

Block**4**

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BLOCK 4 ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

Block 4 consists of four units. They are given below:

Unit 1 Bio-Diversity consists of types of biodiversity, importance and uses of biodiversity, distribution of biodiversity in the world, biodiversity in India, human impact on biodiversity and conservation of Himalayan biodiversity.

Unit 2 Climate Change consists of what is climate change, what causes climate change, how climate change affect humans, IPCC report on climate change, climate change and the north-south debate, India's response to climate change issues.

Unit 3 Sustainable Development: An introduction consists of definition and conceptual understanding, fundamentals of sustainable development, sustainable development indicators and steps for sustainable development.

Unit 4 Natural resources consists of meaning and types of natural resources, biodiversity: our strength, exploitation on natural resource, threats to biodiversity, conservation of biodiversity and management of natural resources.



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UNIT 1 BIODIVERSITY

Structure

- 1.1 Introduction
- 1.2 Types of Biodiversity
- 1.3 Importance and Uses of Biodiversity
- 1.4 Distribution of Biodiversity in the World
- 1.5 Biodiversity in India
- 1.6 Human Impact on Biodiversity
- 1.7 Conservation of Himalayan Biodiversity
- 1.8 Let us Sum Up
- 1.9 Key-words
- 1.10 Check Your Progress- Possible Answers
- 1.11 References and Selected Readings

1.1 INTRODUCTION

Biodiversity refers to the richness and variety of life forms on the earth. It is the most complex and important feature of the earth, which is responsible for sustenance of life forms on our planet. It also refers to a variety and variability among plants, animals and microorganism species. Biodiversity also include a number of organisms at different levels spread across genes, species and ecosystems. It is one of the essential components of the nature that makes the earth a habitable place. Biodiversity describes the richness and variety of life on earth, and it is also recognized as a major indicator of ecosystem health solely responsible for sustenance of life on earth. Biodiversity holds ecological and economic significance, and it gives nourishment to all life forms in different ways and types, besides housing, fuel, clothing and several other resources. It also provides opportunity to tourism and hence monetary benefits through tourism. Therefore, it is very important to have a good knowledge of biodiversity for a sustainable livelihood.

The different ecological regions have different types of rich floral and faunal biodiversity responsible for existence of these different ecosystems for millions of years. The different types of important ecosystems in India are the mountainous and Himalayan ecosystem, coastal and marine ecosystem, arid and desert ecosystem; plateau and river ecosystems. Biodiversity of fauna and flora are important component of these different ecosystems, and is vital for the health and vitality of these different and fragile ecosystems.

In this unit you have been introduced to the concept of biodiversity with special emphasis on the types and importance of biodiversity in general. After reading this unit, you should be able to:

- Understand the concept of biodiversity and its importance

- Describe the types and status of biodiversity in India
- Understand the human impact on biodiversity and efforts for conserving it

1.2 TYPES OF BIODIVERSITY

The uniqueness of our earth is that it provides habitat to millions of life forms. There are over 10 million species that live in this planet. It is really fascinating to understand the diversity of life forms which is the result of evolution of life and human species. Biological diversity or biodiversity is the term given to the variety of life forms from genes to species, through to the broad scale of ecosystems. The word biodiversity is a contraction of biological diversity which was first used during the National Forum on Bio Diversity held in Washington in 1986.

The biodiversity that we see today is the outcome of over 3 billion years of consistent evolution during which millions of species were created and modified by natural processes. Biodiversity is generally expressed in terms of the wide variety of plants, animals and microorganisms. So far, about 1.7 to 1.8 million species has been identified, mostly small creatures such as insects. Broadly, biodiversity is classified under three different types:

- Genetic diversity
- Species diversity
- Ecological diversity

Genetic diversity

It refers to the variations among the genetic resources of the organisms. Every individual of a particular species differs from each other in their genetic constitution. Genetic variation existing within a species is called genetic diversity. It is the level of biodiversity that refers to the total number of genetic characteristics in the genetic makeup of a species. For example, it includes different varieties of crops and breeds of livestock. That is why every human looks different from each other. Similarly, there are different varieties in the same species of rice, wheat, maize, barley, etc. Cultivated rice belongs to only two species, yet includes over 120,000 genetically distinct varieties.

Species diversity

Species diversity refers to the variety of different types of species found in a particular area. It is the biodiversity at the most basic level. It includes all the species ranging from plants to different microorganisms. No two individuals of the same species are exactly similar. For example, humans show a lot of diversity among themselves. Species diversity refers to the variety of species within a region. It includes the full range of species in the region, from micro-organisms to multi-cellular plants and animals. Species are distinct units of diversity, each of which have specific role in an ecosystem. This is the most popular level of biodiversity. It is represented by the incredible variety of different species on the planet.

Ecological diversity

An ecosystem is a collection of living and non-living organisms and their

interaction with each other. Ecological biodiversity refers to the variations in the plant and animal species living together and connected by food chains and food webs. It is the diversity observed among the different ecosystems in a region. Diversity in different ecosystems like deserts, rainforests, mangroves, etc., includes ecological diversity. Ecosystem or community diversity refers to the variations in the ecosystems or communities in which species live. This is next higher level of biodiversity in the hierarchy of genetic and species diversity. It includes different ecosystem types such as deserts, forests, wetlands, mountains, lakes, rivers, and agricultural landscapes.

It is the combination of life forms and their interactions with each other and with the rest of the environment that has made Earth a uniquely habitable place for humans. Biodiversity provides a large number of goods and services that sustain our lives. This biodiversity in fact forms the web of life of which we are an integral part and upon which we fully depend. Biodiversity is often used as a measure of the health of biological systems.

You have read about types of biodiversity. Now answer the questions in check Your Progress 1.

Check Your Progress 1

- Note:** a) Use the space given below for your answer
 b) Compare your answers with those given at the end of the unit

1. Elaborate your understanding about the concept of biodiversity.

2. Differentiate between different levels of biodiversity.

1.3 IMPORTANCE AND USES OF BIODIVERSITY

Biodiversity is immensely important for sustaining life on the earth. The vast array of interactions among the various components of biodiversity makes the planet habitable for all species, including humans. In fact biodiversity is essential for proper functioning of ecological systems of the earth. The services provided by healthy ecosystems, in turn, are the foundation for human well-being. These ecosystem services not only provide the basic material needs for survival, but also underlie other aspects of a good life, including health, security, good social relations and freedom of choice. Biodiversity and its conservation or maintenance is very important for sustaining life on this planet. Some of the very important reasons which explain the importance of biodiversity as a prerequisite for sustenance of life on earth are ecological stability, economic value and ethical importance.

Ecological Stability

Every species has a specific role in an ecosystem. They capture and store energy and also produce and decompose organic matter. The ecosystem

supports the services without which humans cannot survive. A diverse ecosystem is more productive and can withstand environmental stress. They are responsible for rain, recharge of ground water and filter and improve water quality. Carbon sequestration is another very important function, which means they convert carbon dioxide into oxygen or improve air quality. Thus, ecological stability is the most important function of biodiversity whereby the balance between rainfall, good quality of water, and air is ensured.

Economic Importance

Biodiversity is a reservoir of resources which is used directly for the consumption of human being and animals as food, and many others are processed for the manufacture of food, cosmetic products and pharmaceuticals. Crops, livestock, fishery, and forests are a rich source of food directly, where as a number of wild plants, weeds, seeds and roots of plants are used for medicinal purposes. Similarly, wood, fibers, perfumes, lubricants, rubber, resins, poison and cork are all derived from different plant species. The national parks and sanctuaries are a source of tourism. They are a source of scenic beauty and joy for many people.

Ethical Importance

Nature has provided a balance between different species, and hence all the species have a right to exist. Human being should not disturb the natural balance created by the nature, and so the use and exploitation of various natural resources from nature should not result in their voluntary extinction. Biodiversity preserves different cultures and spiritual heritage in different geographical regions, and therefore, it is very important to understand the diverse services provided by the biodiversity.

These are some of the basic day to day requirements of human society that are derived from nature as material resources. These resources are either directly used by human society or converted into some useful commodity for commercial use. A wide range of industrial materials are also derived directly from the biological resources, these include building materials, fibers, dyes, pharmaceuticals, cosmetics and oil. In fact, biodiversity and the ecosystem services associated with it are considered to be fundamental to healthy economic systems. The degree to which biodiversity supports business varies between regions and between economic sectors, however the importance of biodiversity to issues of resource security (food, fiber, fuel wood, timber, paper, medicinal resources and fresh water etc.) are increasingly recognized as universal.

Apart from the direct and indirect material uses and a number of direct and indirect services of biodiversity, there are also a number of social and cultural services of biodiversity. The cultural services include (i) Spiritual and religious values, (ii) Knowledge system, (iii) Education and inspiration, and (iv) Recreation and aesthetic values. Philosophically it could be argued that biodiversity has intrinsic aesthetic and spiritual value to mankind. It is also a great source of knowledge. While exploring pattern of biodiversity across the globe, scientists indirectly discovered many secrets of nature including the process of evolution of life on the earth. Biodiversity provides great deal of fun and recreation. People around the world derive these values

through leisure activities such as ecotourism, mountaineering, wildlife and bird-watching etc. Popular activities such as pet keeping, gardening, caring for aquariums and collecting butterflies are all strongly dependent on biodiversity. Thousands of species are being involved in such pursuits.

Ecosystem services associated to biodiversity have been categorized into two sets: supporting services and regulating services. Supporting services include (i) Primary production, (ii) Provision of habitat, (iii) Nutrient cycling, (iv) Soil formation and retention, (v) Production of atmospheric oxygen, and (vi) Water cycling. These are the basic ecosystem services which support life in the biosphere. In other words these are the processes or attributes which supply the basic needs of life viz., oxygen, water, food and shelter. Regulating services on the other hand include (i) Invasion resistance, (ii) Pollination, (iii) Seed dispersal, (iv) Climate regulation, (v) Pest regulation, (vi) Disease regulation, (vii) Natural hazard protection, (viii) Erosion regulation, and (ix) Water purification. These are the functions which play regulatory role for various ecological processes including supporting services. In simple words, these regulate or determine nature, intensity or magnitude of various ecological processes which are essential for supporting life. Both the sets of ecosystem services are often not readily visible but these are essential for sustenance of life.

1.4 DISTRIBUTION OF BIODIVERSITY IN THE WORLD

It is extremely difficult to inventory all the species on Earth because biodiversity is not evenly distributed; rather it varies greatly across the globe as well as within regions. Among other factors, the diversity of all living things (biota) depends on temperature, precipitation, altitude, soils, geography and the presence of other species. Biodiversity is not evenly distributed; rather it varies greatly across the globe as well as within regions. Among other factors, the diversity of all living things (biota) depends on temperature, precipitation, altitude, soils, geography and the presence of other species. This is the reason why the exact number of species on Earth is unknown.

We know that different geographical regions of the earth receive different amounts of sunlight energy throughout the year. This happens because of the curvature of the Earth and the fact that it is tilted slightly on its axis relative to the sun. This impacts the length of warm, cold, wet, and dry seasons in these different regions, as well as the temperature, humidity, and other environmental factors that define the region. Another consequence of the Earth's curvature and rotation is that the hydrologic cycle distributes water differently among these different regions. The result is striking differences in the global distribution of rain and snow. As a result, different regions on the planet have specific sets of environmental conditions, which results in differences in predominant vegetation. Species residing in different regions are characterized by specific adaptations that allow success under the particular set of environmental conditions of the region. This is the reason why biodiversity is not distributed evenly on the Earth. In fact flora and fauna diversity depends on climate, altitude, soils and the presence of other species. Most of the terrestrial diversity is found in tropical forests. There are certain regions in the world which harbor rich biodiversity. Biodiversity

hotspots and mega-biodiversity countries have been indentified on the basis of such criteria.

A biodiversity hotspot is a region containing an exceptional concentration of endemic or localized species, but is threatened by human-induced loss of habitat. These hot spots support nearly 60% of the world's plant, bird, mammal, reptile, and amphibian species. A conservative estimate ranges from 3 to 100 million species. For practical purposes, a total of 12.5 million species has been estimated as the known species. Out of this, only about 1.7 million species have been described till date. This figure suggests that only 13% of species on the Earth have yet been described. Furthermore, comprehensive catalogues of all 1.7 million species are not available and are poorly known in biological terms. New species are regularly discovered (on average between 5–10,000 new species each year, most of them insects) and many, though discovered, are not yet classified (estimates are that nearly 90% of all arthropods are not yet classified). Worldwide efforts are being made to develop accurate biodiversity database. In general, core data sets are improving, expanding and becoming more easily available. A number of INGO's such as WWF, IUCN, Conservation International, and Wetland International are actively contributing to the generation and maintenance of global biodiversity data and information.

1.5 BIODIVERSITY IN INDIA

India is one of the most diverse nations in the world. It ranks ninth in terms of plant species richness. Two of the world's 25 biodiversity hotspots are found in India. It is the origin of important crop species such as pigeon pea, eggplant, cucumber, cotton and sesame. India is also a centre of various domesticated species such as millets, cereals, legumes, vegetables, medicinal and aromatic crops, etc. India is equally diverse in its floral and faunal wealth.

1. There are about 45,000 species of plants, which is about 7% of world's total. About 33% of these are endemic.
2. There are 15,000 flowering plants, which is 6% of world's total. Roughly, 1,500 plant species are endangered.
3. There are 91,000 animal species, representing about 6.5% of world's fauna. These include 60,000 insect species, 2,456 fish species, 1,230 bird species, 372 mammals, over 440 reptiles and 200 amphibians with largest concentration in Western Ghats and 500 molluscs.
4. Livestock diversity is high. There are 400 breeds of sheep, 27 of cattle and 22 of goats found in India.
5. It has also globally important populations of some of Asia's rarest animals, such as the Bengal Fox, Asiatic Cheetah, Marbled Cat, Asiatic Lion, Indian Elephant, Asiatic Wild Ass, Indian Rhinoceros, Markhor, Gaur, Wild Asiatic Water Buffalo etc.

Bio Geographic Regions and Provinces of India

There are 10 biogeographic regions or zones in India which are further divided into 25 biogeographic provinces. These are as follow

1. Trans Himalaya: This zone has three provinces Ladakh mountains,

Tibetan Plateau, Trans- Himalaya Sikkim.

2. The Himalaya: It has four provinces-North-West Himalaya, West Himalaya, Central Himalaya and East Himalaya.
3. The Indian Desert: This zone includes two provinces- Thar and Kutch.
4. The Semi-Arid: This constitutes two namely-Punjab Gujarat-Rajasthan.
5. The Western Ghats: Two provinces namely Malabar plains and Western Ghats Mountains are included in this zone.
6. The Deccan Plateau: This zone has five provinces Central Highlands, Chhota Nagpur, Eastern Highlands, Central Plateau and Deccan South.
7. The Coasts: Three provinces namely- West coast, East coast and Lakshadweep.
8. The Gangetic Plains: This zone has two provinces- Upper Gangetic plains and lower Gangetic plains.
9. North East India: Two provinces are included- Brahmaputra valley and North-East hills.
10. Islands: This zone include two provinces-Andaman and Nicobar. It is highly diverse set of biomes.

1.6 HUMAN IMPACT ON BIODIVERSITY

People have lived in the natural surroundings with the existing flora and fauna for thousands of years. However, in the recent few decades, greater access to the global market and greater pressure to feed the growing population has increased the demand for natural resources. This has greatly added degradation of ecosystems and loss of biodiversity in most of the productive lands. Despite remoteness and inaccessibility of the far flung area, biodiversity depletion has not been less prevalent as compared to areas around the urban centers. In fact, human-induced biodiversity loss is reported from several parts of the rural and remote far flung areas.

The steadily increasing population in the hotspot has led to extensive clearing of forests and grasslands for cultivation and widespread logging. Both legal and illegal logging often occurs, resulting in severe soil erosion. The cultivable land is also often cleared after harvest seasons for livestock grazing. In order to get more agricultural production, traditional native varieties of crops have been replaced by high yielding mono cropping in most of the agricultural land. This poses additional threat to loss of agro biodiversity and use of chemical fertilizers and huge quantity of water for irrigation, resulting in further degradation of natural ecosystem and biodiversity. The conversion of forests and grasslands for agriculture and settlements has led to large-scale deforestation and habitat fragmentation in most of the rural areas.

Large areas of remaining habitat in the hotspot are highly degraded. Overgrazing by domestic livestock, including cattle and domesticated bovine animals has led to the degradation of common village lands

including common grazing land. The fuel wood collection and non-timber forest product extraction, both for domestic consumption and export, has inflicted severe damage to many forest ecosystems. Unplanned and poorly managed tourism has led to environmental deterioration. It is estimated that habitat loss and degradation has led to destruction of over 75% of original biodiversity of different ecosystems and regions. Expansion of urban areas and conversion of agricultural land for non agricultural use life industry and settlement for housing and construction of roads and urban settlements have further resulted in loss of biodiversity and destruction of natural ecosystems.

1.7 CONSERVATION OF BIODIVERSITY

Conservation of biodiversity means 'the management of human use of biodiversity so that it may give maximum benefit to the present generation while maintaining its potential to meet the needs and aspirations of the future generations'. There are two basic strategies of biodiversity conservation all around the world: in-situ (on site) and ex-situ (off site). In-situ conservation refers to the conservation of biological diversity in their natural habitats through protection of total ecosystem. This includes: Protected areas, Biosphere reserves, sacred forests and sacred lakes. Ex-situ conservation refers to the conservation of biodiversity at place away from their natural habitat. This includes: botanical garden, zoological garden, germ plasma banks and genetic resources centers.

For prioritizing conservation efforts, biodiversity hotspots has been identified all over the world. Biodiversity hot-spots are defined as the bio-geographic region characterized both by exceptional levels of plant endemism and by serious levels of habitat loss. However, many hill-tribe communities have traditionally recognized and protected sacred groves, which have served as effective refuges for biodiversity for centuries. Today, several protected areas — Corbett National Park, Manas National Park, Kaziranga National Park, Chitwan National Park, and Sagarmatha National Park - have been distinguished as World Heritage Sites for their contribution to global biodiversity.

Protection of wildlife has been a long tradition in India. The adoption of a National Policy for Wildlife Conservation in 1970 and Wildlife (Protection) Act in 1972 lead to a significant growth in the protected areas network. In order to conserve the biological diversity, Protected Area Network (PAN) was established in India in 1970 under which biodiversity rich areas have been declared as Sanctuaries and National Parks. Presently, India has over 100 national parks and over 500 sanctuaries covering about 5% geographic area of the country, with a plan for further expansion.

Besides Sanctuaries and National Parks, 15 Biosphere Reserves have also been created in India. Biosphere Reserve represents comprehensive approach to conservation which aims at conserving all forms of life, along with its support system, in its totality, so that it could serve as a referral system for monitoring and evaluating changes in natural ecosystems. In India Biosphere Reserves were created under the 'Man & Biosphere' (MAB) Programme by UNESCO in 1971. Biosphere Reserves in Indian Himalaya include: 1. Nanda Devi in Uttaranchal 2. Manas in Assam 3. Dibru-Shikowa in Assam 4. Dehang-Debang in Arunachal Pradesh 5. Kangchendzonga in

Sikkim.

You have read about importance and uses of biodiversity, distribution of biodiversity in the world, biodiversity in India, human impact on biodiversity and conservation of biodiversity. Now answer the questions in check your progress 2

Check Your progress 2

Note: a) Use the space given below for your answer

b) Compare your answers with those given at the end of the unit

1. Explain how biodiversity is affected by human activities?

2. Why should we conserve biodiversity?

1.8 LET US SUM UP

In this unit we have described the concept of biodiversity while focusing on the biodiversity of the Himalayan region. The major points that have been discussed are:

- Biodiversity refers to the variety and variability of life forms at the levels of genes, species and ecosystem.
- Biodiversity provides numerous goods, cultural services and ecological services. It is immensely important for making the earth a habitable place.
- The Himalayas, one of the biodiversity hotspot, sustains rich biodiversity of fauna and flora. This biodiversity is vital for the health of this fragile ecosystem.
- Biodiversity and agrobiodiversity in the Himalayan region are under constant threat of erosion due to various human activities and changing practices.
- Conservation efforts in form of creation of protected areas have been made in biodiversity rich pockets of the region.

1.9 KEY-WORDS

Species: Organism with similar genetic make-up and which can interbreed.

Ecosystem: A piece of vegetated land or water-body where life can continue without external support.

Community: All the living beings which live in a same ecosystem or habitat.

Endemic Species: Species whose distribution is confined to a particular region.

UNIT 2 CLIMATE CHANGE

Structure

- 2.1 Introduction
- 2.2 What is Climate Change
- 2.3 What Causes Climate Change
- 2.4 How Climate Change Affect Humans
- 2.5 IPCC Report on Climate Change
- 2.6 Climate Change and the North-South Debate
- 2.7 India's Response to Climate Change Issues
- 2.8 Let us Sum Up
- 2.9 References and Selected Reading
- 2.10 Check Your Progress Possible answers

2.1 INTRODUCTION

In the recent years, climate change as a phenomenon has received unprecedented attention from different quarters of society including scientific institutions, policy planners, social and print media, academia and NGOs. The global attention of climate change issue is based on the available data and case studies from around the world which have demonstrated how the millions of world's poorest people are already being forced to cope with impacts of climate change. The global increased incidence of drought, more intense storms, floods and perceptible environmental stress impacts the efforts of the world's poor to build a better life for themselves and their children. This realization led to the Global discussions and debates on climate change, which got the momentum after the Bali Conference on Climate Change in 2007, where it was discussed that climate change is an environmental problem which impacts every aspects of life including international economy, public health, migration, livelihood, international peace and security.

The development of the climate regime can be traced from the environmental activities of 1980 and 90s. Climate change as an environmental fact has began to felt in the year 1987 with the release of the Brundtland Commission report, Our Common Future. The report comprehensively focused on the issues of environmental pollution with regard to depletion of ozone layer, loss of biological diversity and the rising greenhouse gas temperature and argued for achieving sustainability by formulating effective socio-economic policies.

The various linkages between global warming and climate change makes it necessary to understand the difference between these two terms, and how global warming contributes to the climate change. Global warming is the long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily

fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. The term is frequently used interchangeably with the term climate change; though the latter refers to both human- and naturally produced warming and the effects it has on our planet. It is most commonly measured as the average increase in Earth's global surface temperature.

Climate as a global issue is affecting the lives of both developing and developed countries, moreover, the debates on climate change is helping to build up a comprehensive climate change regime with country-specific action plan. The present unit will focus on building the basic understanding of all issues relating to the climate change debates and its implications for both developing and developed countries, and building the response plan towards climate change regime.

After studying this unit, you will be able to:

- know the meaning and causes of climate change;
- how climate change affect human life and what can we do to mitigate climate change;
- understand India's response plan towards climate change regime.

2.2 WHAT IS CLIMATE CHANGE

Climate change has been defined differently by different institutions and individuals, but in a simplified way, it can be understood as a long-term change in the average weather patterns which define the Earth's local, regional and global climates. These changes also have a broad range of observed effects that are synonymous with the term. The changes which have been observed in Earth's climate since the early 20th century are primarily driven by human activities, particularly burning of the fossil fuel. The increased level of burning of fossil fuel increases heat-trapping greenhouse gas levels in Earth's atmosphere which raises the average surface temperature of the earth. The human produced increase in global temperature level is referred to as global warming. Some natural processes can also contribute to climate change, including internal variability (e.g., cyclical ocean patterns like El Niño, La Niña and the Pacific Decadal Oscillation) and external forcing (e.g., volcanic activity, changes in the Sun's energy output, and variations in Earth's orbit).

The study of climate change stemmed out of serious concern of the society which began many decades back by scientists across the worlds, who study the factors which propelled them in the past. The quantification of present impact of climate change and projection of future impacts of climate change processes have brought scientists from different disciplines and countries to understand its impact from ground, water, under water, air and outer space. The climate data generated over a period provide evidence of climate change key indicators, such as global land and ocean temperature increase; rising sea levels; ice loss on North and South poles and the recession of a number of glaciers in the mountains in general and Himalaya in particular. The frequency and severity of environmental changes which lead to extreme weather such as hurricanes, heat waves, wildfires, droughts, floods and precipitation; and cloud and vegetation cover changes are some of important

impacts where data on its different components are being collected to arrive at scientific conclusions and policy formulations globally. The study has further indicated that there is a global increase of 1 degree Celsius average temperature all across the world and it is currently increasing by 0.2 degrees Celsius (0.36 degrees Fahrenheit) per decade.

2.3 WHAT CAUSES CLIMATE CHANGE

Natural and manmade are the two main factors that have primarily contributed to the climate change system. The natural factors that have contributed to climate change include the sun's intensity, volcanic eruptions, and changes in naturally occurring greenhouse gas concentrations. A number of manmade factors have accelerated the process of climate change system at a much faster rate since the 20th century. The most important manmade factor is the emission of greenhouse gas (GHG), and is now the leading cause of the earth's rapidly changing climate. An optimum amount of greenhouse gas in our environment is essential to keep the planet warm enough for the existence of plants and animals. Now, due to the ever increasing economic activities since the last century, coupled with the sporadic increase of human population have increased the volume of these gases in our atmosphere. The increase of greenhouse gases in our atmosphere has increased the concentration of carbon dioxide, methane, and nitrous oxide to unprecedented levels. According to the data collected by the Intergovernmental Panel on Climate Change (IPCC), the atmosphere's share of carbon dioxide, which is the planet's chief climate change contributor, has risen by 40 percent since preindustrial times.

2.4 HOW CLIMATE CHANGE AFFECT HUMANS

Humans had adjusted and adapted to the microclimatic and geographic conditions of their habitat and locations on the earth. They had further evolved their agricultural and other allied economic activities in conformity with their climatic conditions. The changes in their climatic conditions as a result of climate change will affect their balanced economic activities, and change the balance it had evolved in their agriculture, pastoralism, shelter, housing pattern, clothing and fooding pattern. Climate change transforms global ecosystems balance, the higher temperature worsens and increases the frequency of many types of disasters, including storms, floods, heat waves, and droughts. Such events can have devastating consequences leading to jeopardizing the access to clean drinking water, availability of fuel wood and fodder. The global increase in temperature can also result in decrease in agricultural production and create wild fires damaging forests, property, creating hazardous-material spills, polluting the air, and leading to loss of life.

Weather and Climate have a profound influence on life on Earth. They affect landforms, soil types and vegetation. They are part of the daily experience of human beings and are essential for their health, food production and well being. The mental alertness, physical characteristics and even social differences, when closely examined, have at least some relationship with climate. There are many causes of climate change. Many are natural and involve processes which influence the flows of energy into, out of and within

the Climate system. However, concern has grown that man's activities may be affecting these processes, thus also affecting climate. If one wishes to understand, detect and eventually predict the human influence on climate, one need to understand the system that determines the climate of the Earth and the processes that lead to Climate Change.

Climate change will also increase the intensity of air pollution. When the earth's temperatures rise, not only does our air gets dirtier—with smog and soot levels going up—but there are also more allergenic air pollutants such as circulating mold (thanks to damp conditions from extreme weather and more floods) and pollen (due to longer, stronger pollen seasons). As its ice sheets melt into the seas, our oceans are on track to rise one to four feet higher by 2100, threatening coastal ecosystems and low-lying areas. Island nations face particular risk, as do some of the world's largest cities, including New York, Miami, Mumbai, and Sydney. The earth's oceans absorb between one-quarter and one-third of our fossil fuel emissions and are now 30 percent more acidic than they were in preindustrial times. This acidification poses a serious threat to underwater life, particularly creatures with calcified shells or skeletons like oysters, clams, and coral. It can have a devastating impact on shellfisheries, as well as the fish, birds, and mammals that depend on shellfish for sustenance.

According to the World Health Organization, "climate change is expected to cause approximately 250,000 additional deaths per year" between 2030 and 2050. The fatalities and illness from heat stress, heatstroke, and cardiovascular and kidney disease would increase. The worsening of air pollution would result in worsening of the respiratory health particularly for the 300 million people living with asthma worldwide. Extreme weather events, such as severe storms and flooding, can lead to injury, drinking water contamination, and storm damage that may compromise basic infrastructure or lead to community displacement. Indeed, historical models suggest the likelihood of being displaced by a disaster is now 60 percent higher than it was four decades ago—and the largest increases in displacement are driven by weather- and climate-related events.

The UN Framework Convention on Climate Change and the Kyoto Protocol has reflected the existing disparities between developing and developed countries in creating the environmental problem over a period of time and demanded to develop a legal framework in addressing the challenges of climate change in terms of sharing responsibility at the international level. The 4th Report of Inter-governmental Panel on Climate Change (IPCC) clearly attributed human activities as the cause of green house gas emission and the warming of the earth's surface. In this context, climate change is often argued from the perspective of North-South conflict and contestation.

You have read about what is climate change, what causes climate change, how climate change affect humans. Now answer the questions in Check Your Progress 1.

Check Your Progress 1

Note: a) Use the space given below for your answers.

b) Check your answers with those given at the end of the unit.

1. What do you understand by climate change?

2. What are the important factors that are responsible for Climate Change?

2.5 IPCC REPORT ON CLIMATE CHANGE

The Inter-governmental Panel on Climate Change (IPCC) was set up jointly by the United Nations' bodies and the World Meteorological organizations and the first meeting was convened in the year 1998 to discuss the scientific uncertainties prevailing over the issues of climate change. The IPCC has described climate uncertainties in relation to magnitude, timing, and regional patterns of climate change. The first meeting of IPCC was held as part of the political interest among countries over the world to participate in the development of models to address the challenges of global climate change. IPCC being an inter-governmental body has assured the involvement of government representatives, scientists and policy makers in the process.

Subsequently, the issue of global warming was accepted and discussed in the United Nations Conference on Environment and Development (UNSED) at Rio, 1992. The acceptance of global warming at the global platforms led to the formulation of international Framework Convention on Climate Change (FCCC), which was signed by over 160 countries. The Climate Convention signed at the Rio conference acknowledged the importance of the balanced relationship between humans with their environment. The Convention emphasized to maintain the harmonious relationship between human society and their environment towards stabilizing the greenhouse gas concentration in the environment. Further, it set the objective for concrete action to reduce and stabilize the climate change. The signatories to the Convention consensually agreed upon the initiation of mitigation actions to combat the impacts of climate change.

2.5.1 Some Highlights of the Climate Change Convention

- The convention showed its serious concern on the increasing concentration of greenhouse gas in the atmosphere due to human activities.
- Convention noted that the largest share of global greenhouse gases emission was from the developed countries as compared to developing countries.
- The convention recognized various mitigation actions which can help in reducing the emission of greenhouse gas.
- The convention specified the most vulnerable countries with low-lying coastal areas, which were liable to get submerged under water and flooded due to climate variability.

- Convention affirmed that actions responding to climate change needs to be coordinated with the socioeconomic development in an integrated pattern.
- The Convention mentioned its determination in protecting the climate systems from further deterioration due to human economic activities.
- The stabilization of the concentration of greenhouse gases needs to be achieved within a specific timeframe while ensuring effective food production and economic development in a sustainable way.
- The stabilization of concentration of greenhouse gases needs to be achieved within a specific timeframe while ensuring effective food production and economic development in a sustainable way.

2.6 CLIMATE CHANGE AND THE NORTH-SOUTH DEBATE

The existing dialogue between the developed and the developing countries over issues of disparity in economy, infrastructure, income level, GDP, education, employment, health and environmental parameters shows huge difference. This difference is also referred as the North-South divide since most of the developed countries are located in northern hemisphere and developing countries in southern hemisphere of our earth. Hence, there are two different interest groups with different economic, social, political and environmental interests, and this is referred as North – South debate. The emerging issues of climate change also has similar north – south interests and challenges, and requires to be addressed separately for the developing and the developed world. The climate change debate needs to address the issue of equity not only in relation to the future generation but also in relation to the present generation. In this context, the main concern of the International Community was the development of an international legal regime which can reflect and address the vast disparities between developing and developed countries with regard to wealth and the greenhouse gas emission. In response to the new challenge relating to climate change, the international community phrased the common but differentiated responsibility (CBDR) principle as the guiding principle of climate change science. The principle of differentiated responsibility was well incorporated in the UN Framework Convention on Climate Change.

2.6.1 Common but Differential Responsibility

The CBDR principle was derived from the principle of equity, which is an important principle of international law. For the first time, the Rio Declaration on Environment and Development was being instrumental in incorporating the principle of CBDR at the global level. The principle 7 of Climate Convention in Rio Declaration conveys that States shall co-operate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command (Atapattu, 2008).

This principle has become the most contested issues in the forum of Rio Conference. Principle 7 often emphasised the legal responsibilities of the developed countries to combat climate change impacts due their contributions towards environmental problems in the past. Often, the principle 7 was debated over the issue of whether the principle is implying legalities or it can be adopted as guiding principle in the Climate Convention. CBDR as the guiding principle was profusely endorsed by the UN Framework for Climate Convention in the Article 3 under 'principles'. Article 3 states The Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities. Accordingly, developed country Parties should take the lead in combating climate change and the adverse effects thereof.

The Protocol embodies substantive obligations in relation to climate change for both developing and developed countries. These commitments ranged from developing national inventories/strategies of greenhouse gas emissions, formulating and implementing national level programs with regard to mitigate and adaptation strategies of climate change, promoting and cooperating the transfer of sustainable technology, promoting sustainable and integrated development, cooperating in preparing adaptation plans, promoting and supporting scientific research and promoting education, training and public awareness about the effect of climate change (Atapattu, 2008). For instance, in the first commitment period from 2008-12, the industrialized countries are committed for specific quantitative reductions in emissions. The Protocol involved inbuilt mechanisms to facilitate concrete action plan for combating climate change and the action plan aimed towards including the developing countries under the general obligations of the Climate Convention.

2.6.2 The Kyoto Mechanism

The Kyoto mechanisms include three strategies to reduce emission level such as:

- i. Joint Implementation (JI)** will allow industrialized countries to facilitate the implementation of projects pertaining to reduction of emission level.
- ii. The Clean Development Mechanisms (CDM)** allows industrialized countries to implement projects which will reduce the emission level of developing countries. For example, the project on rural electrification by providing solar panels or encouraging reforestation on the degraded land.
- iii. Emission Trading** allows industrialized countries to purchase assigned amount of units of emission from other industrialized countries to meet the emission target (Houghton 2009).

Thus, the Kyoto Protocol involves specific principles and mechanisms to reduce the greenhouse gas emission; however, it does contain any obligations for developing countries with regard to reduction of emission. Therefore, the protocol had led to intense controversy on the issue of equity over climate change. In this context, most of the debates had happened with regard to the principle of general obligations of all the states to cooperate

and protect the environment. On the contrary, it was also argued that since the Kyoto protocol applies for the commitment period; therefore, no specific obligations were formulated for the developing countries on the basis of their minimal contributions to greenhouse emission. The exclusion of developing countries from the global climate change regime has reflected the notion of differential principles for developing vis-à-vis developed countries. Further, it was argued that there may be a need to impose differential policies within the developing countries with regard to climate change policies.

You have read almost IPCC report on climate change, climate change on the North-South debate, Now answer the questions in Check Your Progress 2

Check Your Progress 2

Note:a) Use the space given below for your answers.

b) Check your answers with those given at the end of the unit.

1. What are the important highlights of Climate Change Convention

2. What do you understand by The Kyoto Mechanism?

2.7 INDIA'S RESPONSE TO CLIMATE CHANGE ISSUES

Within the developing nations, India's around 700 million rural population is dependent on the climate sensitive sectors such as agriculture, forest, fisheries, water, biodiversity and coastal zones. Further, the rural population is more vulnerable to the climate variability as they have low adaptive capacity in relation to extreme and fluctuating weather condition. The National Commission Report found out that the impact of climate change can be felt in sectors of natural ecosystem and the socio-economic system. In the context of current debate, developing countries like India is taking necessary actions in terms of execution of programmes and action research. Technology transfer needs to take priority in the mitigation and adaptation process. The central argument on the position of India and the other developing countries in the global climate change debate is as follows:

- Developing countries India, in particular have a strong opinion that the unsustainable consumption pattern of the industrialized countries are responsible for the climate change.
- India and other developing countries economy are vulnerable to climate change and the impact of climate change can hamper the progress in poverty eradication, and the socio-ecological condition of the country.
- Developing countries have potential in limiting GHG emission by facilitating effective programmes like policies aiming towards effective energy and economic management, development of both

conventional and renewable energy resources, and limitation of health hazards.

- Developing countries have undertaken certain price reforms and removing subsidies which have positive impact in the context of energy saving.
- With regard to differentiated responsibility, countries like India needs to stabilize the carbon emission level and further aims at reducing the GHG concentration at a sustainable level.
- Developing countries including India needs to adopt an equitable approach while framing the mitigation strategies. The approach will accommodate differing perspective of uncertainties and risks associated with every country with respect to carbon emission to initiate a global trading system of carbon emissions.

2.8 LET US SUM UP

The understanding of issues relating to climate change as a global phenomena surrounds around the economic, social, political and environmental in the context of developed and developing countries contribution to climate change. The north south dialogue further explains the two interest groups with two different types of claims and contribution to climate change and the possibility of framing the action plan for combating the climate change events. The efforts of the international agencies and scientific community in bringing out the issues revolving around the CDBR and Kyoto Mechanisms highlights the various initiatives in this direction. The unit has broadly focused on the conceptualization of climate change through basic science and the related debates in the context of increasing global warming and its impact on the human communities, ecosystems, economy, technological innovation, and mitigation policy options at national and international level.

2.9 REFERENCES AND SELECTED READINGS

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2.10 CHECK YOUR PROGRESS POSSIBLE ANSWERS

Check Your Progress 1

1. Climate change has been defined differently by different institutions and individuals, but in a simplified way, it can be understood as a long-term change in the average weather patterns which define the Earth's local, regional and global climates. These changes also have a broad

range of observed effects that are synonymous with the term. The changes which have been observed in Earth's climate since the early 20th century are primarily driven by human activities, particularly burning of the fossil fuel. The increased level of burning of fossil fuel increases heat-trapping greenhouse gas levels in Earth's atmosphere which raises the average surface temperature of the earth.

2. There are many causes of climate change. Many are natural and involve processes which influence the flows of energy into, out of and within the Climate system. However, concern has grown that man's activities may be affecting these processes, thus also affecting climate. If one wishes to understand, detect and eventually predict the human influence on climate, one need to understand the system that determines the climate of the Earth and the processes that lead to Climate Change.

Check Your Progress 2

1. Some Highlights of the Climate Change Convention

The convention showed its serious concern on the increasing concentration of greenhouse gas in the atmosphere due to human activities.

Convention noted that the largest share of global greenhouse gases emission was from the developed countries as compared to developing countries.

The convention recognized various mitigation actions which can help in reducing the emission of greenhouse gas.

The convention specified the most vulnerable countries with low-lying coastal areas, which were liable to get submerged under water and flooded due to climate variability.

Convention affirmed that actions responding to climate change needs to be coordinated with the socioeconomic development in an integrated pattern.

The Convention mentioned its determination in protecting the climate systems from further deterioration due to human economic activities.

2. The Kyoto mechanisms include three strategies to reduce emission level such as:

Joint Implementation (JI) will allow industrialized countries to facilitate the implementation of projects pertaining to reduction of emission level.

The Clean Development Mechanisms (CDM) allows industrialized countries to implement projects which will reduce the emission level of developing countries. For example, the project on rural electrification by providing solar panels or encouraging reforestation on the degraded land.

Emission Trading allows industrialized countries to purchase assigned amount of units of emission from other industrialized countries to meet the emission target.

UNIT 3 SUSTAINABLE DEVELOPMENT: AN INTRODUCTION

Structure

- 3.1 Introduction
- 3.2 Definition and Conceptual Understanding
- 3.3 Fundamentals of Sustainable Development
- 3.4 Sustainable Development Indicators
- 3.5 Steps for Sustainable Development
- 3.6 Let Us Sum Up
- 3.7 References and Selected Readings
- 3.8 Check Your Progress - Possible Answers

3.1 INTRODUCTION

The concept of sustainable development has arisen from a worldview which sees the survival, progress, and continued maintenance of the human community as dependent on the continued health and viability of the earth's life support systems. The word sustainable development refers to a model of human development in which equal thought and preference is given to the future generations while meeting the human needs. It also implies the processes of fundamental change in our social system and institutions, where the preference for future generations has been included at individual and societal level. This change in attitude from present visible issues to an invisible future imagination is based on a deep realization and social awakening concomitant with the expansion of globalization. It is paradoxical that this change relates to addressing the challenges embedded in the new global awareness that the earth is finite, and all of the planet's life support systems including social and economic systems are globally interconnected and interdependent. Sustainable development is a central concept for our age, and it is both a way of understanding the world and a method for solving global problems.

The world is perplexed at the grave population explosion, which continues to multiply rapidly, by around 75 to 80 million people per year. We have already reached to almost 8 billion in 2021, and perhaps would reach 9 billion by the early 2040s. Now, these billions of people are looking for their foothold in the world economy. While the poor are still struggling to find the food, safe water, health care, and shelter they need for mere survival. The struggle is unending for those just above poverty, who are continuously trying for improved prosperity and a brighter future for their children. The privileged high-income society is confident that technological advances will offer them and their families even higher levels of wellbeing. This unending race for better living, comfortable life and growing big monetarily has gradually depleted the resource base and eroded the social fabric of community living based on mutual sharing of the resources. The impact

of these changes has finally forced the world to think for the survival and continuity of the human civilization, and thus the discussions and actions started for sustainable development.

In this unit you will know more about the concept of sustainable development, which simply stands for meeting the needs of present generations without compromising the ability of future generations to meet their own needs. In other words, it means a better quality of life for everyone presently, and for generations to come. Sustainable development is a vision of progress which integrates the immediate needs of the society and also addresses the future objectives of local and global action, to balance the social, economic and environmental change which are inseparable and are interdependent components of human progress.

After studying this unit, you should be able to

- explain the meaning of sustainable development
- describe various components of sustainable development
- discuss various indicators of sustainable development
- suggest few measures for the promotion of sustainable development.

3.2 DEFINITION AND CONCEPTUAL UNDERSTANDING

The concept of sustainable development arises from a worldview, which sees the survival, continued progress, and maintenance of the human community as dependent on the continued health and viability of the earth's life support systems. The term "sustainability" is derived from the Latin root *sus-tinere*, which means to "under-hold" or hold up from underneath, implying robustness and durability over time. Accordingly, sustainability depicts a paradigm that seeks to protect the planet's life support systems to ensure longevity for humans and other species. Sustainable development can be defined as the process of strategic changes in our social systems and institutions needed in order to achieve sustainability. The term "development" is criticized by some as connoting growth. Unfettered growth of the "ecological footprint" of the human population, defined as the portion of the biosphere used to support human production, consumption and waste, is, of course, ultimately not sustainable.

Sustainable development is defined as balancing the fulfilment of human needs with the protection of the natural environment so that these needs can be met not only in the present, but in the indefinite future. Sustainable development is a pattern of resource use that aims to meet human needs while preserving the environment. The field of sustainable development is conceptually divided into four general dimensions: social, economic, environmental, and institutional. The first three dimensions address key principles of sustainability, while the final dimension addresses key institutional policy and capacity issues.

The term, sustainable development, was coined by the Brundtland Commission which defines sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs". When the Brundtland Commission

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published Our Common Future, it ignited worldwide attention to the concept of sustainable development. The Brundtland report defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” The report adopted the perspective that economic inequities will lead to over-exploitation of resources, and economic growth is needed in the poorer countries in order to satisfy basic human needs, but that this development must follow a “new pathway” that does not entail environmental destruction. It also noted that meaningful political participation is needed to ensure that the fruits of economic growth are equitably distributed.

The Brundtland report proposed a number of new ways for achieving sustainable development. It also led to the 1992 United Nations Conference on Environment and Development (UNCED) (commonly called the Earth Summit) held in Rio de Janeiro. The fruits of the Conference included Agenda 21, the Rio Declaration, the United Nations Framework Convention on Climate Change, the United Nations Convention on Biological Diversity, and the Statement of Principles for the Sustainable Management of Forests, all of which were adopted by the 178 governments that attended the Conference.

Now, sustainable development has become a buzzword, and is used extensively in all kinds of seminars, workshops, symposium and conferences. The concern for sustainable development is becoming increasingly louder with the increasing pace of economic and industrial growth. In fact, all sectors of developing countries seem to be vibrating with economic buoyancy. There is expansion of trade, investment, market, and increase in Gross National product (GNP), productivity, per capita income, profit, efficiency, salary, etc, across the globe. The free trade system could more tellingly be called the free ride system, because the producers do not have to include in their product costs all the indirect costs they cause society, such as pollution of the land, sea and air, ozone holes, disappearing topsoil, exploding health costs, allergies, global warming, destruction of species, pesticides in food, antibiotic-resistant bacteria, crime, unemployment, escalating social costs, etc. Many of the most common, and most damaging products on the market, would never be manufactured if they were priced at their real costs to society as a whole.

You have read about definition and conceptual understanding. Now, answers the questions in Check Your Progress 1

Check your Progress 1

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit

1. What is the need for sustainable development?

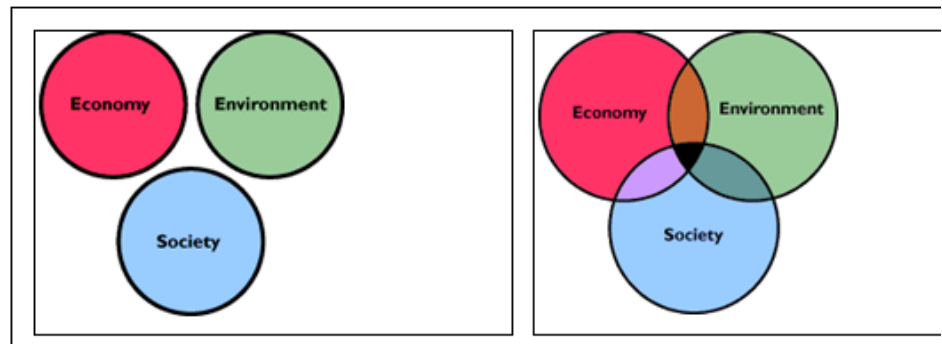
2. What do you mean by sustainable development?

3.3 FUNDAMENTALS OF SUSTAINABLE DEVELOPMENT

The available research and analysis of sustainable development components shows the existence of three major components, which is economical, ecological and human. The economic potential of sustainable development changes very slowly, while the human component or the socio economic development changes very fast. It has been observed that rapid economic growth in order to obtain maximum benefits, especially for developing countries, creates a heavy burden on the ability of our planet to support. Therefore, economic growth should be such that negative environmental impact is limited. Hence, the concept of sustainable development represents a paradigm shift, where development must be conceived as a multidimensional activity with major changes in social structures, attitudes and national institutions, aiming at accelerating the economic growth and reducing inequality. In other words, the economic dimension should aim to ensure a balanced and sustainable economic environment.

The ecological component of sustainable development suggests that economic development should be in conformity to the environment. Environmental development is the capacity of the environment to grow and to bring the peculiarities of environment while ensuring the protection and renewal of natural resources and environmental heritage. Thus, economic growth should not affect the environment in order to talk about sustainable development. When society, economy, and environment are viewed as separate, unrelated parts of a community, the community's problems are also viewed as isolated issues. This piecemeal approach has a number of negative side effects. Sustainable development is deeply linked between the economy, the environment and the society. The figure shown below is frequently used to show the interconnectedness of economy, environment and the society. The understanding of the linkages between these three parts is the vital key to understanding sustainability, because sustainability of the three systems independently and collectively contributes to the quality of life. It is more about the understanding of these connections and achieving a balance among the social, economic, and environmental components on the earth.

Interconnectedness of the three systems



Sustainable development involves the simultaneous pursuit of economic prosperity, environmental quality and social equity. "Sustainable community development means the ability of the community to make developmental choices which respect the relationship between the three E's, i.e. economy, ecology, and equity.

- **Economy** - economic activity should serve the common good, be self-renewing, and build local assets and self-reliance.
- **Ecology** - humans are part of nature, nature has limits, and communities are responsible for protecting and building the natural assets.
- **Equity** - the opportunity for full participation in all activities, access, benefits and decision-making of a society.

Sustainable development shows a compassionate concern for the posterity and for the world as a whole. It contends that social development, environmental soundness, and economic growth are not contradictory or incompatible. Healthy environment and good society are, rather, prerequisites for sustainable development. Sustainable development is based on a broader economic system which fulfils inter-generational equity criteria. Its objectives are focused on the future, not the present, quality not quantity, protection not production, conservation not consumption (Das, 2018).

Sustainability is also related to the quality of life in a community - whether the economic, social, and environmental systems that make up the community are providing a healthy, productive, meaningful life for all community residents, present and future. Hence, the field of sustainable development can be conceptually broken into three constituent parts: environmental sustainability, economic sustainability, and socio-political sustainability. Sustainable development integrates the imperatives of developmental and environmentalism. It emphasis on economic, social, and ecological integration, and has three broad objectives of economic efficiency, social acceptability and ecological sustainability.

Sustainability is an issue for all communities, ranging from small rural villages that are losing their natural environment, upon which their livelihoods depend, to large metropolitan areas where crime and poverty are decreasing the quality of life. Sustainability is not about maintaining the status quo or reaching perfection, nor is it a community where nothing ever goes wrong. A sustainable development process seeks to maintain and improve the economic, environmental, and social characteristics of an area

so that its members can continue to lead healthy, productive, enjoyable lives at present and in future.

Sustainable development improves the economy without undermining the social or environmental imperatives. It focuses on improving our lives without continually increasing the amount of energy and material goods that we consume. A sustainable community does not consume resources energy and raw materials faster than the regenerative capacity of the natural systems. Sustainability requires that human activity only uses nature's resources at a rate at which they can be replenished naturally. An unsustainable situation occurs when natural capital (the sum total of nature's resources) is used up faster than it can be replenished. Thus, there is urgent need to develop an ecosystem approach, or inter generational approach for the management of natural capital and social capital. Ultimately, an ecosystem approach tends to evolve and change from a consumptive economy to an economy oriented towards conservation, maintenance of capital stock, and recycling of materials.

3.4 SUSTAINABLE DEVELOPMENT INDICATORS

Indicators of sustainable development are more visible in social goals such as human development and quality of life, or socioeconomic welfare. These indicators provide early warnings about non sustainable trends of economic activity and environmental deterioration. The concept of indicators of sustainable development became popular during the Rio Earth Summit's call for indicators of sustainable development (United Nations 1994, Agenda 21). The most popular and well discussed indicators of sustainable development are: (i) Gross Sustainable Development Product (ii) Environmental Kuznets Curve (iii) Social Indicators for Sustainable Development

i. Gross Sustainable Development Product

The concept of green Gross Domestic Product (GDP) has been modified as Gross Sustainable Development Product (GSDP), which is defined as the total value of production after giving due care to social capital and natural capital of a region over a specified period of time. It is designed to replace the Gross Development Product (GDP) as the primary indicator of the economic performance of a nation. Following factors are taken into account to arrive at GDSP: -

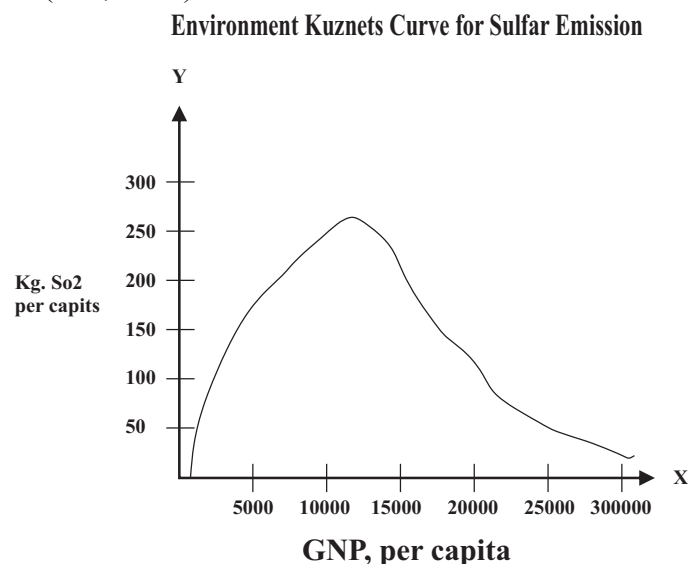
- the economic impact/costs of environmental degradation
- impacts of changes in quality systems on national income and wealth
- global concerns and their impacts on the economy and ecology and society
- the welfare, economic development, and quality of life of future generations
- expenditures on pollution abatement and clean-ups
- the status of each resource and the stocks and productive capacities
- the depreciation or appreciation of natural assets
- the ecological processes and biological diversity

- the costs of economic growth, resources uses of present and future generations .

The measurement of GSDP also gives a proper and sound signal to the public, government and industry about the rate and direction of economic growth. It identifies environmental, health, and social quality; it identifies sustainable and unsustainable levels of resource and environmental uses; it measures the success or failure of sustainable development policies and practices; and it also identifies the resource scarcity. The primary goal of a sustainable local community is to meets its basic resource needs in ways that can be continued in the future (Das, 2018).

ii. Environmental Kuznets curve

The relationship between richness, poverty and environmental pollution is considered as one of the indicator of sustainability. It has been observed that level of pollution is less initially in poor countries, and it becomes more during its economic growth and development stage, and later the pollution level declines as the income level improves in the country. The world's poorest and richest countries have relatively clean environments, while middle-income countries are the most polluted. Because of its resemblance to the pattern of inequality and income described by Simon Kuznets (1955), this pattern of pollution and income has been labelled an 'Environmental Kuznets Curve' (EKC). The World Bank first popularized this idea in 1992, using a simple empirical approach. In simple terminology, the EKC shows the relationship between the environmental degradation and the per capita income. The proponents of EKC are of the opinion that in the early stages of economic growth, degradation and pollution increase, but beyond some level of per capita income, the trend reverses, so that at high-income levels, economic growth leads to environmental improvement. This implies the environmental impact indicator is an inverted U shaped function of per capita income. The EKC pattern does not provide evidence of market failures or efficient policies in rich or poor countries. Rather, there are multiple underlying mechanisms, some of which have begun to be modelled theoretically. An example of EKC of sulphur emission is given in figure below (Das, 2018).



Source: <http://www.ecoeco.org/pdf/stem.pdf>

iii. Social Indicators of Sustainable development

The social indicators of sustainable development as framed by the United Nations Commission on Sustainable Development (CSD) in 1995 are broadly categorized under five indicators, such as poverty; governance; health; education; and demography.

- i. **Poverty:** Poverty is considered as one of the key indicators of sustainable development. Nations with a high percentage of people earning less than one dollar a day are considered to be living below the poverty line. The income inequality is represented by ratio of their share in national income. The proportion of population using poor drinking water quality, poor sanitation facility, households without electricity connection and proportion of population living in slums.
- ii. **Governance:** Governance is the second key indicator of sustainable development. Good governance is an essential element of sustainable development, while the rate of crime and corruption in governance of development activities is considered indicator of unsustainable development.
- iii. **Health:** The key indicators of sustainable health care are mortality rate under five years of age, and life expectancy at birth, health care delivery, nutritional status and health status and risks.
- iv. **Education:** As far as education is concerned, sustainable education includes educational levels and literacy. The core indicators are the gross intake ratio to last grade of primary education, net enrolment rate in primary education, adult secondary (tertiary) schooling attainment level, and the adult literacy rate.
- v. **Demography:** The two vital demographic indicators of sustainable development are population growth and the dependency ratio. The indicators of demographic themes for sustainable development are the lower fertility rates and lower dependency ratios.

You have read about fundamentals of sustainable development, sustainable development- indicators. Now, answer the questions in Check Your Progress 2.

Check Your Progress 2

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit

1. What do you mean by Gross Sustainable Development Product?

2. What is the Environmental Kuznets Curve?

3.5 STEPS FOR SUSTAINABLE DEVELOPMENT

Sustainable development is an important development agenda of the 21st century and is more known for the vital paradigm shifts in the theoretical understanding and practical application of development. Now all countries have to take appropriate measures for the promotion of sustainable development in all development programmes, projects and policies. Therefore, for the guidance and supervision the United Nations has emphasized its institutional framework for sustainable development. In its institutional framework for sustainable development, it has mentioned that for the attainment of sustainable development, good governance, sound economic policies, social democratic institutions responsible to the needs of the people, and improved infrastructure are the basis for sustained economic growth, poverty eradication, and employment generation (Das, 2018).

Based on the available literature, practices and policies dealing with measures of sustainable development some measures for the promotion of sustainable development have been suggested as under:

1. The conservation of land, water and energy resources is fundamental for the promotion of sustainable development. Appropriate action has to be taken for the conservation of scanty resources. Conservation of resources by the present generation will provide future generation with widest range of possibilities.
2. The development of technologies and approaches which will minimize the environmental damages. Such development requires scientific knowledge and continuous investment needs to be promoted.
3. In order to meet the suggested environmental targets, political and public support is encouraged to meet the desired critical objectives.
4. Public participation in decision making in all environmental issues is very important, and hence efforts and scope should be made to increase their role in particular in the planning processes.
5. A number of developed and developing countries have already initiated good practices which are in tune with the promotion of sustainable development:
 - (a) in Brazil, the bio-fuels programme has saved the country \$100 billion in external debt-a fact that makes such fuels attractive in many countries
 - (b) in South Africa, the implementation of carbon capture and storage technology brings benefits in terms of technology transfer.

The United Nations has strengthened and integrated the three dimensions of sustainable development policies and programmes, and to promote the full integration of sustainable development objective with social development issues.

3.6 LET US SUM UP

This unit has discussed the concept and definition of sustainable development with real life examples from the society and environment. It also dealt

with various components of sustainable development as understood and viewed globally. The various indicators of sustainable development were analyzed in the light of rural and urban, industrial and agrarian and finally, the developed and developing countries. Finally the unit enumerated the various measures to promote sustainable development.

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<http://www.ecoeco.org/pdf/stern.pdf>

3.8 CHECK YOUR PROGRESS - POSSIBLE ANSWER

Check your Progress 1

1 What is the need for sustainable development?

Answer: The need for sustainable development arises for two important reasons. Those are: (i) the current system of development considers development of mankind alone and ignores the interdependent ecosystem; and (ii) it treats environment as a commodity.

2 What do you mean by sustainable development?

Answer: According to the Brundtland Commission "Sustainable development" is that which "meets the needs of the present without compromising the ability of future generations to meet their own needs." It has three components: a) Economy - economic activity should serve the common good, be self-renewing, and build local assets and self-reliance. b) Ecology - humans are part of nature, nature has limits, and communities are responsible for protecting and building natural assets. c) Equity - the opportunity for full participation in all activities, access, benefits, and decision-making of a society. It has three objectives: i. Economic efficiency, ii. Social acceptability, and iii. Ecological sustainability

Check Your Progress - 2

1. What do you mean by Gross Sustainable Development Product?

Answer: The Gross Sustainable Development Product is the total value of production after giving due care to the social capital and natural capital of a region over a specified period of time.

2. What is the Environmental Kuznets Curve?

Answer: In simple terminology, the EKV shows the relationship between the environmental degradation and the per capita income. The proponents of EKV are of the opinion that in the early stages of economic growth, degradation and pollution increases, but beyond some level of per capita income, the trend reverses, so that at high income levels, economic growth leads to environmental improvement. This implies the environmental impact indicator is an inverted U shaped function of per capita income.



UNIT 4 NATURAL RESOURCES

Structure

- 4.1 Introduction
- 4.2 Meaning and Types of Natural Resources
- 4.3 Biodiversity: Our Strength
- 4.4 Exploitation on Natural Resource
- 4.5 Threats to Biodiversity
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4.1 INTRODUCTION

One of the most critical issues on the national and global agenda is the need to preserve natural resources for future generations while trying to meet the present day requirements. Today, the entire world has awakened to the need for sustainable development by maintaining judicious use of the natural resources and adopting developmental models and policies which assure proper environmental protection. It is well known that, the humans all across the globe are not only polluting nature but also destroying it thorough an aggressive expansion of urbanization vis-à-vis consumerism. Some 11 thousand years back, agriculture started in the lap of nature and at its beginning, it was a beautiful synergy between human technique and rhythmic nature. This went on with smiling, dancing and rippling notes of traditional wisdom and bounties of nature. As an aftermath of Second World War and till then, unabated mechanization as well as increasing use chemicals have been transforming our agriculture into a huge source of pollution of the environment and nature.

After studying this unit, you should be able to understand:

1. the role of natural resource in the life human being
2. impact of development activities on the natural resource base
3. impact of development on the natural resource management strategies
4. role of various government bodies in the management of natural resources
5. factors responsible for the depletion and over exploitation of natural resources
6. various threats in the management of natural resources

4.2 MEANING AND TYPES OF NATURAL RESOURCES

Nature has been defined as the 'Omnipresent' expanses, definite and indefinite, created and evolving having all the biotic, a biotic and social dimension, evolving within and around life forms and life process. Natural resources has been defined as "the sum total of all physical, chemical, biological and social factors which construct the surroundings of man is referred to as environment and each element of these surroundings constitutes a resource on which man thrives in order to develop a better life". Any part of our natural environment, such as land, water, air minerals, forest, rangeland, wild life, fish, micro organisms or even human population – that man can utilize to promote the welfare, may be regarded as a natural resource. There are two types of natural resources viz. Exhaustible and Inexhaustible natural resources. Exhaustible resources are limited in nature and liable to be degraded in quantity and quality by the human activities. Examples are forests, soil, water and fossil fuels etc. Inexhaustible natural resources are unlimited in nature, and they are not likely to be exhausted by human activities, like solar radiation, air and precipitation etc.

Environment: The Environment is everything which surrounds an organism and influences its life in many ways. It includes physical and biological components. The physical components of the environment are soil, water, air, light and temperature. These are termed as abiotic components. The plants and animals are collectively referred to as biotic components. All these components of the environment work together, interact and modify the effect of one another.

Water: About 70-73% of earth is covered by water. Water is available in the form of oceans, seas, rivers, lakes, ponds, pools, polar ice caps and water vapor and this forms the hydrosphere. The main component of hydrosphere is water. Water exists in all the three forms i.e., solid (snow), liquid (water) and gas (water vapor).

Air: It is an inexhaustible natural resource and very essential for the survival of all the living organisms on earth. In atmosphere, about 95% of the total air is present up to a height of 20 km above the earth's surface. The remaining 5% of air is present up to a height of about 280 km. Air is a mixture of different gases; nitrogen and oxygen are the major components. Thus, total volume of air present in atmosphere consists of 78% nitrogen 21% oxygen and remaining 1% is made up of other gases such as argon, neon, helium, krypton, xenon and radon.

Soil: The word soil is derived from a Latin word '*solum*' meaning ground. It is a stratified mixture of inorganic and organic materials, both of which are products of decomposition.

Minerals: Earth's crust is rich in inorganic materials which include ores that are used on a large-scale to yield metals such as iron, aluminum, copper, tin, nickel, silver, gold, platinum etc. These minerals are very useful in industrial and technological growth. Some of the metals are used as catalysts, for e.g., vanadium, tungsten and molybdenum. Some of the non-metallic materials (minerals) are vital to industrial growth such as sand, fluxes, clay, salt,

sulphur, phosphorus, diamonds, gems, coal and by-products of petroleum (petrol, kerosene, lubricants).

Flora and fauna: Flora refers to plant species and fauna refers to animal species. The term biota includes both plant as well as the domesticated and wild species of animals. Our country has a rich diversity of flora and fauna. There are over 45,000 plant species and 81,251 animal species. It represents about 7% of world's flora and 6.5% of world's fauna.

4.3 BIODIVERSITY: OUR STRENGTH

Biodiversity is the variation of life forms within a given ecosystem, biome, or for the entire Earth. Biodiversity is often used as a measure of the health of biological systems. The biodiversity found on Earth today consists of many millions of distinct biological species, which is the product of nearly 3.5 billion years of evolution.

"Biological diversity" or "biodiversity" can have many interpretations and it is most commonly used to replace the more clearly defined and long established terms, species diversity and species richness. Biologists most often define biodiversity as the "totality of genes, species, and ecosystems of a region". An advantage of this definition is that it seems to describe most circumstances and present a unified view of the traditional three levels at which biological variety has been identified:

- genetic diversity
- species diversity
- ecosystem diversity

One of the most pressing issues on the national and global agenda is the need to conserve biodiversity for future generations while trying to understand and document the indigenous knowledge of resource management practices. So far, this challenge, has been partially addressed by the national and global agencies, who have restricted themselves to conservation of biodiversity as outlined by the World Commission on Environment and Development (1987), which led to calls for 'sustainable development'. As a result, the model of 'development' which was foisted upon the 'Third World' for the last fifty years, a strong argument has been made that development dictated from outside rather anchored in the knowledge base of the target population is in principle modernization disguised and not fully concerned with the local needs. Only recently it has been realized by the scholars and researchers that indigenous knowledge systems should constitute the core of development models in the third world. Because indigenous knowledge has permitted its holders to exist in 'harmony' with nature, allowing them to use it sustainably, it is seen as especially pivotal in discussions of sustainable resource use.

In agricultural systems, a diversity of crops and varieties is needed to combat the risks farmers face from pests, diseases and variations in climate. Crop biodiversity also underpins the breadth of dietary needs and services that consumers demand as societies become wealthier. For some time, scientific experts have been concerned about declining diversity of crop genetic resources on farms. Many argue that the very processes that engendered the

remarkable advances in agricultural productivity during the 20th century, such as the Green Revolution, also eroded the valuable stocks of genetic resources long maintained by farmers. The over all categories of floral and faunal biodiversity available to us is as under:

Flora

| Item | No. of species |
|--------------|----------------|
| Bacteria | 830 |
| Algae | 2500 |
| Fungi | 23000 |
| Lichens | 1600 |
| Briophyta | 2700 |
| Pteridophyta | 1022 |
| Gymnosperms | 64 |
| Angiosperms | 17000 |
| Total | 48736 |

Fauna

| Item | No. of species |
|------------|----------------|
| Fishes | 2546 |
| Amphibians | 204 |
| Reptiles | 428 |
| Birds | 1228 |
| Mammals | 372 |
| Total | 1,26,188 |

Protozans-2577, Porifera-519, Enidaria-237, Ctenophora-10, Platyhelminthis-1622 Ctenophora-10, Platyheminthis-1622, Nematoda-2350, Rotifern-310, Mollusca-5042, Anthrapoda-57525, Protocordata-116, Echinodermata-705, Annelida-1093.

You have read about meaning and types of natural resources, diversity: our strength. Now, answer the questions in Check Your Progress 1.

Check Your Progress 1

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit.

1. What do you mean by Natural Resources Management (NRM)?

2. What do you understand by biodiversity?

4.4 EXPLOITATION ON NATURAL RESOURCES

A number of activities relating to development including construction activities of all kinds, forest based industries, hydel /irrigation projects, mining, oil drilling, pollution, resource extraction and road and transportation put enormous pressure on natural resource base. There are some human induced activities, which relating to agriculture, fishery, expansion of forest villages, grazing/increased domestic animals habitat, habitat depletion / exchange due to horticulture, monoculture forestry have led to different kinds of encroachment on natural resource.

Collection made by scientific/ educational institution

- Exploitation by local authorities as revenue resource
- Fuel wood collection
- Food gathering
- Food hunting
- Smuggling of timber/ forest produce
- Trophies/ specimen collection of medicinal plants and orchids and
- Unregulated trade / market forces

Human induced disasters causing stress on Natural Resource

- Floods
- Major oil spills/ leakage
- Wildlife depredation
- Epidemic
- Forest fires due to humming and
- Intentional forest fire

Threats to NRM- Wrong and faculty Approaches

- Diseases
- Fire as management tool
- Genetic uniformity
- Hybridization
- Inadequate water and food for wildlife
- Increased competition
- Introduction of exotic species
- Lack of patronage of local / native species

Low population/ restricted range (protectionism)

Management of human resources

- Change in people's life style
- Conflicting / increasing demands
- Dilution of traditional values

Environment and Sustainable Development

- Erosion of indigenous knowledge
- Generation gap
- Human harassment
- Ignorance / lack of awareness
- Inadequate trained human resource
- Inappropriate land use
- Lack of effective management
- Negative attitude
- Tourism development

Political and policy issue

- Civil unrest / political movement
- Change in use/ tenure/ legal status
- Insurgency or armed conflict
- Intercommunity conflict
- Intervention failure
- Lack of clear policy implementation
- Lack of interdepartmental coordination
- Lack of intervention
- Military activities
- People's pressure

4.5 THREATS TO BIODIVERSITY

The following categories of threats have been recognized by International Union Council for Conservation Nature (IUCN):

Endangered

Under this category included taxa whose number have reduced to a critical level of whose habitats have been so drastically reduced that they are seemed to be in immediate danger of extinction e.g. : *Nepenthes khasiana*, *Rhinanthera imschootiana*, *Vanda cerulean*.

Vulnerable

Taxa likely to move into endangered category in near future, if the casual factors continue, operating included taxa of which most or all the population are decreasing because of over exploitation, extensive destruction of habitats or other environmental disturbances. For e.g. *Discora deltoidea*, *taxus wallichiana*.

Rare

Taxa with small world population that are not at present endangered or vulnerable but are at risk. These taxa are usually localized within restricted geographical areas or habitats or are thinly scattered over more extensive range. e.g. *Farictia macrantha*, *Rauwolfia serpentina*.

The term threatened is used in the conservation context for species which are in one of the three categories: Endangered, Vulnerable and Rare. India's biodiversity is one of the most significant in the world. As many as 45,000 species of wild plants and over 77,000 if wild animals have recorded, which comprise about 6.5 percent of the world's known wildlife. In the last few decade India has lost at least half it's forests, polluted over 70 percent of it's water bodies, built on or cultivated much of it's grasslands and degraded most of it's coast.

4.6 CONSERVATION OF BIODIVERSITY

Why Conservation?

Indian region is a treasure house at wild genetic resources. Wild species and relatives of crop plants contain valuable genes that are of immense genetic values in crop improvement programmes. The important wild related species and types in various crop groups, prevailing under different phyto-geographic zones at the country needs particular attention in the agro-biodiversity management system for a sustainable use to help maintain food, nutritional and agricultural economic security. The main objectives of biodiversity conservation are:

- The main objectives of the conservations are
- The conservation of biological diversity
- The sustainable use of component biodiversity

India's efforts for Biodiversity Conservation

Dr. M.S. Swaminathan (1983) suggested the following conservation measure

- Cultivated varieties in current use.
- Obsolete cultivars
- Primitive cultivars or land races
- Wild species and weedy species closely related to cultivated varieties
- Wild species of potential values to man
- Special genetic stock developed by man
- The fair and equitable sharing of benefits arising from the utilization of genetic resources.

In-situ Conservation

- It includes conservation of plant and animals in their native ecosystems or even in man made ecosystem, where they naturally occur.
- It applies only to wild fauna and flora.
- It aims at preservation of land races with wild relatives in which genetic exists.

Ex-situ Conservation

- It is done through establishment of gene banks.
- It is the chief mode for preservation of genetic resources

- Generally seeds or in-vitro maintained plants cells, tissue and organs are preserved under appropriate conditions.

The drawbacks of ex-situ conservation are:

- Loss of viability over passage of time and susceptibility to insect or pathogen attack.
- Inability to maintain distinct clones except for inbreed and apomicts species.
- Non-applicability to vegetative propagated crop.

4.7 MANAGEMENT OF NATURAL RESOURCES

There is an urgent need to think deeply about destruction of natural resources. With the exponential increase in human population and increased technological advancement, the natural resources get relentlessly exploited. There is a need for optimization of its usage. This is possible only when we adopt the concepts of management and conservation of natural resources. Management and conservation mean scientific utilization of resources while maintaining their sustained yield and quality. India produces only half of the national requirement of petroleum products and it imports the rest from other countries. Natural gas is the most popular petroleum product and its consumption during last two decades has increased tenfold. If we need to save fossil fuels from total exhaustion, we should encourage the usage of non-conventional resources of energy such as solar energy, wind energy, biomass energy etc. Biogas is a natural gas. It is produced from animal, water and weeds and other plants. India comes first in developing and using biogas technology. It is cheap, non-polluting and labor saving fuel. Biogas can be used for cooking, lighting and in vehicles.

According to world conservation strategy on natural resource management (NRM), it is the management of human use of the biosphere, lithosphere and hydrosphere so that it may yield the greatest sustainable benefit to the present generation, while maintaining its potential to meet the needs and aspiration, not the greed, of future generation. With the current rate of development, population growth and migration, communities are increasingly unable to meet their sustained needs, growing demand for fuel wood and other forest products, pollution due to industrialization and a market for rare animal species and medicinal plants have all threatened the biological diversity and thereby have hampered sustainable human development. Further the race for development and cultivation of improved varieties in larger area has threatened the biodiversity to a considerable extent. The complex dynamics of resource management system can be well understood by the flowchart (figure 1) and various issues/dimensions involved in resource management is represented in(figure 2).

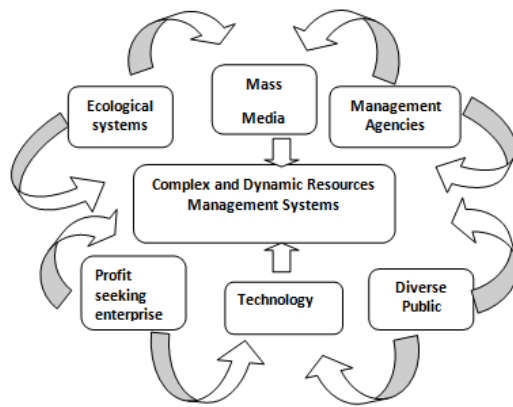


Figure 1: Complex and Dynamic Resources Management Systems

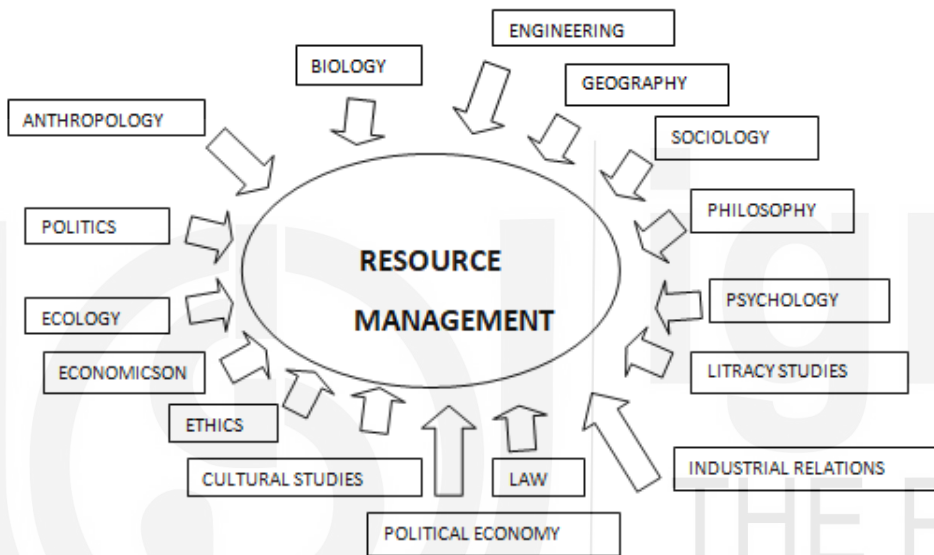


Figure 2: Various issues/dimensions involved in resource management

Meaning and Need for Resource Management

The main driving forces of resource consumption are population and economic growth, and the pattern of development, broadly defined to include technological level, economic structure, and the patterns of production and consumption. The projected 50 % growth in the global population over the next fifty years will put a significant pressure on the environment. If, over the next fifty years, the population of the developing countries achieves levels of material wealth similar to today's levels in industrialized countries, world consumption of resources would increase by a factor ranging from two to five. Without dramatic technological improvements or changes in the patterns of consumption, growth in resource use and environmental impacts due to increased population and economic growth in developing countries are likely to outweigh technological efficiency gains in industrialized countries.

Human wealth is based on the use and consumption of natural resources, including materials, energy and land. Continued increase in resource use and the related environmental impacts can have a multitude of negative effects leading to ecological crises and security threats. The sustainable use

and management of natural resources have therefore come into focus and has been the subject of many policy discussions over more than a decade, beginning with the summit in Rio de Janeiro in 1992.

Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber and fuel. This has resulted in substantial gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystems (Millennium Ecosystem Assessment, 2005). What is driving our material and energy use to the extent that it is becoming a global environmental problem and a threat to future generations? There is no simple answer to this question, because a number of interdependent socio-economic and environmental factors are at play. Nevertheless, there are three basic factors which determine the growth of resource consumption, and the resulting environmental impacts of human production and consumption patterns.

Management of Forests

The world forest is derived from the Latin word 'foris' meaning outside, the reference being to a village boundary or fence, and it must have included all uncultivated and uninhabited land. Today a forest is any land managed for the diverse purpose of forestry, whether covered with trees, shrubs, climbers, etc., or not. The Indian word 'jungle' has been adopted in the English language to describe a collection of trees, shrubs, climbers, etc., that are not grown in a regular manner, as contrasted with 'forest', which is any vegetation under a systematic management. Technically forest has been defined as:

- a. In general point of view a forest is an area set aside for the production of timber and other forest produce, or maintained under woody vegetation for certain indirect benefits which it provides, e.g. climatic or protective;
- b. In ecological point of view forest is a plant community predominantly of trees and other woody vegetation, usually with a closed canopy; and
- c. In logical point of view an area of land proclaimed to be a forest under a forest law.

Forestry is the theory and practice of all that constitutes the creation, conservation, and scientific management of forests and the utilization of their resources to provide for the continued production of the required goods and services. Forests are a very striking feature of the land surface. They vary greatly in composition and density, and stand in marked contrast with meadows and pastures. The scenic effect of forests changes with the seasons like the patterns in a kaleidoscope. Certain forests are evergreen, like the Deodar forests of Kashmir, while others are deciduous, becoming leafless either before the advent of winter when vegetative activity almost ceases, such as the oak forests of the Himalayas, or else just before the onset of intense dry summer, to reduce transpiration to the minimum, like the Teak forests of Central India. The falling leaves in some species become bright orange or golden yellow. In others the young foliage is pink. Such autumnal

and verbal tinges are in vivid contrast with the general green or straw-colored background, and are extremely pleasing. Unlike animals, plants do not have the power of locomotion. They also cannot construct shelters or generate heat to which stand the adverse effects of the environment of which they are captives. Therefore, to survive they wear the evidence of this fact in the form of structural adaptations, such as leaflessness in summer to minimize transpiration, thorns to ward off browsers, poisonous sap, etc.

The forests of a country are a natural asset of immense value. Unlike its minerals resources, including fossil fuels, which in course of time either get exhausted or their utilization will become uneconomic due to increased costs for obtaining and processing them, the forests, if of adequate extent, ideally dispersed, scientifically managed and judiciously utilized can be kept perpetually productive and useful, conferring many benefits, direct and indirect, on the people. Thus forests are a renewable resource. Directly, forests meet the needs of small timber, fuel, bamboos and a variety of other products, including fodder which is indispensable requirements of the people living in close proximity of the forests. They also provide facility for the grazing of their livestock, and yield a variety of products of commercial and industrial value such as structural timber, charcoal, and raw materials for making paper, newsprint, rayon, panel products, bidi leaves, gums, resin, dyes, tans and a number of other economic products including medicinal drugs. Forests also provide employment to a large population engaged in their protection, tending, harvesting and regeneration as also in ancillary occupations processing forest raw material and marketing them. These are productive functions of the forests.

Management of Soil Resources

Rapid deterioration of soil health and degradation of soil environment as a consequence of persistent nutrient depletion and operating process of erosion, salinisation, acidification and desertification have been at concern to a soil scientists in recent years as these are posing a threat to the potentiality of our soil resources to support the increasing food demands in future.

Soil Degradation

- Physical- Soil Erosion, Water Logging, Desertification, Compaction, Crusting, Overgrazing
- Chemical-Nutrient runoff, Acidification, Salinisation, Alkalinisation, loss of organic matter, Nutrient imbalance, Nutrient Depletion, Accumulation of toxicants.
- Biological-monoculture, pesticides and herbicides, Disposal of industrial waste, toxic containing sewage water, Genetic Manipulation
- Approaches towards soil conservation
- The primary purpose of soil conservation is to prevent soil erosion and heal the damage where it has not advanced too far to respond to curative methods.
- The land should wear a vegetative cover throughout the year.
- Engineering and agronomic practices should be applied conjointly.

Reclamation of eroded lands

- Ravines should be provided with sufficient and suitable vegetative cover.
- Instead of agriculture, these lands should be reclaimed for forestry, pasture or horticulture.
- Their deficiency in nutrients and moisture for plants growth should be improved.
- Further misuse of such land should be prevented. Over transplanting by man and cattle trails fenced etc.
- Vegetative cover provided, should be protected against reckless destruction by local population.

Measures for controlling soil erosion deposition hazard-

- Plantation at wind breaks and shelterbelts
- Sand dune stabilization
- Stubble mulching
- Wind string cropping
- Primary and secondary tillage
- Conserving soil moisture.

Management of Water Resources

Groundwater has been exploited in India quite substantially in the past few decades for irrigation. However, unlike surface water resources, there has been a conspicuous lack of scientific assessment of groundwater resources. Availability of this important natural resource has been taken for granted; utilization of ground water has not been commensurate with the available potential in a state e.g. about 86% in Gujarat and 3% in Assam indicating considerable regional imbalance. India has 4% of the world's water resources. The present water demand of India's agriculture is nearly 83 percent of the total water use in the country and shall not change appreciably by the end of the century. Use of most of the available water is for agriculture, and is confined to 33 percent irrigated area and the remaining 67 percent is still dependent on monsoon rains. The disproportionate use of water in certain pockets results in wastage as discernible from water logging of vast cultivable areas caused by the seepage and evaporation between dam gate and the field and only 15 percent of the wasteful flood irrigation method.

Excessive use of water makes the field more vulnerable to soil erosion. Irrigation, thus, can be identified as the most important single activity responsible for agriculture induced environmental stress although other activities such as deforestation for expanding agriculture, production oriented agronomic practices, use of fertilizers and plants protection chemicals have their individual contribution.

Approaches towards water conservation

Management at surface water resources such as

- Canal water

- Run-off water
- Khadins
- Nadis, Tanks
- Gully
- Plugging
- Water harvesting dams
- Water spreading
- Percolation tank

Management of ground water resources

The ground water resources in arid region have four major problems:

- Sixty five (65) percent area has saline ground water with total soluble salt content over 3200 ppm.
- Deep static water level
- Poor yield from wells
- Due to over exploitation, static water level started declining, soluble salt content have increased and yield reduced.

Following methods are available for artificially recharging the aquifers-

- Water spreading
- Recharging through pits
- Wells and shafts
- Pumping to induce recharge from surface water bodies

Extension approaches for NRM

- Creation of natural resources like forests, water bodies etc.
- Conservation of resources in an ecology niche.
- Regeneration of natural resources by organizing self-propelling processes.
- Preservation through social fencing.
- Recycling of waste water by products.
- Rejuvenation of degraded or age old resource base.
- Protection of target species.
- Pollution control through policy formulation.
- Elimination of negative factors operating in the eco-systems.
- Social fencing for protection, preservation.
- Integration of biotic, abiotic and social factors.
- Rationalization in the use of dwindling resources.
- ITK and ITW: appropriate use and application.
- Watershed management to generate livelihood and conserve natural resources.
- Monitoring : Benefit monitoring evaluation (BME)

- Auditing is required to get account of depletion and to suggest interventions
- People’s participation: this is the most important and critical to accomplish any objective in NRM.

You have read about exploitation of natural resources, threats to biodiversity, conservation of biodiversity and management of natural resources. Now, answer the question in Check Your Progress 2.

Check your progress 2

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit.

1. What are the important roles of forest in our society?

2. What are the right approaches of soil conservation?

4.8 LET US SUM UP

Natural resources has been defined as “the sum total of all physical, chemical, biological and social factors which construct the surroundings of man is referred to as environment and each element of these surroundings constitutes a resource on which man thrives in order to develop a better life”. Any part of our natural environment, such as land, water, air minerals, forest, rangeland, wild life, fish, micro organisms or even human population that man can utilize to promote the welfare, may be regarded as a natural resource. Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber and fuel. This has resulted in substantial gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystems Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber and fuel. This has resulted in substantial gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystems. There is an urgent need to conserve our natural resources for our survival and future generations.

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4.10 CHECK YOUR PROGRESS – POSSIBLE ANSWERS

Check Your Progress 1

1. What do you mean by Natural Resources Management (NRM)?

Answer: Natural resources has been defined as “the sum total of all physical, chemical, biological and social factors which construct the surroundings of man is referred to as environment and each element of these surroundings constitutes a resource on which man thrives in order to develop a better life”. Any part of our natural environment, such as land, water, air minerals, forest, rangeland, wild life, fish, micro organisms or even human population – that man can utilize to promote the welfare, may be regarded as a natural resource.

2. What do you understand about biodiversity?

Answer: Biodiversity is the variation of life forms within a given ecosystem, biome, or for the entire Earth. Biodiversity is often used as a measure of the health of biological systems. "Biological diversity" or "biodiversity" can have many interpretations and it is most commonly used to replace the more clearly defined and long established terms, species diversity and species richness. Biologists most often define biodiversity as the "totality of genes, species, and ecosystems of a region".

Check Your Progress 2

1. What are the important roles of forest in our society?

Answer: Forests are solely responsible for maintaining the water cycle, which includes the rain and ground water table. They also act as sink which absorbs the carbon dioxide and converts them into oxygen. They also maintain the balance between the floral and faunal biodiversity, while supplying a number of minor forest based products for our use.

2. What are the right approaches of soil conservation?

Answer: The good approaches towards soil conservation are:

1. The primary purpose of soil conservation is to prevent soil erosion and heal the damage where it has not advanced too far to respond to curative methods.
2. The land should wear a vegetative cover throughout the year.
3. Engineering and agronomic practices should be applied conjointly.



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