NEW SYLLABUS OF U.P. STATE UNIVERSITIES

B.Sc. III Year, Semester-VI, Paper-II

ECOLOGY AND ENVIRONMENT

Unit-I : Natural Resources & Sustainable Utilization

Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water, Wetlands; Threats and management strategies, Ramsar sites, Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy, Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting.

Unit-II : Ecology & Ecosystem

Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem – Concept of an ecosystem-structure and function of an ecosystem. Abiotic and biotic components and their interrelationship- Biogeochemical and hydrological cycles, and Energy flow in an ecosystem.

Ecological Succession-Definition & types. Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary & secondary), Hydrosere and Xerosere.

Food chains and food webs, Ecological pyramids, Primary and Secondary Production and Productivity; Types of ecosystems : Natural and Man-made-Forest Grassland, Aquatic and Agro-Ecosystems. Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.

Unit-III : Soil Formation, Properties & Conservation

Soil : Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soil processes, Soil Erosion, Biogeochemical cycles, Soil Conservation : Biological–Contour farming, Mulching, Strip cropping. Terracing and Crop rotation. Mechanical–Basin Listing, Construction of dams, Watershed Management, Soil reclamation

Unit-IV : Biodiversity and its conservation

Definition-genetic, species and ecosystem diversity. Value of biodiversity : social, ethical and aesthetic values; hotspots of Biodiversity threats to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecade, ecotypes, ecological indicators. Conservation of Biodiversity : Ex-situ and in-situ conservation, Red data book, botanical gardens, National park, Sanctuaries, hot &

hottest spots and Biosphere reserves. Role of Seed Bank and Gene Bank Valuing plant resources, ecotourism, Role of NBPGR, FAO, BSI.

Unit-V : Phytogeography

Biogeographic regions of India & world, Agroecological & Floristic zones of India, Natural vegetation of India, static and dynamic plant geography, basic principles governing geographical distribution of plants, Phytogeographical regions of India, Vegetational types in Uttar Pradesh.

Unit-VI : Environmental audit & Sustainability

Elementary knowledge : Concept of environmental audit; Guidelines of environmental audit; Methodologies adopted along with some industrial case studies; Environmental standards : ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Life cycle analysis; Concept of energy and green audit, Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice.

Unit-VII : Pollution, Waste management & Circular Economy

Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG; Waste- Types, collection and disposal, Recycling of solid wastes (hazardous & non-hazardous) - classification, collection and segregation, Incineration, Pyrolysis and gasification, Sanitary landfilling; composting, Biogas production, Circular Economy & sustainability.

Unit-VIII : Environmental ethics, Carbon Credits & Role of GIS

Carbon credit : concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust.Wasteland reclamation. Consumerism and waste products. Clean development mechanism.

Geographical Information Systems : definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.

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UNIT 1

Natural Resources and Sustainable Utilization

1.1 GENERAL INTRODUCTION

Natural resources are the components of the atmosphere, hydrosphere and lithosphere, that are necessary for life. These include energy, air, water, soil, minerals, plants and animals.

For man, resources are those substances which are required for his survival, comforts and prosperity. These are obtained directly from the environment.

The nature of resources required by man varies from society-to-society. It depends on factors like culture, the level of development and the nature of work of that particular society. For example, silver, gold or uranium have no use for the one tribe living in Andaman islands. With the development of nuclear energy, uranium has became an important resource these days, though it was of no importance in the 18th century.

Classification of Natural Resources

Natural resources can be classified as follows :

1. Depending on their Nature : Depending on their nature, natural resources are of two types :

(a) **Inorganic,** including air, water and minerals.

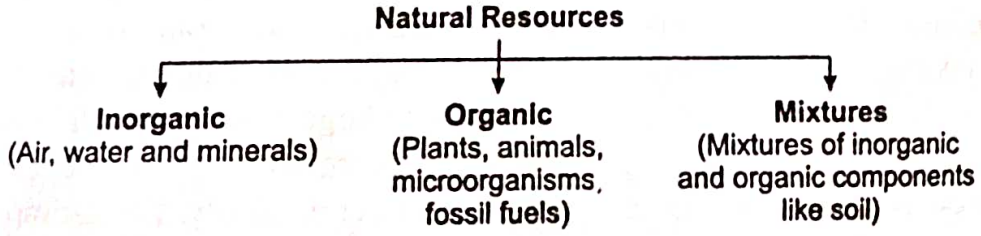
(b) **Organic,** including plants, animals microbes and fossil fuel. Soil is an inorganic as well as an organic resource.

2. Depending on their Abundance : Depending on their abundance and availability, natural resources are of the following three types :

(a) **Inexhaustible :** Wind tidal energy, clay and sand are inexhaustible natural resources. Though air is available in plenty, it may become a limiting factor qualitatively if its pollution is not checked.

(b) **Exhaustible resources :** Resources that are limited and can be diminished or degraded, if not properly used are called exhaustible resources, *e.g.*, **fossil fuels.**

Table : Natural resources depending on their nature



used in industry and domestic way can be cleaned and used again for similar or other purposes. Such resources that can be used again and again are called cyclic resources.

[II] Based on origin

On the basis of their origin resources may be biotic (organic) or abiotic (inorganic). **Biotic resources** are obtained from the biosphere. Forest and forest products, crops, birds, animal, fish, and other marine life forms are examples of biotic resources. Coal and mineral oil also belong to this category since they originate from organic matter. Some biotic resources like forest and livestock are renewable, whereas coal and oil are non-renewable. Resources composed of non-living inorganic matter are called abiotic resources. Land, water and minerals like iron, copper, lead and gold are abiotic resources. Some abiotic resources are found as nodules in oceans as nodules of copper and manganese.

[III] Based on Utility

Every resource has some utility. For example, some are used as food, some as raw materials and others as sources of energy.

Though serious concern has already been felt in all nations of the world for a need to conserve their own natural resources we would examine this subject with reference to our country. The various types of natural resources may be considered as follows, (i) soil, climate, flora and fauna of India; (ii) forests; (iii) fish; (iv) landuse, (v) water; (vi) wildlife, and (vii) energy resources.

Conservation of Natural Resources

Expanding human population resulted into expanding needs of man. With scientific progress and technological development man started utilising natural resources at a much larger scale. Continuous increase in population caused an increasing demand for resources. This created a situation when the non-renewable resources may come to an end after some time. As a result we would be using all those resources which are infact the property of future generation. It is a matter of much concern. There must be some sort of balance between the population growth and the 'utilisation of natural resources.

The non-availability of resources and their price-rise are having an adverse effect on the economics of countries world over. During 1980s the world has experienced a state of imbalance between the growth rates of population and economic development. The prices of resources as petroleum, after 1973 showed abrupt hike. Hence the growth rates of food production and economic development suffered setbacks.

There are several other examples of the problems created by over utilisation of resources. In some areas, there is no enough water for agriculture and industry, whereas in other areas there are problems of water logging due to over-irrigation. In some countries much of underground water is being utilised for food grain production. This resulted in lowering of water table in northern China. There is thus need for water conservation.

Conservation is also concerned with complete elimination of some unique species for which there may be no alternative at all. One can not imagine a situation if

Penicillium had been 'eliminated from the nature before mankind made use of it as an antibiotic, or if *Cinchona* become extinct before quinine was discovered as a cure for malaria. It is therefore in our own interest to conserve our plant, animal and microbial wealth. There is global realisation about the urgent need to conserve the biological diversity.

Conservation has been defined as "the management for the benefit of all life including humankind of the biosphere so that it may yield sustainable benefit to the present generation while maintaining its potential to meet the needs and aspirations of the future generations". Living resources conservation has three specified objectives : (i) to maintain essential ecological processes and life support systems, (ii) to preserve biological diversity, and (iii) to ensure that any utilisation of species and ecosystems is sustainable. Conservation, therefore makes important contributions to social and economic development.

Biological diversity includes the following two related concepts.

1. Genetic diversity. This is the amount of genetic variability among individuals of a single species and between species.

2. Ecological diversity (species richness). This is the number of species in a community of organisms. Maintaining both types of diversity is fundamental to the functioning of ecosystems and hence to human welfare.

We have so far given attention to preserve large mammals, crocodiles, birds etc. ignoring plants, particularly forest trees. We have to take steps to keep the species away from decline.

Our late Prime Minister Smt. Indira Gandhi emphasised our ancient care, conservation and worship of trees and animals while launching the World Conservation Strategy in India on 6th March, 1980. In her own words "The interest in conservation is not sentimental one but the rediscovery of a truth well known to our sages. The Indian tradition teaches us that all forms of life, human, animal and plants are so closely linked that disturbance in one gives rise to imbalance in the others."

There are two main categories of conservation : ***in situ*** conservation and ***ex situ*** conservation.

In India a large number of institutions are involved in conservation and utilisation of biodiversity. There fall under Ministries of Environment and Forests, Agriculture, and Science and Technology.

We can not imagine a world economy without coal, oil or other mineral. Concept of exhaustibility of resources is always linked with the level of available technology. For example it impossible to get additional oil or coal from greater depths provided that one have appropriate technology for the purpose, and is not much expensive.

We are left with two alternatives under such a situation (i) an efficient and sophisticated technology may be developed which enables the extraction of minerals from greater depths, and (ii) alternative sources of energy as solar, wind, water will have to be developed to reduce dependence on conventional sources of energy. Recently there has been a growing concern the world over, (iii) to conserve national sources.

1.2 INTRODUCTION : ABOUT SOIL (LAND)

Soil is the top cover of the earth in which plants can grow. It is complex composite mass which consists of weathered rock material mixed with decomposed organic matter derived from remains of plants and animals.

Soil may be defined as the shallow upper layer of earth that are formed by the weathering of underlying rocks in association with organic matter and with living organisms and has become a suitable habitat for plants animals.

According to Treshow (1970) soil is a complex physical, biological system providing support, water, nutrients and oxygen for the plants.

Soil is an important habit for a large number at terrestrial organisms, either burrowing or living on its surface. Its organisms exhibit a complex food chain with herbivours camivorus and the predtors and prey. The study of soils is known as *pedology*.

Pedology is the science dealing with the laws of origin, formation and geographic distribution of the social as a body in nature. Pedology teaches us that soil is a distinct body is nature consisting of definite parts each one possessing chemical, physical and biological properties of its own.

About Soil

Land is the major constituent of lithosphere. It is the source of many materials essential to man and other organisms. Land forms one-fifth of the earth's surface. It measures about 13,393 million hectares. About 36.6 -per cent of land area is covered by factories,.roads, railway tracks, houses, deserts mountains and polar ice and glaciers. About 30 per cent of land is under forests, 22 per cent is covered by pastures and meadows. Only 11 per cent of land area is fit for tilling.

Soil is the topmost layer of land. It is formed by the weathering of . rocks mixed with decomposed organic matter (humus). **Treshow** (1970) defined soil as a-complex system of physical and biological components which provides support, A nutrients, water and oxygen to the plants and soil organisms.

The processes involved in **soil formation** are :

1. Fragmentation or Weathering : It is the mechanical break down of rocks into smaller pieces. It is brought about by strong winds, temperature fluctuations, running water and roots growth.

2. Chemical Weathering : By the action of oxidation reduction, hydration, hydrosis and carbonation soil material. goes into solution with rain water. This water with CO_2 forms carbonic acid which combines with calcium and magnesium of the rockes to from their carbonates. Aluminium and silicone minerals are converted in clay and iron compounds. In this way rocks are broken down into fine particles.

Plants are also responsible for soil formation. Roots secrete certain acids which disintegrate the rocks.

3. Organic Matter : Organic matter of ded and decaying organisms also ontributed to soil formation. Microorganisms decompose the plant and humus from ne full developed soil.

Humus increases the water holding capacity of the soil and influences the rate at which air and can circulate through it.

Texture of Soil

As soil influences the flora and fauna of the area, its texture is of considerable importance. It is determined by the size of constituent particles :

	Name of Particles	Diameter of Particles
1.	Gravel	2.00 mm and more
2.	Coarse sand	2.00 mm to 0.2 mm
3.	Fine sand	0.20 mm to 0.02 mm
4.	Silt	0.20 mm to 0.02 mm
5.	Clay	Below 0.002 mm

Soil formed with various integration of soil particles are of the following main types :

(a) Sandy soils mainly consists of sand particles. These are loose, and poor in nutrients. The water holding capacity of such soils is poor.

(b) Clay soils chiefly consists of clay particles. The clay particles are of colloidal dimensions. They have high plasticity and possess high water holding capacity. Clay particles have very small interspaces between them sf that neither water nor air can circulate freely. Such soils on getting water become water-logged. Thus they are not suitable for plant growth.

(c) Loam soils have sand, silt and clay particles in more or less equal proportions. Such soils are the most suitable for plant growth.

(d) Sandy loam soils are those soils in which sand particles predominate.

(e) Clady loam soils have a predominance of clay particles. Both sandy and clay loam soils are suitable for plant growth.

(f) Silt loam soils have predominance of silt. On getting water, silt loani becomes water-logged with poor air circulation. Such soils are not suitable for plant growth.

The percentage of Sand, Silt and Clay in main soil types is as follows :

The percentage of Sand, Silt and Clay in main soil types is as follows :

	Soil Class	Percentage		
		Sand	Silt	Clay
1.	Sandy soil	85-100%	0-15%	0-15%
2.	Clay	0-59%	59-0%	31% or more 7-27%
3.	Loam	23-52%	28-50%	7-27%
4.	Sandy loam	50-80%	0-50%	0-20%
5.	Clay loam	20-30%	15-53%	20-30%
6.	Silt loam	0-50%	50-88%	0-27%
7.	Silt clay loam	40-73%	0-20%	27-40%

Soil properties

The physical properties of soil depend on its texture, porosity, and water holding capacity. Salt contents pH, inorganic and organic nutrients like nitrogen, phosphorus and potassium determine its chemical properties. The soil conditions are controlled by topography, climate and biotic factors.

Soil Depletion

Acidification, alkalination, salinisation and soil erosion cause deterioration in soil quality and destruction of land resources.

Urbanisation, construction of dams, roads, and railways, industrialisation and mining activities, and overgrazing are causing depletion of productive land.

Some measures of conservation of soil

Some of soil conservation measures areas follows :

1. To increase the soil fertility by adding chemical fertilizers or manures.
2. To establish woodlands where no other crop is possible.
3. To grow only such plants (trees, grasses, crop, etc.) which can bind the soil particles.
4. To make terraces on slopes to prevent erosion by water.
5. To do strip cropping to reduce erosion to the maximum.
6. To make dams across streams and gullies.

1.3 LAND UTILIZATION

Land is an important exhaustible resources, which is being degraded by rain, wind, deforestation, erosion, landslides, and so on. This precious, resource must be managed properly and should be used according to its suitability capability.

Fertile agricultural land should not be sacrificed for non-agriculture proposes, such as road buildings development of industries, or construction of water reservoirs. Urban areas should not be sdecelopedtein hilly areas and deforesation should be checked.

Some essential components of land management are as follows :

1. With the help of remote, sensing methods, a land classification and land capability map must be prepared.

2. The land must be classified keeping in mind the nature of the soil, physical features, availability of water and its storage, runoff, and so on. The land is usually classified as type I and II (good agricultural land—continuously cultivated, crop rotation can be practised), type III and IV (steeper slopes)—may be used for cultivation, perennial crops rotated with pastures can be grown, periodic tallowing is done, requires a lot of attention), type V, VI, VII (may not be suitable for cultivation, can be used to develop pastures or tree crops), and type VIII (thin soil cover, steep slopes or marshes and swamps—can be used as a habitat for grams fur bearers, forests, recreational or scenic areas, water shed aquaculture for swampy areas, etc.).

3. Changes resulting from land use should be monitored and the " intensity and frequency of natural hazards like cyclones, floods, and so on should be anticipated.

stable, scientific agriculture. Vegetation of the most important agency of soil conservation. Soil conservation is a national problem and for this in India, soil surveys were initiated since 1928. An extensive project for collection of data on soil published in 1935 in an ICAR, Bulletin. The important method employed for soil conservation are as follows :

1. Soil Fertility : The soil fertility mainly depends upon its humus and mineral contents. The fertile soils usually supports the crops which protect soil better, leave more residue material which is rich in humus. To maintain the fertility of soil grazing should be avoided and mineral need should be properly supplied. The legume crops due to the fixation activity of nitrogen have proved to play an important role in the maintenance of soil fertility.

The rotation of crop is also helpful in maintaining the soil fertility in fields. Crop rotation is the method of alternating sowing of leguminous and cereal crops. The crop rotation prevents soil, depletion and especially when used with fern manures and commercial fertilizers is valuable in the control of erosion, weeds and many plant diseases. Fertility of soil is also maintained in uncultivated land by rotation of grasses.

The soil fertility may also be maintained by the control of grazing. The grazing of plants or their green parts leads to starvation and death of them, resulting in the damage of crops and hence the fertility of soil is lost.

2. Reforestation : The forests, which are supposed to be the national wealth, which provide timber, fuel, wood pulp, gums resins, turpentine, etc. are also important in checking floods and soil erosion. The forests build up a thick layer of humus, they protect soil from erosion. The rocks of plants also serve as natural dams in holding water and soil. Thus, for the conservation of soil, the cutting of timbers forest fires, etc. should be prevented.

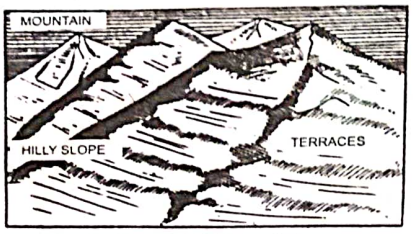


Fig. 1 : Terraced fields on hilly slope

3. Contour Plantation : This method of soil protection is practised on hill slopes. In this method the land is ploughed against the slope instead of up and down the slope. Similarly tilling, seeding and harvesting are also made crosswise. This result in the formation of cross-wise ridges and check the flow of water. The long slopes are broken up into a number of strips laid out across the slopes so that crop rows are on the level. The crops which grow dense such as cereals, are altered with clean tiled crops, *i.e.*, those are cultivated to leave bare soil between rows such as cotton maize or potatoes. Sometimes the slope is divided into a series of small flat

fields called terraces (this method is known as terracing), these consists of a broad bottomed channel and an outlet. Sometimes low ridges are also built us across the terraces which serve as small dams, for holding water and thus in checking soil erosion.

4. Fallowing : This is the natural method for maintaining the soil fertility. In this method the fields, after cutting the crops are ploughed and then allowed to lie, idle for a season. This method, though expensive, builts up a good supply of valuable mineral elements especially nitrogen in the soil.

Soil Reclamation

The acidity, alkalinity and salinity of soil is also a great problem, soil salinity is due to excess of soluble salts, acidity and alkalinity is due to insoluble salts. The saline soil are usually basic and most of the plants unable to grow either due to acidic or alkaline medium or due to high osmotic concentration of soil solution. In these saline soils normally salt tolerant plants (halophytes) like *Suaeda, Salsoda, Tamarix, Salvdora*, etc. may grow, such type of soils are not suitable for agriculture and usually known as 'Usar' or 'Reh' or 'Kaller'. Therefore, in recent days an attempt has been made to improve such types of soils so that it may be used for agricultural purposes. This process is known as *reclamation*. The main aim for soil reclamation is the removal of salts from soil or rendering them in active. Some important methods for soil reclamation are as follows :

(1) Removal of salts by excessive irrigation : Accumulation of salts in normal practice in soil takes place due to poor irrigation. So far soil reclamation the soil is floated for long periods by which the salts are leached down.

(2) Chemical reclamation : The acid soils may be reclaimed by addition of $CaCO_3$ (lime), while saline and alkaline soil are reclaimed by addition of calcium sulphate (gypsum) which react with salts and forms insoluble $CaCO_3$.

(3) Cultivation of salt tolerant crops : Certain crops differs in their salts tolerance. Sugar beet, sugarcane, cotton, etc. may be grown on moderately saline soils, rice can also on saline soil because when fields are ploughed and seedlings are transplanted, the salts leaches down.

1.6 WATER

Natural Resources and Sustainable Utilization Water

Natural resources, particularly water, are vital for sustaining life and ecosystems on Earth. Sustainable utilization of water resources is essential to ensure their availability for current and future generations while minimizing negative impacts on the environment Some key aspects of sustainable water resource utilization are as follows :

Efficient Water Management : Efficient water management practices involve reducing water wastage in agriculture, industry, and households, This can be achieved through the use of water-efficient technologies, such as drip irrigation in agriculture and low-flow fixtures in homes.