a variety of crops and kinds to reduce damage from insect infestation or weather extremes, or to benefit from the local microclimate and soil types. In Lamboll and Van Broekhoven, the purposeful selection and cultivation of many regional bean types by farmers in Tanzania's central highlands is examined. Therefore, biodiversity serves as an important component of many impoverished people's livelihood systems and is generally employed to lower risk, enhance sustainability, and increase production [4].

Emerged and started to promote the welfare of environment and species on moral and ethical grounds. 3.2 Fortress conservation early environmentalists in developing nations were driven by a similar goal to preserve nature and animals in their untainted state. The creation and administration of protected areas, including as national parks, nature reserves, and forest reserves, were the key priorities. Early endeavors included the creation of botanical gardens in South Africa and forest reserves in the West Indies. Around the turn of the century, there was an increase in the movement to protect forests and wildlife, and after World War II, it picked up again. Many managed hunting grounds and game reserves were designated as national parks during this time because the colonial emphasis on hunting and game management fused with a rising interest in animal conservation on a global scale. All of these regions were identified, established, and managed by a top-down, politically driven process, with central selection and execution by government ministries. Protecting locations with a high species variety or those where famous animals or natural environments were under danger received special attention.

Local interests were seldom acknowledged or taken into consideration, and the selection criteria were centered on the need to conserve characteristics of global relevance. In order for natural biological processes to sustain the ecosystem and continue to offer habitat suited for animals, the management goal was to limit human interference within PA bounds. This followed a protectionist or "fortress conservation" strategy, similar to the early years of conservation experience in the USA, in which local residents living inside the park were evacuated and barred from using the natural resources they had previously depended on. This resulted in frequent continuous conflict between locals and PA officials. Within the newly created park limits, the Maasai and other pastoralists in East Africa continued to graze their animals, hunt wildlife, and develop land. The authorities were compelled to devote more resources to upholding and monitoring borders and implementing laws in an attempt to stop such acts. The demand on PAs and the surrounding regions from a growing population as well as the rising expense of protection caused problems to worsen over time. Sometimes, fencing areas had a negative impact on the species that the PAs had been designed to protect, especially when fences crossed migratory paths. Fortress conservation's top-down, centralized approach of PA management typically fell short of protecting species to the extent desired and frequently brought suffering on nearby residents. The endeavor to separate development concerns from conservation issues became more difficult, and the strategy was finally replaced by another discourse known as community-based conservation [5], [6].

Community-Based Initiatives

Community-based conservation, as opposed to fortress conservation, is based on a better understanding of the connections and mutual dependency between local people and conservation, as well as the need for people to engage in conservation initiatives. Local people's choices and actions often result in the loss of bioresources, hence the approach views cooperating with them and winning their support for management as being crucial to conservation. As knowledge of the depth and usefulness of indigenous knowledge has increased, so has our awareness of how economically sensible impoverished rural people [7], [8].

Thus, the benefits of community-based conservation are now generally acknowledged, as is the significance of incorporating locals in project development and execution. But whether the structural adjustment has been as effective in practice as it has been in discourse remains to be seen. The major objective is still the preservation of biological resources, with the implicit understanding that, when carried out properly, preservation benefits the community as a whole. Even while the majority of conservation professionals, if not all of them, now support including local populations in their programs, there is little proof that local people's opinions are taken into account when planning, managing, and implementing initiatives. Additionally, the complexity of involvement receives little attention, and methodological issues are often ignored. Many programs still do not adequately analyze issues from the viewpoints of stakeholders or take into account who is responsible for paying for conservation.

This is crucial, particularly when what has to be protected has significant value on a national or international scale but little significance to underprivileged locals. 3.4 Conservation outside protected areas Despite the fact that conservation practice has greatly advanced from the legacy of fortress conservation, the establishment and management of Protected Areas, chosen for their contribution to global biodiversity and containing high species diversity or rare or endemic habitats under threat, still receive the majority of conservation funding. Even in cases when project activities are listed as being related to conservation outside of PAs, this often refers to the management of buffer zones rather than completely unrelated regions to PAs. Such a persistent emphasis on PAs is a reflection of the attitude of wildlife or environment conservation, which emphasizes the need to safeguard rare and vulnerable species as well as natural ecosystems [9].

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CHAPTER 17

MAKING PROJECT DESIGN BETTER

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The purpose of this last chapter is to address the methods for accomplishing the integration of bioresource conservation into the policies, strategies, and procedures for rural development. We begin by summarizing some of the key findings and arguments made in the prior chapters. We list integration roadblocks and talk about how they influence how bioresources are handled at the project level. Finally, we provide a broad framework for action and emphasize the need for a more in-depth analysis of how rural development initiatives affect the interrelated processes of environmental change and stakeholder livelihoods.

The goal of the research is to determine how to more effectively take into account biological and ecological problems in rural development, where reducing poverty and enhancing welfare are the main objectives and factors. It shows that given population and economic expansion, human value systems, and market demands, habitat loss and land-use intensification beyond PAs are rather inevitable. The task is to guarantee that growth and change take place with the least possible impact on bioresources, that productive and sustainable systems are formed, and that the social groups most reliant on biological resources are not harmed. The word "biodiversity" is used in a number of contexts, often to refer to both the variability and variety of nature as well as its larger benefits. We use the phrase strictly or scientifically to prevent ambiguity and use the term "bioresources" to refer to the values of variety and abundance when considered together.

The research examines how bioresources are valued, identifying those that result from variety and those that result from abundance. It also takes into account how these values are distributed and how they benefit various social groups, identifying those who profit or lose from the dwindling of bioresources and environmental change. The synergies between development and conservation are undeniable, but there are also trade-offs and conflicts that must be recognized and understood early in the project development process. The majority of development organizations have abandoned protectionist conservation strategies and, at least theoretically, acknowledge the need of community engagement in bioresource management. Less attention is paid to the practical methods of implementing this ideal in significant rural development initiatives or to the methodological challenges of including people in project planning and administration. Many efforts do not effectively analyze challenges from the viewpoints of stakeholders or take into account who is responsible for paying for environmental change or protection. The unwritten presumption still holds that development and conservation work in harmony and, when carried out properly, benefit all parties involved. This oversimplification, in our opinion, is at the core of many issues and is particularly concerning when there are perceived gaps between local and global interests.

Obstacles to Advancement

Although there has been significant advancement in the management of bioresources in the context of rural development, it is helpful to reflect on why the aforementioned issues persist as well as some institutional obstacles and difficulties:

1. There is a persistent focus on the global values of biodiversity associated with rare, threatened, and endemic species and habitats as well as the creation of protected areas to preserve them. It would be easier to include local bioresource values into project and program development if rules and procedures were expanded to accommodate larger bioresource issues in productive and degraded environments.
2. There is a high information need for a thorough comprehension of local interactions. Project preparation expenses might rise as a result of information gathering and analysis. By employing a process method created to make it easier to incorporate recently obtained information and understanding into the project's work, this may be at least partly solved.
3. There are still issues with how environmental evaluations affect project design. Project design would be enhanced by a more comprehensive integration of EA into project cycle activities and by broadening the evaluation process to incorporate microeconomic/environmental linkages.
4. While it is crucial to identify projects' negative effects and the mitigating actions required to counteract them, this should not take priority over the need to find effective management solutions for the utilization of biological resources to support local livelihoods.
5. The issue of institutional capability in-country might be a major roadblock to the successful use of an information-intensive strategy. Lack of knowledge in systems-based microeconomic analysis and the incapacity of the government or local NGOs to appropriately represent stakeholder interests are two examples of institutional weaknesses.
6. Due to the size of the majority of donor-funded projects, it is difficult and expensive to account for local variance and cost-benefit ratios. Adopting a process approach that permits nonstructured and flexible management and decentralizing decision-making to the local level wherever feasible will help solve this issue in part [1]–[3].

In this paper, we've thought about the significance of comprehending how people interact with bioresources in project design and management, as well as the need of including local residents' interests and viewpoints. The current issue is to create functional mechanisms for advancing concepts and integrating these concepts into regular developmental activities. In order to facilitate the process of creating particular local activities from widely expressed strategic objectives, we have devised a broad framework for planning. Adopting a stakeholder approach that includes in-depth research of the viewpoints and financial interests of various stakeholders and representation of these interests in project and program design is a crucial component of this framework [4].

Investigating the System

Gaining knowledge of the neighborhood environment and how people interact with it is the first step in the process. This comprises: An understanding of what is happening to the system in the absence of intervention, including the impact of shocks and stresses, as well as what is happening to the system in the absence of intervention, including the identification of stakeholder groups with different sets of interest in project activities and environmental change. In Figure 1 shown the simplified representation of problems, inquiries, and exchanges.

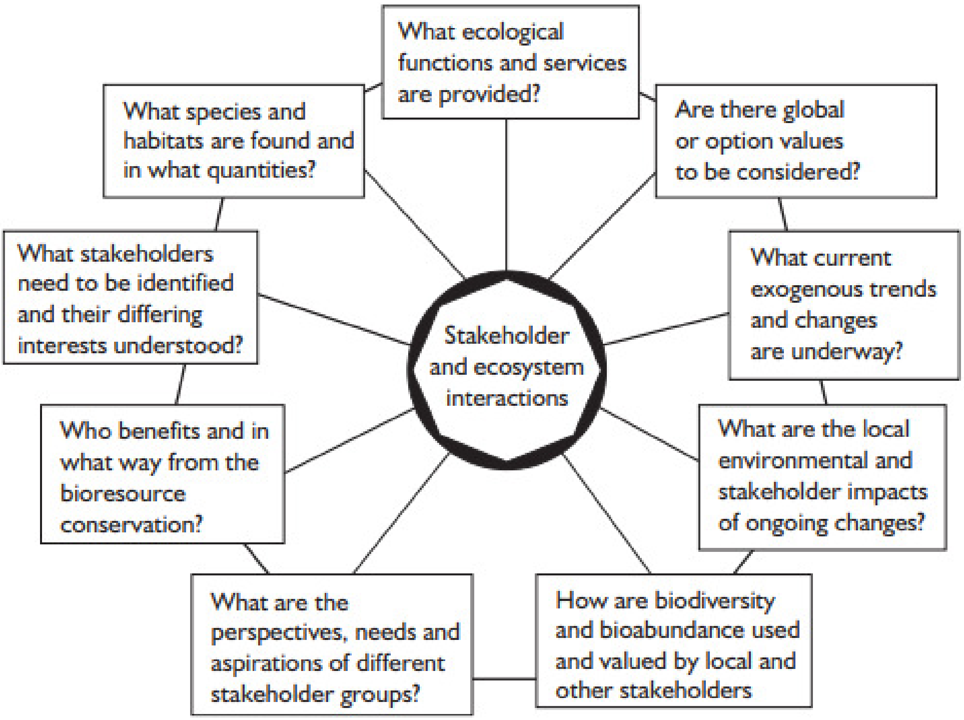

Figure 1: The simplified representation of problems, inquiries, and exchanges is called the "people-ecosystem web."

Step 2. Creating a vision and a justification for action In light of the aforementioned, the second step of the process entails thinking through the available intervention choices, learning from previous mistakes, and taking into account the institutional and policy environment that has an effect on the system and influences the amount of space for maneuver. The extent and nature of the intervention are then decided by combining the information from numerous sources. The effective representation of stakeholder interests in decision-making, especially those of groups with little influence or authority, is a crucial component of the process. This results from carefully carried out stakeholder analysis, but it also probably needs direct engagement methods. Step 3. Implementation and evaluation the third step of the process is the action stage, when actions at the field level are planned and carried out. This phase must be very iterative and adaptable in order to allow interventions to take into account new knowledge and understanding as it becomes available and to address issues and obstacles that have just been discovered. Therefore, it is very important to develop an efficient feedback loop for guiding and altering the management process [5], [6].

A warning

The above structure has the risk of being interpreted and employed mechanically whereas, in reality, there is flexibility between the stages and processes. Because the stages overlap, interact, and have an impact on one another, the difference between neighboring boxes in Figure 1 is arbitrary. The framework should thus be seen as a mechanism for directing the development of locally unique and ecologically conscious actions rather than as a prescriptive instrument [7], [8].

In summation, we would like to emphasize two overlapping themes of this paper: the importance of local realities, particularly the intricate interactions between locals and bioresources, and the fact that every rural development project, including agricultural projects, is location specific. Although each project must be evaluated holistically, it is also crucial to take into account microeconomic incentives, especially the cost-benefit ratios of the project's effect and the change in bioresources. We contend that if these concerns are not addressed throughout the planning and design phases of projects, there will continue to be resistance to project activities or inadequate adoption of messaging and technologies, which will lead to subpar project performance. Additionally, it may have unanticipated negative effects on some stakeholder groups, such as the poorest and most marginalized, undermining the overarching objective of eradicating poverty. The paper's goal is to provide a comprehensive framework for solving these issues. We anticipate that using it will make initiatives and programs more successful and enhance the probability that they will accomplish their goals [9].

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CHAPTER 18

MANAGEMENT OF NATURAL RESOURCES AND PRESERVATION OF BIODIVERSITY

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The sustainable use of important natural resources, such as land, water, air, minerals, forests, fisheries, and wild flora and fauna, is referred to as "natural resource management." These resources work together to produce ecosystem services that enhance the quality of human existence. Natural resources offer essential services for consumption as well as those that benefit the general welfare. Environmental processes preserve climate cycles, nutrient recycling, soil productivity, and air and water purification. The presence of many ecosystem types, species of creatures with the whole spectrum of genetic variations and adaptations to various climatic and environmental conditions, as well as their interactions and activities, are all examples of biological variety. The diversity of all life on earth is referred to as biodiversity. India is one of the world's top 17 mega-biodiversity nations. Despite having just 2.5% of the world's geographical area, India is home to a huge and varied array of plants and microorganisms that make up 7.8% of the world's known species. Genetic variety refers to the variance in chromosomes, genes, and chromosomal types seen in various animals. A species' genetic variety becomes more apparent as its size and habitat's environmental factors rise. The variability in the quantity and wealth of the spices in a location is referred to as species diversity. Ecosystem variety refers to the combination and interaction of species coexisting with one another as well as the local physical environment. Landscape variety refers to the distribution and dimensions of different ecosystems.

Key Concerns: Three

1. Renewable resources are used more than they can be replenished, which is one of three ongoing worries about NRM.
2. The depletion of non-renewable resources is caused by inadequate investments in human, financial, and social capital.
3. Pollution overloads the environment's ability to act as a "sink," harming ecosystem processes and human health.

The Critical Need To Protect Natural Resources

Natural habitats are regions of land and water where native plant and animal species predominate in the biological communities and where human activity has not significantly altered the area's main ecological functions. Sustainable development depends on preserving and protecting biodiversity, or the variety of life in all its manifestations, including genetic, species, and ecological diversity, as well as its capacity to alter and adapt. The Convention on Biological Diversity defines biodiversity as consisting of elements such as ecosystems and habitats, species and communities, genes and genomes, all of which have significant social, economic, cultural, and scientific value[1], [2].

Problems for Biodiversity

Biodiversity is seen as a source of resources that may be exploited to make goods like food, medicine, and industrial items. But as a result of rising demand, biodiversity is slowly disappearing. The various factors posing a threat to biodiversity include habitat destruction, which is the main factor in biodiversity loss and is brought on by extensive industrial and commercial activities like mining, irrigation, and extensive clearing of forests and water bodies, among other things. Habitat fragmentation: As the population grows, urban infrastructure, construction, etc. fragment the habitats. The ability of organisms to disperse is limited by the fragmented, isolated habitats. Contamination: The loss of biodiversity as a result of environmental contamination, such as that caused by industry, the air we breathe, and the water we drink. The biggest danger to maintaining biodiversity is acknowledged to be habitat degradation.

Agricultural areas are examples of modified habitats, which are generally natural environments that have been transformed by the introduction of alien plants and animals. Both habitat types are capable of supporting significant biodiversity on all scales, including endemic or endangered species. Critical habitats may exist in both natural and modified ecosystems and may be necessary for the survival of endemic, restricted-range, or endangered species as well as migratory species, severely endangered species, or both. Since certain alien species have the potential to become invasive, spread quickly, and outcompete local species, the planned or unintentional introduction of alien, or non-native, species of flora and animals into regions where they are not typically found may pose a serious danger to biodiversity[3], [4].

The following are typical steps used to preserve biodiversity:

1. **Modified habitats:** It is important to prevent habitat degradation and to look for ways to improve habitat and safeguard biodiversity throughout operations.
2. **Natural habitats:** It's important to make sure that they aren't altered or deteriorated unless there are no other options and the overall advantages of continuing activities there exceed any negative effects on the environment and biodiversity.
3. **Legally protected places:** When dealing with sites that are legally protected by national legislation, one must adhere to the standards outlined in the management plans for such protected areas.
4. **Alien species having the potential to become invasive:** It is important to exercise caution when introducing new alien species unless they are properly controlled within an established regulatory framework or action plan.

Hotspots for Biodiversity

Biodiversity hotspots are places that host essentially unaltered natural ecosystems and have a high concentration of native species and populations that are related to those ecosystems. A great variety of regionally endemic species, or species that are either absent from or are only sometimes seen outside the hotspot, may also be found there. Hotspots' natural values are put at risk by the present, planned, or proposed management actions, and it is probable that this risk will grow over time in the absence of proactive conservation management. Because hotspots' natural assets are still largely unaltered, taking immediate action to preserve them may be cost-effective in supporting our efforts to conserve biodiversity.

Bio-Prospecting

The investigation of the economic potential of genetic and biochemical resources is referred to as biodiversity prospecting. Numerous studies have been conducted over the past few years on the economic analysis of genetic diversity in the context of the commercial search among genetic codes found in living organisms to produce chemical compounds with industrial and pharmaceutical value for use in agricultural, industrial, and medical applications. It should be conceivable to defend the preservation of biodiversity on the basis of its many pharmaceutical and other economic uses, and biodiversity prospecting specifically refers to "the exploration of biodiversity for commercially valuable genetic and biochemical resources." The living world provides several advantages to humans, both directly and indirectly. Food, medications, pharmaceuticals, textiles, rubber, and wood all come from biodiversity. Additionally, there are potential resources in the biological resources. The diversity of species also offers a variety of free ecological services essential to preserving the health of ecosystems. Biodiversity is useful to contemporary agriculture in three ways, including as a source of food and for better variety[5], [6].

Because there is often not much material to be gathered, the Millennium Ecosystem Assessment calculates that the effect of bio-prospecting on ecosystems is minimal both now and in the future. The Assessment also notes that since bio-prospecting gains from protecting biodiversity, there is a significant synergy between the two. It does however caution that there is still a lot of ambiguity about the possible effects of bio-prospecting operations. Bio-prospecting does not yet violate international treaty requirements that govern activity expected to have substantial negative environmental consequences in commons since the predicted impact is modest, but unknown. Although not thoroughly explored in this issue brief, the legal ramifications of any potential environmental effects from bio-prospecting must be taken into account by decision-makers when drafting future laws and policies to regulate this activity and materials between states, especially for developing countries.

Advantages of bio-selection

Since the beginning of civilization, bio-prospecting has played a significant role in the discovery of novel medications. More than 8000 kinds of medicinal plants have been used by many millions of people for medical purposes worldwide. The Indian herbal sector alone presently employs over 800 different varieties of therapeutic plants. Despite the fact that scientists and pharmaceutical companies continue to incorporate elements from nature, their search strategies and applications have altered.

1. With the development of molecular biology and the accessibility of advanced diagnostic techniques for screening, pharmaceutical companies may now conduct research via bio-prospecting quite successfully. Extracts from biological specimens are subjected to quick and accurate screening techniques in high-tech labs, enabling the separation of compounds with a particularly specified action.
2. The recent discovery of numerous life-saving medications, particularly anti-neoplastic medications, has rekindled pharmaceutical corporations' interest in bio-prospecting. A number of medications are being isolated from plants.
3. Partnerships between pharmaceutical corporations and nations that provide the raw materials and expertise for medicines provide undeveloped nations with an income stream as well as chances for the community to improve access to education and jobs.

Numerous research have revealed that the value of bioprospecting advantages will be better if the search is based on the information and expertise of local people[7], [8].

Biological Prospecting's Restrictions

It is becoming more and more concerning that many pharmaceutical businesses and biotechnology firms are scouring the woods, farms, and rivers of the developing world in quest of biological treasures and local expertise in order to create copyrighted and successful goods. The great majority of the time, indigenous groups who chose, preserved, and enhanced traditional plant species for medicine did not get any compensation or acknowledgement. Pharmaceutical companies are often charged with depriving locals of information and financial advantages in order to commit fraud.

1. While multinational corporations engaged in bio-prospecting are free to patent biomaterials, no concrete rules or conditions have been established for honoring and rewarding the contributions of indigenous people and other unofficial innovators who are in charge of preserving, utilizing, and advancing biodiversity. One of the unanswered concerns in bioprospecting has been whether or not pharmaceutical companies have exclusive rights to ecological habitat in resource-rich areas after the investigation and identification of active medicinal constituents in biological samples.
2. Despite being approved by the multinational CBD, commercial bio-prospecting agreements are sometimes impossible for source communities, governments, or the convention itself to adequately monitor or enforce. In many instances, there is no law in place to guarantee that the nations where these plants were originally produced would get fair compensation.
3. Ecosystem imbalance brought on by overuse of natural resources is always a risk. It is a known truth that the world's tropical rainforest areas, which are home to more than 50% of medicinal plants, are dwindling. This is mostly because of various business interests, such as bio-prospecting[9].

Traditional wisdom and bio-pragmatism

Traditional knowledge has always been a valuable resource that is simple to get and is thus open to appropriation. Traditional knowledge, especially that pertaining to the treatment of different ailments, has given technology-rich nations ideas for developing biologically active compounds. In other words, bioprospecting makes use of traditional knowledge. Traditional knowledge consists of both codified and uncodified knowledge. Since codified Indian traditional knowledge exists in regional languages and a language barrier prevents the patent offices from searching this knowledge as prior art before issuing patents, bio-piracy of this knowledge persists. Traditional knowledge has been utilized for generations to create remedies that have been tried and true for treating human illnesses. Due to the trustworthiness of conventional medical systems and the lack of such data with patent offices, it is simple for outsiders to get patents on these therapeutic formulations drawn from traditional medical systems. Article 8 of the CBD requires each contracting party to respect, preserve, and uphold the knowledge, innovations, and practices of indigenous and local communities that embody traditional lifestyles relevant for the conservation and sustainable use of biological diversity. Article 15 of the CBD does not address the issue of traditional knowledge[10], [11].

The management of all natural resources, including biodiversity, heritage, and conservation concerns, is the main goal of biodiversity and conservation. This includes ensuring their fair and sustainable use, protection, management, and, where required, the restoration of this resource base. It also emphasizes resource threat mitigation as a foundation for inclusive socioeconomic development, which supports sustainable economic growth.

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CHAPTER 19

USE OF NATURAL RESOURCES IN A SUSTAINABLE MANNER

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The Resources of Biology

Any resource that has a biological foundation is a biological resource. The overexploitation of bioresources, which might not only have a detrimental influence on the ecosystem but could completely destroy it, is the dilemma that the world is now confronting. Therefore, careful treatment of bioresources is crucial for making the most use possible of our riches in bioresources without overusing them. Biodiversity The term "biodiversity" refers to the great range of ecosystems and living things, including both plants and animals as well as their habitats and genes. It is essential for the health of ecosystems that provide us the goods and services we need to survive. There is biodiversity everywhere. The complexity of the biodiversity notion shows the interdependence of genes, species, and ecosystems.

The number of species of animals, fungi, single-celled prokaryotes like bacteria, and single-celled eukaryotes like protozoans on our planet ranges from 3 to 30 million. Only roughly 1.4 million of the total number of species in this biological system have been named and recognized. Insects, which typically rule terrestrial and freshwater populations worldwide, make up somewhat less than half of the identified species. Ecosystem management the maintenance and preservation of biological variety depend on ecosystem management in a specific place. An ecosystem is a living system made up of communities of plants, animals, and microorganisms as well as their non-living surroundings. The location or kind of site where a population or an organism normally exists is known as its habitat. One of the most important challenges at the global level now is the widespread loss of biological capital[1], [2].

Humanity's subsistence, health, wellness, and ability to enjoy life are all reliant on biological systems and processes. The foundation of many ecosystem services that maintain the health of the natural environment is biodiversity. All people must recognize the interconnectedness between humanity and biodiversity since all communities eventually rely on its resources and services. At least 95% of all terrestrial animal species are invertebrates, including insects, centipedes, spiders, earthworms, and snails. Birds and terrestrial vertebrates are significantly outnumbered by invertebrates in any given region in terms of biomass. Therefore, it is not unexpected that invertebrates are essential to ecosystem function. Ecomanagement takes into account the interdependence of species, how certain species defend against erosion, and how various species play a part in successional processes like recovery after natural and artificial disruptions.

Due to the enormous variety of agroclimatic and sociocultural variables present there, India is a mega-diversity region. Genetic diversity is being lost as a result of a number of factors, the most significant of which is the conversion of environments rich in biodiversity for human habitation, industrial, agricultural, and aquaculture purposes. The United Nations General Assembly passed the World Charter for Nature in 1982. It has taken the stance that all living forms, regardless of how valuable they are to humans, are distinctive and need to be treated with respect. Throughout human history, religion, art, and literature have all acknowledged the social, ethical, and economic worth of these resources. Today, more quickly than at any point in the previous few million years, biodiversity is disappearing. Direct reasons of the present declines in biodiversity include habitat loss and fragmentation, invasive species, overharvesting of living resources, and contemporary agricultural and forestry practices[3]–[5]. In Figure 1 shown the sources of biological resources.

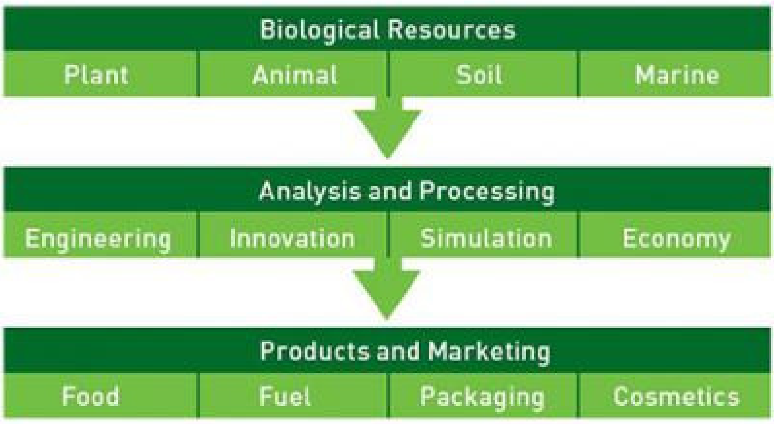

Figure 1: Illustrate the sources of biological resources.

The degree program combines advanced study in the natural sciences with pertinent interdisciplinary topics like engineering and sociology to give you the knowledge and critical thinking skills to assess the potential of specific biological resources in the future in a way that is scientifically sound. This knowledge is essential for many practical uses, including the creation of "bio-based products" like bioenergy, biopackaging, bioplastic, or novel food sources, to mention a few[6], [7]. Additional opportunities to develop expert research skills are provided by various interactive learning formats, such as applied research projects, field trips, lab work, and field work. For example, conducting ecological fieldwork or breaking down plant-based biological resources in a lab setting[8], [9].

The degree to which the benefit of biodiversity has been acknowledged has significantly increased in recent years. By maintaining and utilising biological resources in ways that do not reduce the variety of genes and species on earth or destroy significant habitats and ecosystems, biodiversity conservation aims to assist sustainable development. There is a widespread dearth of information and awareness of biological variety, and it is vital to build institutional, technological, and scientific skills to provide people the fundamental knowledge they need to plan and carry out the required actions[10].

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CHAPTER 20

RESOURCES BIOLOGICAL AND BIODIVERSITY

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In a time when managing agricultural, livestock, and aquaculture practices is complicated by accelerating climate change, population growth, urbanization, environmental degradation, increased market risk, tightening resource constraints, and a growing need for engagement of the pri, there is a fundamental need to increase productivity, especially of small to medium holders, increase access to markets, reduce risks, boost rural employment, and provide environmental services. In the future decades, there will be a need for a multiple increase in global food production with much lower resource availability than there are now. The heavy use of synthetic fertilizers, excessive dependence on pesticides, limited adoption of biological pest management, low usage of animal and green manure, and low degree of farm diversification provide ever-increasing obstacles to sustainable agricultural output in developing nations. Similar to this, food safety is garnering more attention globally due to the growing understanding of the significant connections between food and health. Enhancing food security, which occurs when people have access to enough and wholesome food, requires improving food safety. Food safety has also grown to be a common issue across rich and poor nations as global food commerce increases. Natural capital includes both ecological benefits and biodiversity. The maintenance of life-support systems and a high standard of living depends heavily on biodiversity, which includes species, ecosystems, and genetic variety. Biodiversity loss is a major issue on a national and international level. Changes in land use and marine usage, excessive exploitation of natural resources, pollution, climate change, and the introduction of invasive alien species are some of the pressures on biodiversity [1], [2].

The use of synthetic fertilizers and pesticides, intensive tillage, and over irrigation in current agricultural practices have undoubtedly helped many developing nations meet their population's food needs, but they have also caused environmental and health problems, including deterioration of soil fertility, overuse of land and water resources, pollution of the environment, and increased costs of agricultural production. The challenge facing modern agriculture is how to increase output while maintaining environmental quality and using the few resources at hand to fulfill the population's current and future food needs. The rising need for food as well as the requirement for environmental quality may both be satisfied by sustainable agricultural techniques. The current approach to sustainable agriculture involves low-cost, environmentally friendly farming that uses local microorganisms. It also underlines the need of farmers cooperating with natural processes to preserve resources like soil and water while reducing the price of agricultural output and trash creation, both of which have a negative impact on the quality of the environment. By using such sustainable agriculture management techniques, the agro-ecosystem will become more robust, self-regulating, and profitable.

Microbes have long been recognized for their role in soil fertility and the creation of green, sustainable energy. The microbiological methods of producing green energy have drawn attention in recent years as a sustainable method for producing biofuels such as methane, ethanol, H2, butanol, syngas, etc. According to recent studies, cyanobacterial biomass output for biofuels, food supplements, and biofertilizers for safe agriculture has increased noticeably. They have been categorized as both helpful and safe bio-agents based on how they affect plant production. In actuality, these two very different types of microbes coexist in nature, and which one is dominant at any given moment largely depends on the environmental circumstances. The impact of useful or efficient soil microorganisms for sustainable agriculture, which not only contribute to soil fertility, crop development, and yield, but also enhance the quality of the environment, has been studied for many years by soil microbiologists and microbial ecologists.

These minute microbes are expected to play a significant role in ensuring food security without harming the environment, according to modern sustainable agricultural principles. It is encouraging to see recent trends favoring the use of bio-inoculants natural fertilizers, insecticides, and pesticides instead of synthetic ones to increase crop output. Cyanobacteria have the potential to contribute to the reduction of GHG emissions and improvement of agricultural output. Cyanobacteria may play a key role in the ecological rehabilitation of damaged soils, according to a new theory. Cyanobacteria are a class of photosynthetic organisms that can thrive with just the bare minimum of water, carbon dioxide, and light. They are phototrophic and naturally exist from the Antarctic to the Arctic poles in a variety of agro-ecosystems including paddy fields. They create certain bioactive molecules that enhance soil nutrient status, boost crop development, and protect crops from diseases in addition to meeting their own nitrogen needs via nitrogen fixation. Cyanobacteria are helpful for treating wastewater because they can break down a variety of hazardous substances, including pesticides. There has been a conceptual model put out on the function of cyanobacteria in environmentally friendly farming practices. This study focuses on the contribution of cyanobacteria to agriculture, ecological restoration, and environmental sustainability [3].

Policy Difficulties

Making ensuring that biodiversity is effectively conserved and used sustainably is the major problem. Increasing the level of protection for species, habitats, and terrestrial, marine, and other aquatic ecosystems is implied by this. Strategies include putting in place ambitious regulations, stopping the illicit trade and exploitation of endangered species, and incorporating biodiversity issues into economic and sectoral strategies. In addition, expanding the role of taxes, fees, and charges that are related to biodiversity as well as other financial tools like payments for ecological services, biodiversity offsets, and tradable licenses are necessary for biodiversity conservation.

Progress and Performance Evaluation

The performance of the environment may be evaluated in relation to both national and international objectives. The 1992 Convention on Biological Diversity is the principal international accord on biodiversity. The 2030 Agenda for Sustainable Development, which was adopted in September 2015, also explicitly mentions biodiversity in Goal 15.

The 1971 Convention on Wetlands of International Importance, the 1979 Convention on the Conservation of European Wildlife and Natural Habitats, the 1973 Convention on International

Trade in Endangered Species of Wild Fauna and Flora, and the 1979 Convention on the Conservation of Migratory Species of Wild Animals are additional international agreements that pertain to biodiversity [4].

Principal trends and most current developments

Overexploitation, fragmentation, deterioration of the ecology, and conversion to other land uses pose threats to many forest resources. The major stresses are caused by human activity, which includes growing agricultural, building transportation infrastructure, unsustainable forestry, air pollution, climate change, and purposeful forest fires. Commercial forest exploitation depends in large part on the need for wood to meet renewable energy goals. Unevenly dispersed forests exist. The majority of the world's forest resources are found in a small number of the most forested nations. About 27% of the world's forest land is in OECD nations. In the majority of OECD nations, the extent of forests and wooded land has stayed consistent or slightly risen since 1990, but globally, it has been falling as a result of ongoing deforestation in tropical nations, often to make room for agriculture, grazing, and logging. The majority of OECD nations utilise their forest resources in a sustainable manner. The majority of people who manage forests that can produce wood do not overuse their forest resources, keeping the usage intensity below 100%. However, there is a substantial difference across and within nations. In 13 of the 23 nations with longer trends available since the 1990s, forest usage has usually grown. This is in part because wood is used as a biomass source of energy. Given that its woods are new and growing quickly, Korea has a comparatively low intensity.

Interpretation and Comparison

The extent to which forest resources are used sheds light on their quantitative characteristics. It presents national averages that might hide significant differences amongst woods. In addition to data on forest management techniques and protection measures, it should be read with information on forest quality. Although there are challenges in interpreting the data due to variances in the variables monitored, information on the intensity of use of forest resources may be gleaned from forest accounts, international forest statistics, and the FAO/UNECE Forest Resource Assessments for the majority of OECD countries. Historical statistics are either difficult to compare or are not accessible for longer time periods [5].

Principal trends and most Current Developments

The biodiversity is under more stress than ever. Many natural ecosystems have been damaged, which has reduced the benefits they can provide. In addition, many animal and plant species, both within and outside of protected areas, are endangered by habitat loss or modification. The majority of OECD nations are seeing an increase in the number of animal and plant species that have been classified as endangered, especially in those with dense populations and lots of concentrated human activity. On average, freshwater fish and amphibians are in greater danger than birds, plants, and mammals. But specialized birds have decreased by around 30% in the last 40 years, which is a reflection of habitat deterioration. In North America, dry areas, and agricultural lands in Europe had the greatest losses. All OECD nations are seeing an increase in protected areas. They now encompass, respectively, 16% of the terrestrial area and 25% of the marine areas, up from 11% and 5% in 2000. As protected areas vary over time new areas are established, borders are altered, and some sites may be destroyed or altered by forces of economic growth or natural processes it is still difficult to assess the effects for biodiversity and the real levels of protection. The identification of the area and the efficiency of the management have an impact on environmental performance. Since 1970, there have been an increasing number of new terrestrial protected areas named across the world; they currently make about 13% of the earth's surface. Up to 2000, the designation of marine protected zones was delayed. Since then, they have grown by more than 22 million square kilometers, and they currently make up over 17% of the ocean's surface [6], [7].

Interpretation and Comparison

For all OECD nations, data on endangered species are accessible in varied degrees of completeness. The number of species known or estimated may not necessarily precisely represent the number of species actually in existence, as nations use IUCN guidelines to different degrees of rigor when defining species. In general, historical statistics are unavailable or not comparable. Assessment efforts have concentrated on species that are likely to be endangered for many of the incompletely reviewed species groupings, therefore any proportion of threatened species given for these groups would be severely skewed. Extinct species are included in the statistics for certain nations. Data on birds for some nations only include breeding species. All OECD nations have protected area data available. The World Conservation Monitoring Centre has standardized the criteria, however there may be regional variations. A nation's efforts to conserve ecosystems, species, and landscapes created by human-environment interactions that are valued for cultural or other reasons may be seen in the size and management style of its terrestrial and marine protected areas. Protected areas are not usually properly linked to one another or reflective of the nation's biodiversity. The success of managing these places is not reflected in indicators of the size of protected areas. Natural capital includes both ecological benefits and biodiversity. The maintenance of life-support systems and a high standard of living depends heavily on biodiversity, which includes species, ecosystems, and genetic variety. Biodiversity loss is a major issue on a national and international level. It weakens ecosystem resistance to challenges like the damaging effects of climate change and increases susceptibility to them. Physical, chemical, and biological pressures may all be placed on biodiversity. Changes in the climate and the weather are other considerations [8], [9].

Policy Difficulties

Making ensuring that biodiversity is effectively conserved and used sustainably is the major problem. The level of protection for species, habitats, and terrestrial, marine, and other aquatic ecosystems, including oceans, must thus be increased. Achievable policy mixtures, the eradication of illicit, unreported, and unregulated fishing, the eradication of endangered species' exploitation and trade, and the incorporation of biodiversity issues into economic and sectoral policies are some strategies. Enhancing the role of taxes, fees, and charges that are relevant to biodiversity as well as other financial tools like payments for ecosystem services, biodiversity offsets, and tradable permits are also necessary for biodiversity preservation and restoration.

The vast variety of life on Earth is referred to as biodiversity. It may be applied more precisely to all the species found in a certain area or environment. Every living creature, including plants, microorganisms, animals, and people, is referred to as biodiversity. Around 8.7 million species of plants and animals are thought to exist, according to scientists. However, too far, only around 1.2 million species, the most of which are insects, have been recognized and described. This implies that the identities of millions of other creatures are yet unknown. All of the species that are still living today have developed distinctive characteristics through many generations that set them apart from other species. Scientists distinguish between species based on these characteristics. Different species of organism are those that can no longer procreate with one another due to their divergent evolutionary paths. All living things that can reproduce sexually belong to the same species [10].

Given that there is still a lot of species to be discovered, scientists are curious in how much biodiversity there is on a global basis. They also research the number of species that may be found in a particular environment, such as a lake, grassland, tundra, or woodland. Beetles, snakes, antelopes, and many more species may be found on a single meadow. The warm, humid temperature of tropical areas is an example of an optimum environmental setting for plant development in ecosystems that support the greatest biodiversity. Species that are too tiny to perceive with the human eye may also exist in ecosystems. Microscopically examining soil or water samples shows a vast array of bacteria and other microscopic creatures. The globe has certain regions with more biodiversity than others, including parts of Mexico, South Africa, Brazil, the southwestern United States, and Madagascar. Hotspots are places with very high biodiversity levels. Hotspots are also home to endemic species, which can only be found in a single place.

For the sake of survival and the preservation of their ecosystems, all species on Earth cooperate. For instance, cattle are fed on the grass in pastures. The dung that cattle then create replenishes soil nutrients and encourages the growth of further grass. Additionally, farmland may be fertilized with this manure. Humans benefit greatly from many species, especially in the areas of food, clothing, and medicine. However, owing to human consumption and other activities that disrupt or even destroy ecosystems, a large portion of the Earth's biodiversity is under danger. Threats to biodiversity include population expansion, pollution, and climate change. The rate of extinction of species has increased at an unheard-of pace as a result of these concerns. Some experts predict that during the next century, half of all species on Earth will go extinct. Conservation activities are required to safeguard endangered species, their habitats, and biodiversity.

In front of our own eyes, nature is vanishing. Up to one million plant and animal species are in risk of becoming extinct because of habitat loss, farming, poaching, pollution, invasive species, and, increasingly, global warming. As a consequence of population growth, growing, unsustainable production and consumption patterns, and rising demand for biological resources, there has been a dramatic reduction in biological diversity during the previous few centuries. Recognizing this problem is not new. But since the factors driving this decline are intensifying and biodiversity is disappearing at a previously unheard-of rate, it is now more important than ever to take appropriate action. Transitional approaches to a sustainable future are necessary to halt biodiversity loss, reduce climate change, improve our capacity to adapt to it, and accomplish other goals like enhanced food security. The inability of the international community to meet goals established at the international level which is mostly due to economic priorities that lead to uneven and unsustainable development underscores the necessity for such a shift [11].

Biodiversity conservation refers to the protection and management of species, ecosystems, and genetic diversity. Ex situ conservation is the practice of preserving genetic resources and threatened species at locations where genetic material is kept, such as breeding facilities, botanical gardens, and genebanks. The term "in situ conservation" describes preservation of natural habitats. The two most significant treaties in terms of species-based conservation are the

Convention on the Conservation of Migratory Species of Wild Animals and CITES. CITES creates a method to control or prohibit the international trade in certain species by listing vulnerable or endangered species on its appendices. A species listing approach is also adopted by the CMS, which serves as a cornerstone for the drafting of agreements and memoranda of understanding on certain species like gorillas and sharks. The CBD is special. It employs a geographic-based conservation approach. In order to achieve a balanced implementation of the three CBD aims, the ecosystem approach, a technique for the equitable management of land, water, and living resources, is a critical framework for action under the Convention. The ecological method should be used in conjunction with management and conservation tactics like programs that focus on certain species and protected areas. A number of programs of work, including implementation advice to parties, have been developed within the CBD framework to address protected areas and traditional knowledge as well as thematic areas including mountain, marine and coastal, island, inland waters, forest, dry and sub-humid lands, and agricultural biodiversity. Most importantly, it is up to national governments to put conservation into action. The CBD assists in the adoption of national laws and policies via the negotiation and adoption of international objectives, such as the Aichi objectives contained in the Strategic Plan for Biodiversity 2011-2020, and the need that parties produce national biodiversity strategies and action plans.

The sustainable use of biological resources creates healthy ecosystems and benefits humanity. The CBD's second objective is to help countries build workable programs for reducing poverty, promoting sustainable development, and conserving the environment. The majority of CBD work initiatives connect biodiversity protection to sustainable use. Governments, indigenous peoples, local communities, resource managers, the private sector, and other stakeholders can use the Addis Ababa Principles and Guidelines for the Sustainable Use of Biodiversity as a framework to make sure that their use of natural resources won't cause a long-term decline in those resources. The reduction of agricultural biodiversity may provide the clearest illustration of the connection between conservation and sustainable use. The FAO estimates that during the last century, the genetic diversity of agricultural crops has declined by 75%, and now, just 12 plant and five animal species provide 75% of the world's food. Agricultural output is now more susceptible to pests, severe weather conditions, and market shocks as a consequence of the homogeneity of agricultural production systems brought about by the destruction of agricultural biodiversity. The main causes of this homogeneity are intensification and the establishment of monocultures of crop types with high yields and homogeneous genetic makeup.

Dealing with biological variety presents significant difficulties for developing nations. When confronted with urgent, immediate demands for food and fuelwood as well as some way to generate foreign cash to purchase necessary goods and pay off current, growing debts, it is difficult for them to concentrate on long-term needs. For those poor countries that are situated in the tropics, where biological variety is most abundant and most at risk of extinction, this is a serious issue. The 6 to 7% of the Earth's surface area that is covered by tropical wet forests may be home to up to 50% of all species. However, if tropical deforestation and conversion continue at their present rates, all of the accessible primary tropical wet forest regions would have vanished by 50 to 70 years. At the same time, many of the emerging tropical nations are among the most impoverished on the planet, often with large and expanding populations. These nations are increasingly reliant on aid from outside to meet their demands for food, economic growth, and support in protecting their biological resources. Without more focus on both, the world society risks losing living resources with true incalculable worth. I am certain that worries for biological variety span a broad range of industries. Furthermore, biological resource conservation is necessary for prolonged economic growth, and the capacity of emerging nations to achieve sustained economic growth is a prerequisite for their ability to conserve these resources.

The ongoing loss of ecosystems, particularly tropical forests, is the main factor contributing to the present and future rates of extinction of species, despite the fact that pollution and overexploitation pose substantial dangers to many wild plant and animal species. The successful protection of the world's biological variety is dependent on habitat conservation. A species' value or need from the perspective of humans does not always follow from its capacity for adaptation. Consequently, maintaining biological variety for human benefit entails maintaining enough natural habitat for species that cannot survive elsewhere. There are two main approaches that may be used to conserve habitat. First, we may critically assess the causes of the habitat's changes and determine what has to be done to stop them. For instance, we must identify the requirements of people who now clear-cut and burn tropical forests, and we must provide alternatives to this destructive practice. These substitutes must satisfy human requirements while preserving the environment, which will protect the biological resources that rely on it.

The creation of workable alternatives to slash-and-burn agriculture may be the single most important scientific advance for maintaining biological variety in the tropics. The matching grant programs will make an effort to use our funds to leverage investments made by developing country governments, national, international, and nongovernmental organizations in initiatives related to the management of wild plants and animals as well as the inventory and evaluation of biological diversity resources. In our new initiatives to support better biological variety protection in our client nations, we will draw from a plethora of expertise in the United States [12]. It was significant that the Forum on Biodiversity took place. It was a crucial chance to improve our knowledge of the issues and methods for resolving them, as well as to raise public and political leaders' awareness of the value of and dangers to the vast array of species on our planet. At a time when government spending on all activities is dropping in almost every nation in the globe, raising awareness is essential to gaining support for protecting this variety both locally and internationally.

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CHAPTER 21

BIO RESOURCES TO PROMOTE A GREENER SOCIETY

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The term "environment" has several different connotations. The things we see outside of our place of residence and with which we coexist, engage, or oppose are often what we refer to as the environment. Maintaining the ideal balance between ecology and nature, on the one hand, and between man and nature, on the other, is crucial. As long as human civilization has been, man has had a profound care for a healthy environment of which he is a vital component. He never stops working to safeguard the environment from contamination of all kinds, including that of the air, water, sound, and food. In the meanwhile, man never stops trying to extract the many bio-resources that are abundantly present in the environment in the form of animals, plants, etc. in order to create a sustainable society for the survival of humans. The most basic definition of environment is "the study of animals and plants in their interactions with one another and with the environment." The term "environment" refers to a variety of biotic and abiotic factors that have an impact on how creatures live in relation to humans.

Animal Husbandry

Animal breeding and care are the focus of the agricultural field known as animal husbandry. Animals are fed and cared for for a variety of purposes, including food, labor, and fiber. Modern methods are used to produce animal products at a commercial level. According to estimates, animals provide more than one-fourth of the value of agricultural goods. In the USA, the revenue from agricultural items is mostly made up of animal products. Several domesticated animals serve several purposes. Animals raised for milk may also be used for meat, leather, pulling heavy loads, and a variety of other things. The ways that humans employ animals vary depending on their culture and background. Animal domestication and usage are influenced by environmental variables as well. For instance, water buffalo are utilized as a draft animal in South Asia because they are accustomed to high temperatures and humidity. Horses are the main draft animals used to draw the load in temperate regions since they thrive there. Indian cattle, which are suited to hot climates, cannot flourish in the climate of Europe [1].

Draft Animals

The main uses of draft animals are for labour and transportation. Horses, camels, buffalo, oxen, donkeys, mules, yaks, and other draft animals are common. Because it can live well in the arid climate, camels are utilized in deserts. Food and fat are stored in the hump and utilised when there is a food shortage. Horses have been used for transportation, conflict, farming, and athletics. It is renowned for its strength, endurance, and quickness. As a result, they are chosen for lengthy journeys. There are thought to be more than 60 million horses in the globe overall. The biggest land animal is the horse. The eyes, which are situated on the sides of the head, enable the horse to view virtually behind it while facing ahead. Llamas are raised for their meat and milk, whereas males are primarily raised for load bearing. Both have long hairs that is utilized in textiles. Leather may be made from their skin. The alpaca and llama are related. It is raised for wool rather than transportation. Candles are made from llama tallow. Yaks are raised for meat, milk, and transportation. Their hair is woven into clothing and ropes. In Siberia and Alaska, dogs are often used as draft animals. They are used in various regions of the globe to manage sheep and other animal herds.

Cattle

Milk and meat are the two major uses for cattle. Some cattle are raised for dual purposes, however. Around 1.4 billion cattle are thought to be in existence worldwide. India is the country with the most cattle in the world. Separate beef cattle are raised for meat. Butter, cheese, curd, dry milk, and other significant byproducts of milk are widely sold. Goats and Sheep Goats and sheep are raised for their meat and fleece. They may also provide milk in certain situations. In semi-arid regions where cultivation is impossible owing to steep slopes, sheep rearing is also done on tiny pieces of land [2].

New Tendences

The burden on animals is also being increased by the human population. The demand for animal products is rising daily. To enhance the manufacturing of these items, scientists are making great efforts. They have conducted extensive animal studies. Most of the time, they are successful, like when they grow the size of the sheep to produce more wool. Researchers are also working on additional animals that can produce a variety of goods. Guinea pigs and iguana lizards are the subjects of study being done in Peru. According to sheep research, confinement in limited spaces may lead to better outcomes. But this approach is condemned for being inhumane to animals. Animals may now be artificially duplicated via a process called cloning.

Natural Pest Control:

For the benefit of the rural people, a project on biological control of agricultural pests was put into place to raise knowledge of the use of biopesticides rather than chemical pesticides among farmers, women, and the underprivileged. Additionally, methods for mass generating antagonists such entomopathogenic fungi for pest management were used, as well as the use of botanicals as biocontrol agents to demonstrate their effectiveness at the field level. An NGO produced biological fertilizers and insecticides, and laboratory tests on samples of the fertilizers and pesticides were conducted. Fruit-Plant-Nursery: For farmers, cultivating fruit plants in nurseries and using biological software were done. On a farmer's field, demonstrations were given and fruit plant nurseries with vermicompost were set up. In order to establish plantations utilizing vermicompost, Neem oil, bio-fertilizer, and bio-pesticide, commercial nurseries provided farmers with fruit plants including mango, guava, and aonla. By building high-quality Fruit plant nurseries, beneficiaries were able to supplement their income [3], [4].

Fish-Culture-in-Horticulture-Ponds:

A initiative to improve rural farmers via fish farming in horticulture-based farm ponds with polythene lining is now being done. Farmers and jobless youths received training in the usage of stunted fingerlings in agricultural ponds that were coated with polythene. Aquaculture inputs are given to the benefiting farmers in the form of fingerlings and floating fish feed.

Farmers were led through pertinent fish farming material. Value Addition: An integrated biotechnological intervention for job creation was carried out by adding value to the production of brewed vinegar and amla fruit [5].

Biotechnological-Interventions:

At Chennai, an integrated biotechnological interventions project was put into place to provide the rural people alternative income via diverse interventions like vermicomposting, mushroom farming, and clonal propagation. The project's execution contributed to the creation of jobs, the wise and efficient use of resources, and waste management. The department has taken bold steps to develop rural bio-resource complexes around the nation with the goal of using rural bio-resources in a more significant and sustainable way and to open up a wide range of opportunities for the rural population. The idea was backed by an end-to-end strategy that combined networking, resource sharing, financing, and state resource advantages with technology advancements and S&T and BT contributions. The RBC initiatives were carried out in a comprehensive way to benefit the rural population by wisely and sustainably using bioresources.

Bio-events:

By educating the rural population about a variety of enterprising activities, such as the use of biofertilizers, biopesticides, sericulture, aquaculture, mushroom and spirulina production, vermicomposting, floriculture, animal husbandry, waste management, and the use of marine resources, as well as value-added products and processing, at the rural level. There were nine of these bioevents held around the nation. Various NGO's and organizations dealing with sanitation, health management, agro service centers, etc., in addition to farmers, took part in these activities. Since scientists and extension specialists participated, together with thousands of farmers, Bio-events have been a rousing success [6].

Bio-control-Agents:

The farmers received literature on the value of neem seed kernels. A farmer's field training program that included 486 acres of cotton, redgram, and bengalgram cultivation was established off-campus. Production of biological control agents and biofertilizers was started, including demonstrations. On the farmers' field, demonstrations on the creation and use of vermicompost, neem oil, and Trichoderma were held. The mass manufacture and use of biological control agents for mulberry and silkworm pests and illnesses was also taught to farmers.

Mushroom-Cultivation:

The cultivation of mushrooms, from substrate preparation through harvesting and processing to the development of different recipes for value addition, was taught to the beneficiaries. Near the target population, training and demonstration units were set up [7], [8].

Coastal and marine Bioresources

A status report on each site has been created as part of the integrated program on conservation, inventorization, and improvement of coastal bioresources and will be released shortly. To create an action plan for the sustainable exploitation of bioresources and the creation of livelihood opportunities for dependent people, several interactive sessions with various stakeholders, representatives from government agencies, and non-governmental organizations have been held. The primary goal of using bio-resources and eco-friendly practices by members of the public and businesspeople who are environmentally conscious in their daily lives and professional endeavors is to conserve energy, protect natural resources, protect human health, and emit fewer harmful substances into the atmosphere, thereby reducing pollution and saving our mother earth. People and the government, at both the national and state levels, are working tirelessly and effectively to use bio-resources in order to create a "green society" on earth. Great people like Baba Amte, Rajender Singh, Sunderlal Bahuguna, Medha Patkar, and Arundhati Roy have worked hard to preserve ecological balance and prevent environmental pollution while building projects like the Narmada Project so that society and the rest of humanity can live in peace and harmony [9].

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CHAPTER 22

AGRICULTURE AND ENVIRONMENTAL CONCERNS WITH WATER RESOURCES

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Water is necessary for the global population of humans, as well as other animals, plants, and bacteria, to have an appropriate food supply and a productive environment. Global freshwater demand has been rising quickly as human populations and economies expand. . Water scarcities seriously limit biodiversity in both aquatic and terrestrial ecosystems and endanger human food security. Water pollution promotes the development of dangerous human illnesses and degrades water quality. Crops and cattle are the primary suppliers of nutrition for humans, and their cultivation requires water, land, and energy. Over the last 20 years, the amount of food per person has decreased by 17%, in part due to a rise in human population and concomitant limitations of fresh water and agriculture. . Lack of food supply has played a role in the global issue of the more than 3 billion hungry people worldwide. Iron deficiency, which affects 2 billion people, and protein or calorie deficit, which affects about 800 million people, are two of the most major malnutrition issues. Each year, nearly 8 million people die as a consequence of iron, protein, or calorie deficiencies.

There are presently 6.3 billion people on the planet, and more than a quarter million individuals are born every day. By the year 2050, the United Nations predicts that there will be 9.4 billion people on the planet. In addition to drastically reducing water supply per person, population expansion and rising water demand would put stress on biodiversity throughout the whole global environment. . In addition to rainfall, temperature, evaporation rates, soil quality, plant type, and water runoff are other significant elements that affect water availability. Furthermore, there are currently significant challenges in distributing freshwater resources properly across and between nations. The disputes between the emerging industrial, rural, and urban sectors are becoming worse. In this article, we examine how people utilize water, with a focus on agricultural systems, and we discuss the interactions between population increase, water usage and distribution, biodiversity, the environment, and the effects of illnesses that are spread by contaminated water[1], [2].

Aquatic cycle

More than 97% of the estimated 1.4 billion cubic meters of water on Earth is in the seas. Fresh water makes up around 35 1015 m3 of the planet's total water, 0.3% of which is stored in rivers, lakes, and reservoirs. . The remaining fresh water is kept in subterranean aquifers, glaciers, and ongoing snowfall. All of the rain that falls on Earth originates from the roughly 13 1012 m3 of water that makes up the Earth's atmosphere. Every year, the evaporation caused by about 151,000 quads of solar energy lifts 577 1012 m3 of water from the Earth's surface into the atmosphere. The oceans account for 86% of this evaporation. Only 14% of the world's water evaporation comes from land, but 20% of its precipitation does, with any excess water flowing back into the seas via rivers. As a result, solar energy moves a significant amount of water from seas to land every year. This hydrologic cycle component is essential for human existence, natural ecosystems, and agriculture.

The presence of water

Water is seen as a renewable resource since rainfall replenishes it, but its availability is limited in terms of how much is accessible in a given area per unit of time. The quantity of precipitation varies across and between continents, with the majority of continents seeing an annual average of 700 millimeters. Water is often deemed limited in a country when its availability falls below 1 million L per capita per year. . Africa is thus relatively dry despite receiving 640 mm of rain annually on average because of its high temperatures and strong winds, which encourage quick evaporation[3].

Bottled Water Supplies

Early in the 20th century, several dams were constructed in dry areas of the United States in an attempt to boost the amount of water that was accessible. The United States has seen a slowdown in the building of big dams and related conveyance systems to accommodate water demand. However, a dam's estimated lifespan is 50 years, and by 2020, 85% of US dams would be older than 50. Worldwide, several developing nations are still building dams. All dams eventually lose capacity as a result of silt building up behind them. According to estimates, silt buildup causes the world's dams to lose 1% of their annual storage capacity per year.

Use and consumption of water

Water is taken both for use and consumption in a variety of human activities from various resources. All human actions for which part of the removed water is returned for reuse are referred to as uses. Consumption, on the other hand, denotes the nonrecoverability of the removed water. For instance, plant evapotranspiration, which releases water into the atmosphere and is not recoverable. Humans have roughly 60% water, whereas the water content of other living things may vary from 60% to 95%. Humans should consume 1.5 to 2.5 L of water daily to maintain good health. In addition to using it for drinking, Americans consume 400 L of water per person daily for personal needs including washing, cooking, and garbage disposal. In comparison, 83 other nations indicate that the average daily personal water usage per person is less than 100 L. Including withdrawals for irrigation, daily freshwater use in the US is now at 1600 billion liters, or around 5,500 liters per person. About 80% of this sum is derived from surface water, while 20% is taken from groundwater supplies. For all reasons, each human withdraws an average of 1970 L every day worldwide. Around 70% of the water that is extracted globally is wasted and cannot be recovered[4], [5].

Water use and Agriculture

For photosynthesis, development, and reproduction, plants need water. Since some of the water consumed by plants is incorporated into the chemical composition of the plant and the rest is discharged into the atmosphere, the water used by plants cannot be recovered. Plants need to transpire a lot of water in order to fix carbon dioxide and regulate temperature. Between 300 and 2000 L of water are used by various crops for every kilogram of dry matter produced. An estimated 64% of all precipitation that falls on Earth is transferred into the atmosphere on average via plant transpiration from terrestrial ecosystems. Various amounts of soil moisture are required for crop development. For example, US potatoes need 25% to 50% soil moisture, alfalfa 30% to 50%, and maize 50% to 70%. According to reports, rice in China needs at least 80% soil moisture. The amount of rainwater that percolates into the soil, where it is absorbed by plants, depends on a number of factors, including rainfall patterns, temperature, vegetation cover, and soil organic matter content, and soil biota activity[6]–[8].

Food and forage crops need between 300 and 2000 L of water per kilogram of dry crop production. For example, in the United States, throughout the growing season, 1 hectare of maize, with a yield of around 9000 kg per ha, seeps about 6 million L of water per ha, and an additional 1 million to 2.5 million L of soil moisture per ha evaporates into the sky. This indicates that 800 mm of rain must occur throughout the corn crop's growth season. In spite of the US maize Belt's yearly rainfall of 800 to 1000 mm, maize regularly experiences water shortages during the crucial summer growth season.

Using energy for Irrigation

For pumping and distributing water to crops, irrigation demands a considerable expenditure of fossil energy. We estimate that pumping irrigation water consumes 15% of the total yearly energy required for agricultural production in the United States. Overall, the energy used to produce irrigated crops is far higher than the energy used to produce crops that are grown with rainwater. For instance, producing wheat with irrigation uses more than three times as much energy as producing wheat with rainwater. While irrigated wheat needs 14.3 million kcal per ha per year to deliver an average of 5.5 million L of water, rainfed wheat only needs roughly 4.2 million kcal per ha per year. To irrigate 1 hectare of maize with 10 million L of water from surface water sources, 880 kilowatt-hours of fossil fuel must be used. The energy cost rises to 28,500 kWh per hectare, or more than 32 times the cost of surface water, when irrigation water must be pumped from a depth of 100 m[9].

Irrigation has substantial financial and energy expenditures. The average price per hectare to develop irrigated land is between $3800 and $7700. So, in addition to assessing the expenses of creating irrigated land, farmers must also take into account the yearly expenditures of irrigation pumping. For instance, it costs $750 to $1000 to transport 7 million to 10 million L of water per acre. Due to high pumping expenses, around 150,000 acres of agricultural land have already been abandoned in the United States.

Waterlogging and salinization of the soil during Irrigation

Salinization is not an issue with rainfed crops since the salts are naturally washed off. However, dissolved salts accumulate in the soil and prevent plant development when irrigation water is sprayed to crops and then evaporates and transpires back into the atmosphere. The technique of applying 10 million L of irrigation water per ha per year resulted in the addition of 5 t of salts to the soil per ha. With more fresh water, the salt deposits may be washed away, albeit at a substantial expense. Around 50% of all irrigated soils worldwide are negatively impacted by salinization. An estimated 10 million acres of agricultural land are lost to salinized soil each year in the globe. Additionally, there is a lot of salt in the drainage water from irrigated fields. For instance, the Colorado River takes up 580,000 t of salts each year as it passes through Grand Valley, Colorado. 30 t salts per ha per year are thought to be present in the water that is returned to the Colorado River, based on the drainage area of 20,000 ha. South-central Arizona receives 1.6 million t of salt annually from the Salt River and Colorado River.

A further issue with irrigation is waterlogging. Water gradually builds up in the higher soil layers as a result of seepage from irrigation canals and irrigated fields. 60% of the water meant for agricultural irrigation never gets to the crop because of water losses during pumping and transport. Insufficient drainage causes water tables to increase in the higher soil layers, including the plant root zone, which hinders crop development. Because they become unproductive, such irrigated areas are frequently referred to as "wet deserts." For instance, waterlogging in India negatively impacts 8.5 million hectares of crops and causes the loss of up to 2 million t of grain annually. Ample soil drainage and enough water must be supplied to guarantee that salts and extra water are drained from the soil in order to avoid both salinization and waterlogging.

Erosion of the soil and Water Discharge

A sufficient global food supply relies on the continuous existence of fertile soils since more than 99% of the world's food is produced through agriculture. Crop production is negatively impacted by erosion because it decreases soil depth, soil depth, soil nutrients, soil biota, and soil organic matter. Since eroded soil receives 87% less water via infiltration than uneroded soil, the quantity of water available to developing plants is thought to be the greatest detrimental consequence of erosion. In regions where they are grown, soybeans and oats capture around 10% of the rainfall, while tree canopies capture 15% to 35%. As a result, cutting down trees results in increased water runoff and decreased water availability[10], [11].

A water runoff rate of roughly 30% results in serious water constraints for growing crops like maize, which eventually diminish agricultural yields, given an annual rainfall total of 800 mm. Additionally, the main contributor to nonpoint-source pollution in the US is water runoff, which introduces sediments, fertilizers, and pesticides from agricultural fields into surface and groundwater. Soil erosion on agricultural land is a self-degrading cycle. Crop yields drop when topsoil and organic matter are lost to erosion, which also increases water runoff. During successive rains, the cycle is repeated more intensely.

Illnesses in humans and Water Pollution

The issue of water contamination and human illnesses is closely related to the general accessibility of water resources. Nearly half of the world's population currently lacks access to adequate sanitation, and 20% of people lack access to safe drinking water. Many developing nations are particularly affected by this issue since they immediately dump 95% of their untreated urban sewage into surface waterways. For instance, just 8 of India's 3119 towns and cities have comprehensive wastewater treatment systems. When unclean water is utilized for drinking, bathing, and washing downstream, it may cause major diseases and illnesses in people. 90% of all infectious illnesses affecting people in poor nations are caused by waterborne infections overall. Each year, almost 12 million people die largely as newborns and young children due to unsanitary circumstances.

Due to pollution by harmful bacteria, pesticides, and fertilizers, 40% of the fresh water in the US is judged unsafe for drinking or recreational use. Waterborne illnesses cause over 940,000 infections and 900 fatalities annually in the United States. More animal production systems in the US have recently shifted closer to cities, resulting in the contamination of food and water with manure.

It is estimated that the United States produces 1.5 billion t of trash per year, including animal manure. The Centers for Disease Control estimate that each year more than 76 million Americans get an infection from pathogenic Escherichia coli and similar foodborne pathogens, and 5000 of them die away as a consequence.

Worldwide, the prevalence of schistosomiasis, which is also linked to tainted fresh water, is rising. More than 200 million individuals develop this parasitic worm-based sickness every year, which results in an estimated 20,000 fatalities. The development of irrigation canals and dams that are favorable for the parasite's intermediate host and accessible to people, enabling them to come in touch with the contaminated water, are two factors that contribute to the spread of the disease.

Preserving Water Supplies

Water conservation has to be prioritized by all people, communities, and nations. Finding strategies to encourage rainwater to percolate into the soil as opposed to letting it run off into streams and rivers is a crucial strategy. For instance, increasing tree and shrub utilization allows for the 10%–20% capture and slowing of runoff, preserving water before it reaches streams, rivers, and lakes. Additionally, this method lessens flooding[12]. The maintenance of agriculture, animal, and forest production necessitates the conservation of all available water supplies, including rainfall. Monitoring soil water content, adjusting water application needs to specific crops, using organic mulches to prevent water loss and improve water percolation by reducing water runoff and evaporation, using crop rotations that reduce water runoff, preventing the removal of biomass from the land, increasing the use of trees and shrubs to slow water runoff, and using precision ir are some practical strategies that support water conservation for crop production. Humans should practice good forest management in forested regions and refrain from clear-cutting. Urban areas, whose runoff rates are projected to be 72% greater than in places with forest cover, may also benefit from trees. Additionally, runoff from parking lots, driveways, and rooftops is particularly quick; this water may be collected in cisterns and man-made ponds. Government initiatives are required to restrict the pumping to sustainable withdrawal levels or to the known recharge rate since many aquifers are being over drafted. Integrated water resource management programs provide several possibilities for everyone, including farmers and the general public, to preserve water resources.

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