PREFACE

UGC (Open and Distance Learning Programmes and Online Progra With its grounding in the "guiding pillars of Access, Equity, Equality, Affordability and Accountability," the New Education Policy (NEP 2020) envisions flexible curricular structures and creative combinations for studies across disciplines. Accordingly, the UGC has revised the CBCS with a new Curriculum and Credit Framework for Undergraduate Programmes (CCFUP) to further empower the flexible choice based credit system with a multidisciplinary approach and multiple/ lateral entry-exit options. It is held that this entire exercise shall leverage the potential of higher education in three-fold ways – learner's personal enlightenment; her/his constructive public engagement; productive social contribution. Cumulatively therefore, all academic endeavours taken up under the NEP 2020 framework are aimed at synergising individual attainments towards the enhancement of our national goals.

In this epochal moment of a paradigmatic transformation in the higher education scenario, the role of an Open University is crucial, not just in terms of improving the Gross Enrolment Ratio (GER) but also in upholding the qualitative parameters. It is time to acknowledge that the implementation of the National Higher Education Qualifications Framework (NHEQF), National Credit Framework (NCrF) and its syncing with the National Skills Qualification Framework (NSQF) are best optimised in the arena of Open and Distance Learning that is truly seamless in its horizons. As one of the largest Open Universities in Eastern India that has been accredited with 'A' grade by NAAC in 2021, has ranked second among Open Universities in the NIRF in 2024, and attained the much required UGC 12B status, Netaji Subhas Open University is committed to both quantity and quality in its mission to spread higher education. It was therefore imperative upon us to embrace NEP 2020, bring in dynamic revisions to our Undergraduate syllabi, and formulate these Self Learning Materials anew. Our new offering is synchronised with the CCFUP in integrating domain specific knowledge with multidisciplinary fields, honing of skills that are relevant to each domain, enhancement of abilities, and of course deep-diving into Indian Knowledge Systems.

Self Learning Materials (SLM's) are the mainstay of Student Support Services (SSS) of an Open University. It is with a futuristic thought that we now offer our learners the choice of print or e-slm's. From our mandate of offering quality higher education in the mother tongue, and from the logistic viewpoint of balancing scholastic needs, we strive to bring out learning materials in Bengali and English. All our faculty members are constantly engaged in this academic exercise that combines subject specific academic research with educational pedagogy. We are privileged in that the expertise of academics across institutions on a national level also comes together to augment our own faculty strength in developing these learning materials. We look forward to proactive feedback from all stakeholders whose participatory zeal in the teaching-learning process based on these study materials will enable us to only get better. On the whole it has been a very challenging task, and I congratulate everyone in the preparation of these SLM's.

I wish the venture all success.

Professor Indrajit Lahiri
Vice Chancellor

Netaji Subhas Open University

Four-Year Undergraduate Degree Programme
Under National Higher Education Qualifications Framework (NHEQF) &
Curriculum and Credit Framework for Undergraduate Programmes

Subject : Honours in Geography (NGR)
Programme Code : NGR
Course Type : Discipline Specific Core (DSC)
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Module : 1

Module : 2

Module-1

Concept and Nature

Unit 1 ❑ Geographers' approach to environmental studies

Structure

1.0 Objective

Getting an overall idea of the environment and the various approaches to environmental studies.

1.1 Introduction

The study of environment is an interdisciplinary field that systematically studies human interaction with the environment in the interests of solving complex problems. It broadly includes the natural environment, human-made environment, and the relationship between them. C.C. Park, in 1980, referred to environment as a sum total of conditions which surrounded humans at a given point in space and time. The field deals with the basic principles of ecology and environmental science as well as associated subjects such as ethics, policy, politics, law, economics, philosophy, environmental sociology and environmental

justice, planning, pollution control and natural resource management.

1.2 Concept of Environmental Studies

Environmental study basically involves the study of total environment of the earth as a living planet having both physical and biotic components. The field of study encompasses the life layer of the earth in lithospheric, hydrospheric and atmospheric components, which supports all types of life. This life supporting layer is known as bio-sphere. It is characterized by the operation of several physical and biological processes, mutual interaction and interdependence of abiotic and biotic components of the bio-spheric ecosystem. The production and consumption of ecological resources, various positive and negative responses of interactions between different components of the environment result into stability or instability of the bio-spheric ecosystem at different levels (local, regional and global). This study also explains environmental degradation and pollution arising out of increasing pressure of economic and technological activities of humans on the environment. Renewed efforts have been undertaken by humans to stabilize the disturbed ecosystem, to conserve and mange the ecological resources and to ameliorate environmental degradation and pollution through different pollution control and abatement programmes. There are certain basic principles, which govern different aspects of environmental studies such as natural processes, both physical and biological in the life supporting layer (biosphere) and relationships between humans and environment. It is an integrated functional unit of the biotic and abiotic components of the environment, (Singh, S 2008).

Environmental geography provides analytical tools to assess the impact of anthropogenic activities on earth and address environmental issues and their possible solutions. It starts with the following propositions and assumptions.

1. Ecosystem is a fundamental unit for the study of environment.
2. Ecosystem is shaped by the endogenic and exogenic forces.
3. There is a continuous creation, maintenance, destruction and recreation of surface materials of the earth.
4. The earth's physical and biological processes operate in a cyclic manner.
5. Natural environmental system is governed by homeostatic or 'inbuilt self-regulating' mechanism.

6. There is a reciprocal relationship between the abiotic and biotic components of the natural environment.
7. The energy flow and circulation of nutrients in the ecosystem maintain life on the planet earth.
8. There are temporal and spatial variations in biotic and abiotic components in an ecosystem.
9. The diversity and complexity of the ecosystem enhance and maintaints stability.

Thus the subject of Environmental Geography can be perceived and evaluated in a variety of ways and approaches. The following principles and concepts of environmental study may be identified.

1. **Ecosystem is the fundamental ecological unit that includes** both the non-living (abiotic) and living (biotic) components of the earth. The earth is the only known planet having different kinds of life forms in a complex sets of interrelationships between the physical and biological components. Various linkages between the physical and the biological components at different levels maintain the bio-spheric ecosystem.
2. **The bio-spheric ecosystem is governed by discernible processes.** The physical and biological processes operate through a set of cycles as well as a set of sub-cycles. In fact, the endogenetic and exogenetic processes create different types of habitats on the earth surface for living organisms, on the one hand, and sometimes destroy the habitats, on the other hand. The driving force of the endogenetic processes comes from within the earth. Endogenetic forces create different types of relief features of various magnitudes on the earth's surface. Exogenetic forces are engaged ina continuous process of denudation of surface irregularities caused by endogenetic processes.
3. **Various physical, chemical and biological processes** are continuously engaged in the creation, maintenance, destruction and recreation of surface materials of the earth's surface (both organic and inorganic). These materials initially uncontaminated became contaminated and are seldom available for human use because either they are dispersed to such locations which may not be reached by humans for fairly long period of time, otherwise they become so deformed and contaminated that they are not reusable. Sometimes, some renewable natural resources are so

contaminated that they become non-renewable.

4. **Physical and biological processes operate according to the law of uniformitarianism.** The idea developed byJames Hutton along with Charles Lyell worked on two basic principles, (1) earth has always changed in uniform ways and (2) the present is thekey to the past. The very nature of the operation of the physical processes remains almost the same throughout the geologic history of earth though their frequency and magnitude may vary. So, the biological processes, which operate today might have operated in the past though with varying degree of relationships between biological communities and physical or natural environment and between organisms.

5. **Natural environmental system is governed by homeostatic mechanism.** Physical and biological processes of the natural environmental system operate in such a way that any change in any part of the environment at any place in a specific time period is suitably compensated by a negative feedback mechanism in a natural condition. Thus the natural environmental system has 'in-built self-regulating mechanism' known as homeostatic mechanism through which any change in the natural ecosystem is counter-balanced by responses of the system to the change and eventually, ecosystem stability or environmental equilibrium is restored. Sometimes this situation also leads to the evolution of new species. (Singh, S, 2008)

6. **There is a reciprocal relationship between abiotic and biotic components of the environment.** The physical processes create suitable habitats for biological communities on the one hand, biological communities (including humans) modify the environment, on the other hand. In fact, life continuest modify and alter atmospheric, lithospheric and oceanic components of the biosphere since the very beginning of life on earth.

7. **The energy flow and circulation of nutrients in the ecosystem help in the sustenance of life on earth.** Ecosystems are open systems characterised by continuous input of energy (solar radiation) and matter (nutrients) and output of energy and matter and they tend to be in relatively stable equilibrium unless there is disturbance in one or more controlling factors. The circulation of elements or matter or nutrients in the ecosystem is made possible through energy flow. So

energy flow is the main driving force of materials (nutrients) circulation in various biotic components of the ecosystem.

8. **There are temporal and spatial variations in species.** Darwin's theory of evolution of species states that there is a progressive evolution of species through the processes of natural selection and adaptation to environmental condition that lead to a gradual modification and diversification of species over a long period of time.
9. **Ecosystem diversity and complexity enhance and maintain ecological stability**. The stability of ecosystem refers to a balance between the production and consumption of each element of the ecosystem. It means a balance between input and output of energy and normal functioning of different biogeochemical cycles and the stable condition of concentration of all elements.

1.3 Scope of Environmental Studies

The interface of air, water and land, forming life supporting layer, known as biosphere, is the broadest geo-ecosystem that is the spatial unit for the study of environmental science.

Thus the prime concern of environmental study is to study the components of natural environment, separately and together, their linkages at various levels through environmental (physical) and biological processes and human responses to environment.

The scope of the study of environmental geography may be grouped into **9** major subfields:

1. The geo-ecosystem or simply ecosystem as a study unit.
2. The functioning of ecosystem including circulation of energy and matter and ecosystem productivity.
3. Temporal changes in ecosystem: Evolution of plants and animals, and ecological succession.
4. Spatial ecological changes, distribution and dispersal of plants and animals.
5. Global environmental problems.
6. Environmental hazards and disasters.
7. Human and environmental processes.

8. Environmental degradation and pollution.
9. Environmental management.

1.4 Approaches of Environmental Studies

An approach is a way of planning and procedure of getting closer towards some assumptions. The study of relationships between human and environment is a focal theme in the study of environmental geography. But the facets of humman-environment relationship change through time with the development of human society and the dimension of environment. Thus the human environment relationships can be perceived and evaluated in a variety of ways and approaches.

1.4.1 Environmental deterministic approach pays more attention to the complete control of physical environment on human and their activities. All aspects of human life viz. physical, social, economic, political, ethical and aesthetic etc. are dominantly controlled by physical environment. Although this deterministic or environmentalists approach blossomed in the writings of E.C. Semple (1910) in the second decade of the 20th century, its seeds were already sown in the second half of the nineteenth century. In fact, the publication of the book 'The Origin of Species' of Charles Darwin in 1859 laid the foundation stone of the concept of environmental influences on humans and other organisms.

The concept of environmentalism reached the highest point in1910 when American geographer E.C Semple published her book 'Influences of Geographic Environment'. According to Semple, "man is the product of the earth's surface. This means not merely that he is a child of the earth, dust of her dust, but the earth has mothered him, fed him, set him tasks, directed the thoughts, confronted him with difficulties that have strengthened his body and sharpened his wits, given him his problems of irrigation and navigation and at same time whispered hints for their solutions" (E.C. Semple, 1910)

The deterministic approach was fully organized on a scientific plane by E. Huntington. His books 'Civilisation and Climate' (1915), 'The Human and Habitat' (1927), 'Season of Birth' (1938) etc. clearly demonstrate the influences of physical environment on humans.

1.4.2 Teleological approach

The teleological approach is based on religious faith of man being superior to nature

and all other creatures. This approach of man-environment relationship led to excessive and rapid rate of exploitation of natural resources in North America and Western Europe as well as in other parts of the world which were their colonies. A host of scientists and environmentalists have held this religious tradition responsible for present-day ecological crisis. This approach of man towards nature and environment stimulated Europeans to spread all over the world in search of unexplored land and resources. Consequently, numerous colonies were established in all the inhabited continents. After 1750, there began a race for rapacious exploitation of natural resources and widespread industrialization in Europe and America. The process continued for the last three centuries and created most of the present-day environmental problems. (Husain, M, 2002).

1.4.3 Possibilistic approach

The possibilistic approach to the study of man-environment relationships emerged through the criticism of environmental determinism and overtone of teleological approach. Right from the inception of the school of environmental determinism there was dissenting voice raised by those who believed that 'no doubt physical environment influences man and his activities but there is ample scope for man to change the environment so much so that it becomes suitable for man and his society'. Husain, M (2002).

This concept of possibilism was founded by French historian Lucien Febvre. The environment sets certain constraints or limitations, but humans have the commanding power over the environment within certain limit.

Two French geographers, Vidal de la Blache and Jeans Bruhnes, and American geographers Isiah Bowman and Carl Sauer founded the school of possibilism which is based on the philosophy of possibilism in nature at every stage in a given space and time as remarked by Febvre, 'There are no necessities, but everywhere possibilities and man as a master of these possibilities is the judge of their use', (Husain, M, 2002).

1.4.4 Economic deterministic approach

This approach is based on the basic ideology of the man's mastery over environment and continued economic and industrial expansion through the application of modern technologies. Economic determinism is based on two assumptions, (i) positive correlation between population of a given region and the level of economic development and activity in that region, (ii) the interactions of people, resources and society being governed by universal economic principles.

This approach believes in man's ability to solve environmental problems arising out of continued economic growth and industrial expansion. It may be pointed out that this concept of economic determinism led to rapacious exploitation of natural resources in the western developed countries and thus created most of the environmental and ecological problems of global dimensions.

1.4.5 Ecological approach

Ecological approach to the study of man-environment relationships is based on the basic principles of ecology which is the study of mutual interactions between organisms and physical environment, on the one hand and interactions among the organisms, on the other hand in a given ecosystem. Thus, man is considered as an integral part of environment.

'The relationship of man with the natural environment should be symbiotic and not exploitative nor suppressive' (C.C. Park 1980). This school recognizes man, being most skilled and intelligent, as the leader of all biota of the earth. This approach further lays emphasis on wise and restrained use of natural resources, application of appropriate environmental management programmes, policies and strategies keeping in view the ecological principles so that already depleted natural resources are replenished (wherever possible), degraded environment is set right and ecological balance is maintained. The ecological approach lays emphasis on rational exploitation of resources and optimum utilization through recycling of resources, (Singh, S, 2008)

1.4.6 Geographical Approach

The Geographic approach refers to using geographic science supported by Geographical Informartion System (GIS) as a frame work for understanding our world and applying geographic knowledge to solve problems and guide human behaviour. This science provides humans with awareness, predictions and systematic information for planning and decision making. The understanding of the relationships between land use change, hydrology, flooding, biodiversity, etc. helps society become more conscious and a ware of the interrelatedness of our world and how our cumulative behaviour is affecting the evolution of the planet. Today GIS is extending the power of geography by providing digital tools that abstract and organize geospatial data, model geographic processes, and visualize these data and models with advanced computer techniques to solve a host of problems. For example, the use of GIS is valuable to select the route for a new highway. It will

consider all the physical and human factors for its layout and the design: the environment, existing land use, terrain, and social impacts, as well as engineering constraints and costs.

1.5 Summary and Conclusion

Environmental study considers all the aspects of environment. It not only discusses about the composition and components of the environment, but also deals with its quality, problems and solution. It evaluates various environmental systems and different approaches related to it. The complex physical, chemical and biotic factors such as climate, soil and living things that act on organisms and ecological communities, and ultimately, determine its form and survival. So, environmental study is that broad branch of science that tries to cover all the occurrencesof the environment under one canopy.

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Unit 2 ❑ Perception of Enviroment in different stages of Civilization

Structure

2.0 Objective

- To help the learners understand the changing perception of environment through the different stages of civilization.

2.1 Introduction

Environment plays a very significant role in human civilization. Trees, plants, creepers, water, river, air, etc. and different kinds of animals play a vital role towards human civilization. The survival of human being is perhaps impossible, even for a single moment, without nature or natural environment. The human being flourish in its lap and at the end take eternal rest therein. Any kind of intolerance and carelessness towards nature and natural elements may bring destruction to human civilization. So, the newly emerging concepts, like the concept of Environmental Awareness has moved into the mainstream of

public life as a major national and international concern intending to make aware about the role of nature in human life.

2.2 Concept of Civilization

Civilization is the process by which a society advances with its social and cultural attributes. A civilization in any complex society is characterized by urban development, social stratification imposed by the cultural elite, symbolic systems of communication (for example, writing systems), and a perceived separation from and domination over the natural environment. Civilizations are intimately associated with other socio-politico-economic characteristics, including centralization, domestication of both humans and other organisms, specialization of labour, culturally ingrained ideologies of progress and supremacism, monumental architecture, taxation, societal dependence upon farming and expansionism. Historically, civilization has often been understood as a larger and "more advanced" culture, in contrast to smaller primitive cultures. Similarly, some scholars have described civilization as being necessarily multicultural. In this broad sense, a civilization contrasts with non-centralized tribal societies, including the cultures of nomadic pastoralists, Neolithic societies or hunter-gatherers, but sometimes it also contrasts with the cultures found within thecivilizations themselves. In brief it refers to the process of a society developing into a centralized, urbanized, stratified structure.

Civilizations are organized in densely populated settlements divided into hierarchical social classes with a ruling elite and subordinate urban and rural populations, which engage in intensive agriculture, mining, small-scalemanufacture and trade. It concentrates power, extending human control over the rest of nature, including other human beings. Civilization, as its etymology suggests, is a concept originally linked to towns and cities. The earliest emergence of civilizations is generally associated with the final stages of the Neolithic revolution, culminating in the relatively rapid process of urban revolution and state formation, a political development associated with the appearance of a governing elite.

2.3 Concept of Environment

Now a day everyone is concerned about the protection and preservation of environment. Global summits are being held regularly to discuss environmental issues. During the last hundred years, the mutual relationship among environment, social organization and culture has been discussed in sociology, anthropology and geography showing

increasing importance of environment. In fact life is tied with the environment.

Social sciences have borrowed the concept of ecology from biology. As a branch of biology, ecology is the study of the relationship between living beings and their environment. Sociology has been greatly influenced by biology. Sociology also studies the relationship between man and environment through ecology. Field of study of human ecology in sociology is centered around man and his environment. The credit of beginning the study of human ecology in the field of sociology goes to Park and Burgess. There exists a close relationship between man and environment. On the one hand man is born in environment and establishes harmony with environment, on the other hand man tires to control his environment and change it according to his requirements. Hence it requires an understanding of the environment of which man is a part.

Environment

The term environment has been derived from a French word "Environia" means to surround. It refers to both abiotic (physical or non-living) and biotic (living) environment. The word environment means surroundings, in which organisms live. Environment and the organisms are two dynamic and complex component of nature. Environment regulates the life of the organisms including human beings. Human beings interact with the environment more vigorously than other living beings. Ordinarily environment refers to the materials and forces that surrounds the living organism. Environment is the sum total of conditions that surrounds us at a given point of time and space. It is comprised of the interacting systems of physical, biological and cultural elements which are interlinked both individually and collectively. Environment is the sum total of conditions in which an organism has to survive or maintain its life process. It influences the growth and development of living forms. It consists of atmosphere, hydrosphere, lithosphere and biosphere. P. Gisbertrefers environment as anything surrounding an object and exerting a direct influence on it while E. J. Ross explains environment as an external force which influences human being.

Components of Environment: Environment mainly consists of atmosphere, hydrosphere, lithosphere and biosphere. But it can also be divided into other types such as (a) Micro environment and (b) Macro environmentas well as (c) Physical and (d) biotic environment. Micro environment refers to the local surrounding of the organism. Macro environment refers to all the physical and biotic conditions that surround the organism externally. Physical environment refers to all abiotic factors like temperature, light, rainfall, soil, minerals etc. It comprises of atmosphere, lithosphere and hydrosphere. Biotic environment

includes all biotic factors or living forms like plants, animals, micro-organisms.

2.4 Civilization and the Environment

Anthropomorphic climate change, its associated consequences, and the delicate state of the natural world more generally are at the forefront of the new and emerging threats to civilization. In fact, the nature of humankind's largely exploitative relationship with the wider natural world in general is being called into question and is forcing some of us to seriously rethink that relationship. Rousseau characterized the relationship between human beings and the natural world as one marked by harmony and beneficence. But the history of civilization has in large part been about humankind's capacity to conquer nature: conquer the wild frontier, tame the animal world, and civilize the barbaric and savage peoples of our own species. As V. Gordon Childe (1948) explains, "progress" and "scientific discoveries promised a boundless advance in man's control over Nature." This attitude toward nature and natural resources has long predominated in European and Western thinking in particular. John Locke (1965), for instance, in his discussion of the Americas, Amerindians, and property rights, wrote, "Land that is left wholly to Nature, that hath no improvement of Pasturage, Tillage, or Planting, is called, as indeed it is, wast [waste]." The land was there to be improved and exploited in order to accommodate a greater number of people than the Amerindians were inclined to, and if they were not going to make appropriate use of it, then the British were entitled to take it—in fact, it was their duty to do so. As outlined above in relation to progress, a significant aspect of civilization revolves around evolving or developing, whether from a state of nature, savagery, or barbarism, toward urbanized, scientific, technological civilization. A large part of this evolutionary process concerns society's capacity to control nature and exploit its resources. This is illustrated by Adam Smith in 1869. He outlines four distinct stages of human social development. The first stage is "nations of hunters, the lowest and rudest state of society," his prime example being the "native tribes of North America." The second stage is "nations of shepherds, a more advanced state of society," such as that of the Tatars and the Arabs. But such peoples still have "no fixed habitation" for any significant length of time, as they move about on the "whim" of their livestock and with the seasons in the endless search for feed. The third stage is that of agriculture, which "even in its rudest and lowest state, supposes a settlement [and] some sort of fixed habitation." The fourth and most advanced stage is that of civilized, urbanized, commercial society, an efficient and effective exploiter of nature. The higher the

level of civilization, the greater will be the exploitation of nature; the greater the exploitation of nature, the more civilization will progress. But this relationship cannot go on forever. Natural resource extraction and exploitation is not a bottomless pit, but rather is finite and can only support so many people for so long. There are severe consequences associated with the processes of civilization, modernization, urbanization, and all that goes with them. The cycle of extracting more stuff from the ground, processing more stuff, building more stuff, producing more stuff, owning more stuff, throwing away more stuff, and buying more new stuff to replace it is proving unsustainable on such a large scale. The consequences of such excess, in the forms of environmental degradation and climate change, are many and varied; they include melting polar ice caps and rising sea levels, variations in air and sea temperatures, extended periods of drought in some parts of the world while others experience increased rainfall and flooding, and increasing frequency of extreme weather phenomena, to name just a few.

These environmental changes in turn impact our capacity to continue to inhabit certain parts of Earth and our ability to continue to utilize and exploit resources as we have done for centuries. These diverse changes and threats are often interrelated; one realm of security or insecurity can have a direct and dramatic impact on another, generating a kind of vicious cycle of insecurity. For instance, scarcity of and competition for essential resources such as land, food, water, and energy are potential catalysts for violent conflict. The period 2007–2008 witnessed violent food riots in as many as thirty countries around the globe. If the dire predictions are correct, then this is just the tip of the iceberg.

2.5 Changing perception of environment

Environmental perception has commonly been defined as awareness of the environment. American Psychologist William H. Ittelson (1973) described environmental perception as a multi-dimensional phenomenon, as a transactional process between the person and the environment. He analysed the dimensions of environmental experience into four major categories: the environment as external object, as representation of self, as embodiment of value and as arena for action.

The environment refers to anything external to the perceiver which influences the perception process. There is a close relationship between environmental situation and environmental perception.

The significant information are:

- Environments have no fixed or given boundaries to space and time.
- Environments provide information through all the senses.
- Environments include peripheral as well as central information.
- Environments include more information than can adequately be handled.
- Environments are experienced through action.
- Environments have symbolic meaning. Environmental experience always takes on the systematic quality of a coherent and predictable value.
- Environmental perception involves activity on our part in terms of Environmental Perception and Cognition of exploring the environment to determinewhat needs it meets.
- Environmental perception is likely to consider the person -environment relationship from a holistic system or transactional perspective.

We commonly think of perception of the environment as a passive process. People just sit back and absorb data from the environment. Under this way of thinking, culture acts as a distortion. There is one right way to think about the environment, but culture can bias or distortour understanding. We can call this belief in one correct perception of the environment objectivism. A better way of thinking about environmental perception is that perception is active. People seek out information about their environment based on what they need to know for their current projects or interests. In this way of thinking, culture acts as a guide or roadmap. Some people have taken this theory of activeperception as justification for being a relativist. Relativism is the opposite of objectivism. Pragmatism provides an alternative to either objectivism orrelativism.

Pragmatism says that we should judge perceptions of the environment according to how useful they are for people in getting along with their lives. But no one perception necessarily works best for every situation. However, there may be multiple ways of perceiving it, each of which may bemore or less useful for a given person's projects and interests.

To understand how different people come to different perceptions of the environment, we can use the framework of Grid-Group Cultural Theory(GGCT). GGCT was developed by anthropologist

Mary Douglas, who noticed that many groups — from the Lele tribe of Congo to

environmentalists in the United States — followed a fewsimilar patterns of social organization and environmental perception. She and her followerssystematized these similarities into a scheme of four basic worldviews: Individualism,Fatalism, Hierarchy, and Egalitarianism (Thompson et al 1990),

(Douglas and Ney 1998).

Individualism is a worldview based on freedom for individuals to compete for wealth and status. Individualists believe that as long as no artificial restraints are placed on anyone, then the marketplace will allow the best and most deserving to rise to the top. People who fall behind have only themselves to blame. Individualists tend to see the environment as resilient and robust. Nature will take care of itself and bounce back from whatever people do to it.

Therefore, people can be free to exploit it in order to get ahead — there is no need for any restrictions on freedom in order to promote conservation.

Fatalism is a worldview based on dealing with luck. Fatalists do not feel in control of their own fortunes. Both social and environmental forces are unpredictable and uncontrollable.

From a fatalist perspective, all that you can do is to enjoy your good luck while it lasts, and hunker down and try to survive when your luck turns bad. Any attempt to make long-term plans or to achieve social change is a waste of effort.

Hierarchy is a culture based on the promotion of order. Hierarchs seek a society in which everyone knows their place in the overall scheme of things, and people are ranked in order of holiness, expertise, seniority, or some other organizing principle. In this system, people lower on the chain have a duty to obey, while those in positions of authority have a duty to look out for the best interests of all of the people below them. Hierarchs see the world as having definite limits to how people can legitimately interact with it. It's fine to use resources, but only up to a certain limit. It is necessary to have experts, such as priests or scientists, who can determine where these limits lie, and then create and enforce rules so that nobody transgresses them.

Egalitarianism is a culture based on equality and solidarity. Egalitarians aim to live by a creed of sharing and brotherhood/sisterhood, in which no one person has authority or power over any other. The egalitarian way of life depends on shared commitment by all members — everyone has to go "all in" for the good of the group. Egalitarians tend to see the environment as extremely fragile. Fears of a catastrophic collapse – whether it be Armageddon or nuclear meltdown — help to keep up people's enthusiasm for focusing on

the good of the group and avoiding any search for individual advancement.

To illustrate how these worldviews work in practice, we can consider applying them to the issue of climate change. An individualist would tend to be sceptical that climate change is occurring.

A hierarch would focus on ways to regulate and control climate change. Hierarchs would want to scientifically determine the critical threshold at which climate change becomes irreversible and catastrophic — is it 450 parts per million of carbon dioxide in the atmosphere? 350 parts per million? Once this is determined, rules can be made that will ensure that nobody transgresses the threshold. This might come in the form, for example, of emissions permits that restrict the total emissions to under a certain amount. A hierarch's biggest fear is disorder — the anarchy of the market in which people have no respect for the rules that ought to limit their behavior.

An egalitarian sees climate change as confirmation that the environment is fundamentally fragile. Improper behavior aimed at aggrandizing the individual or society has put us out of balance with nature, and now we are getting our comeuppance. The egalitarian solution lies in adopting a simple way of life. Any interference with nature's balance is potentially dangerous, so we should be aiming to move quickly to a zero-carbon society rather than permitting some acceptable amount of emissions.

2.6 In the context of geography, we can identify the following perception of the environment

- **Deterministic view:** Put forward by a number of geographers like Humboldt, Ritter, Ratzel, Huntington, Semple and many others, this school views environment as the supreme power which affects and moulds every aspect of human life. The environment dictates how people will live, what they will eat and wear, even their rites, rituals and religious belief.
- **Possibilistic view:** Put forward by Paul Vidal de la Blache, this viewpoint says that environment presents a number of choices in front of human groups. The choice that the group will make will depend on cultural factors like the actions of their forefathers and religious and cultural beliefs and practices. Hence, the choice may not always be the easiest or the most logical alternative offered by the

environment.

Overall, it is technology which has played an overwhelming role in defining the changing perception of the environment among human societies. Those which used rudimentary technology were at the mercy of the environment and hence perceived it as all powerful. Those societies which developed advanced technology and gradually overcame the difficulties and problems posed by nature rose over this. They began to perceive the environment as resource which can be put to their use to fulfil their various wants and needs.

2.7 Impact of Civilization on Environment

Humanity exacts a terrifying toll on the planet. After all, everything we build or consume comes out of our environment. It all requires a portion of the world and changes that portion in the process. Varied woodlands become a ubiquitous field of corn. A wilderness becomes a grid of streets, lights and skyscrapers. What's more, we remake the world a little more to our liking every day.

To better gauge civilization's impact on the environment, scientists developed eco-footprint analysis (EFA) to measure just how much land is necessary to support a particular segment of the population's consumption level. By this metric, we can judge how much of a demand individual demographics put on nature. People in developed countries such as the United States and Japan, for instance, each require an estimated 10 to 25 acres of land to support their lifestyle. According to population ecologist William E. Rees, the global average breaks down to 5.4 acres per person. Unfortunately, the planet has only enough bio productive surface area to allot 4.4 acres to each of its 6.8 billion residents. Human civilization's ecofootprint is already 22 percent beyond sustainable levels. So far in human history, this insatiable hunger has led to the extinction of countless species, ranging from the woolly mammoths of the Ice Age to the Tasmanian tiger in the 20th century. Even the Nebio-sphericerthals fell to human clubs and human competition for resources. Other species have thrived, either through cultivation and domestication or reckless introduction into new local ecosystems.

We've turned deserts into farmlands and gorges into artificial lakes; we've erected architectural colossi to house both our living and our dead. Even the atmosphere itself has

changed due to our bottomless hunger for resources. Many scientists date human-influenced global climate change back to the Industrial Revolution of the 1800s. Others, such as environmental scientist William F. Ruddiman, insist that carbon dioxide concentrations began to rise 8,000 years ago due to early slash-and-burn agriculture practices. Pollution has also taken its toll on the environment, poisoning ecosystems with harmful chemicals and littering them with refuse. Garbage dumps have become favoured hangouts for advantageous species such as rats and seagulls. Sunken ships and ruined piers have become new underwater habitats. Along with human enterprise, human conflict has also altered the environment. For example, more than three decades after the Vietnam War, the local ecosystem is still rife with craters, unexploded ordnance and widespread toxic residues that span the entire food chain. Some critics of this form of warfare even go so far as to brand it "ecocide" and petition for its inclusion in international law.

2.8 Rethinking about Civilization

Just over a couple of hundred years ago, Edward Gibbon (1963) wrote that humankind may "acquiesce in the pleasing conclusion that every age of the world has increased and still increases the real wealth, the happiness, the knowledge, and perhaps the virtue, of the human race." In many ways, the record of human history bears this out: for example, the life expectancy of a Roman during the days of the empire was around twenty-five years. Today the world average life expectancy is somewhere in the mid- to late sixties, and life expectancy is considerably higher in many parts of the world due to advances in science and technology. (Kinsell 1992; Galor and Moav 2005). The twentieth century also witnessed unprecedented urbanization, a key marker of progress and development, with an increase from 220 million urban dwellers, or around 13% of the world's population, at the beginning of the century to 732 million or 29% by mid-century and reaching around 3.2 billion people or 49% in 2005. With urbanization expected to continue apace, it is estimated that by 2030 almost 5 billion people will live in cities, equivalent to roughly 60% of the global population (United Nations 2005).

2.9 Summary and Conclusion

Today, most advanced societies view themselves as the lord and master of their

environment. Since the second half of the last century, scholars have been pointing out the dangers of thinking like this and a gradual change in the perception of the environment has begun to set in. Now, it is regarded as something to be protected and preserved. However, the perception of the environment continues to be vastly different in different societies and economies. This is probably the reason why most international efforts to protect the environment ends in failure.

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Unit 3 ❑ Concept of Holistic Environment and Systems Approach

Structure

3.0 Objective

- The learners will get an overall idea about the concept of Holistic Environment and systems approach.

3.1 Introduction

Environments present in different forms - global, physical, cultural, internal, political and social. Together they make up our holistic environment. The idea deals with exploring possibilities and developing benevolent co-existence of all beings on the earth. So it is both encompassing and inclusive and sees the life on the planet as a whole.

3.2 Concept: Scope and Nature

First formulated by Jan Smuts, holism has been traditionally defined as a philosophical theory. The theory states that the determining factors in nature are wholes which are irreducible to the sum of their parts and that the evolution of the universe is the record of the activity and making of such wholes. More generally, it is the concept that wholes cannot be analyzed into parts or reduced to discrete elements without unexplainable residuals. The

holistic approach in ecology and environmental science derives from the idea proposed by Harrison Brown that "a precondition for solving (complex) problems is a realization that all of them are interlocked, with the result that they cannot be solved piecemeal." For some scholars holism is the rationale for the very existence of ecology. As David Gates notes, "the very definition of the discipline of ecology implies a holistic study."

3.3 Aspects

The aspects that best describe a holistic environment include:

1. Basis: For an environment to be holistic, it should be based on values that are important to humanity such as love and care. People have a deep concern for their home, their community, their environment. People don't just live for now, but they also need to leave a good sustainable environment for the next generations.

2. Scope : A holistic environment takes into consideration the other forces such as cultural environment, political environment and the global environment.

3. Value : A holistic environment is timely and relevant. It tries to give the needs of the people at the present time. The environment should be valuable to the existing users or caretakers.

The holistic approach to environment does not deal solely with one segment of environment, but it sees the life on the planet as a whole. Its aim is to promote benevolent co-existence of all beings on Earth taking the perspective of science and finding the solutions to the environmental issues of today.

The holistic approach to environment does not only set the question of how to achieve the goal, but also WHY it is necessary and if it contributes to benevolent co-existence of all beings.

Philosophers divide their "love of wisdom" in various ways. Three common sectors are, (1) what we know as real and important (ontology), (2) the ways we get that knowledge (epistemology), and (3) how in the light of knowledge we conduct ourselves (ethics). The three are connected like the points of a triangle; they reinforce one another so that cultural foolishness or wisdom shifts with the times, depending on what is known, how it is known, and what people feel committed to do about it.

Ever since the Renaissance, epistemology has been strongly influenced by science with its analytic and objective method of obtaining knowledge. Within the same time span, as

theism faded, humanity moved to the centre of ontology's stage. The ethic that emerged in harmony with science and humanism is the prevalent one of individuality and self-aggrandizement.

If *Homo sapiens* is the central reality of the universe, then human rights are the sole focus of ethical concern. Further, science is the appropriate way of knowing, for what else so effectively promotes human interests and human power over everything else? But if things other than humans are of surpassing importance, as today's deteriorating world leads some to suspect, then the conventional mode of knowing and the conventional individualistic ethic are called into question. Reconception of reality, of what is centrally important, can open avenues of escape from tradition's species-centred ethic and the mode of knowing that serves it.

What humanity's leading vision and direction will be is today's portentous question. The history of where humankind has been in thought and action, and how the race has arrived at its present difficulties, is interesting but less important. The modern age has produced many theories as to what has gone wrong but few visions of what, from here on, might go right. To fulfil its promise, ecological philosophy needs to launch an imaginative quest for an attractive, rational future.

3.4 Environment as the Level-of-Integration above the individual

Of all the words commonly used in discussions of ecological integrity and deterioration, "environment" is surely the vaguest. That it stands for something important is attested by the many agencies and departments of government that busy themselves with managing its parts and by the army of environmentalists eager to defend them.

Yet beyond general statements pointing up, down, and around, to the air, soil, water, food, forests, wildlife, natural resources, wilderness, parks, cities, culture, society, and especially whatever impacts on community health, few agree about the exact referent of the word "environment."

The Australian Environment Protection Act defines "environment" as "including all aspects of the surroundings of man whether affecting him as an individual or in his social groupings." A proprietary essence is distilled by the Canadian Study Group on Environmental

Assessment Hearing Procedures in identifying environment as "a collectively shared property." Ontario's Act Respecting Environmental Rights gives a more detailed and representatively chaotic definition, taking environment to mean:

The term holism was introduced by the South African statesman Jan Smuts in his 1926 book, Holism and Evolution. Smuts defined holism as "The tendency in nature to form wholes that are greater than the sum of the parts through creative evolution."

The idea has ancient roots. Examples of holism can be found throughout human history and in the most diverse socio-cultural contexts, as has been confirmed by many ethnological studies. The French Protestant missionary, Maurice Leenhardt coined the term *cosmomorphism* to indicate the state of perfect symbiosis with the surrounding environment which characterized the culture of the Melanesians of New Caledonia. For these people, an isolated individual is totally indeterminate, indistinct and featureless until he can find his position within the natural and social world in which he is inserted. The confines between the self and the world are annulled to the point that the material body itself is no guarantee of the sort of recognition of identity which is typical of our own culture.

Ecology is the leading and most important approach to holism, as it tries to include biological, chemical, physical and economic views in a given area. The complexity grows with the area, so that it is necessary to reduce the characteristic of the view in other ways, for example to a specific time of duration.

John Muir, Scottish-born American naturalist and conservationist wrote "When we try to pick out anything by itself we find it hitched to everything else in the Universe"

3.5 Systems approach

The systems approach is an old concept. The approach stands on the assumption that breaking down a complex system into a simple one makes it easier to understand the complexity. Ludwig *von* Bertalanffy, an Austrian biologist, first proposed the systems approach under the name of 'General System Theory' in 1940 and published it in 1968 (Ludwig *von* Bertalanffy,1968). He introduced system as a new scientific philosophy and defined it in a formal manner. He noted that most systems (biological or physical) of any practical *relevance* are open as they interact with the *environment.* Therefore, to understand the system it has to be differentiated from the *environment, i.*e., the boundary of the system has to be clearly defined along with its interaction with the *environment* from within

this boundary.

The approach concentrates on the holistic entity of the system without neglecting the components. It attempts to understand the role each component plays in the system while simultaneously understanding the activity of the whole system. Major concepts of the systems approach are:

1. **Holism:** A change in any part/component of a system that affects the whole system directly or indirectly.
2. **Specialization:** A whole system can be divided into granular (smaller easy to understand) components so that the specialized role of each component is appreciated.
3. **Non-summational:** Every component (subsystem/partial system) is of importance to the whole. It is therefore essential to understand the actions of each component to get the holistic perspective.
4. **Grouping:** The process of specialization can create its own complexity by proliferating the components with increasing specialization. To avoid this it becomes essential to group the related disciplines or sub-disciplines.
5. **Coordination:** The grouped components and sub-components need coordination. Without coordination, the components will not be able to work in a concerted manner and will lead to chaos. Coordination and control is a very important concept in the study of systems as without this we will not be able to develop a unified holistic concept.
6. **Emergent properties:** This is an important concept of systems approach. It means that the group of interrelated entities (components) has properties as a group that is not present in any individual component. This is the holistic view of a system. For example, multicellular organisms exhibit characteristics as a whole which are not present in individual constituent parts like cells.

3.6 Summary and Conclusion

Thus, the holistic approach to environmental issues involves acknowledging the interconnectedness of issues that affect the environment in any development process.

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Unit 4 ❑ System Approach in Environment Geography

Structure

4.0 Objective

- The learners will know about the scientific method that are connected with inputs and processes.

4.1 Introduction

The system approach in environmental geography is a holistic method of studying the Earth's environment by examining the interactions between different components. It helps geographers understand how natural and human systems interact and influence each other over time. This approach emphasizes the interdependence of biotic and abiotic factors and provides a framework for analyzing environmental problems and their solutions.

4.2 Definition of System Approach

The system approach in environmental geography is a scientific method that examines the Earth as a complex system composed of interconnected subsystems. If focuses on inputs, processes, and outputs, considering both natural and human-induced changes. This approach helps in understanding the dynamic relationships among various environmental components such as the atmosphere, hydrosphere, lithosphere and biosphere.

Key Concepts of the System Approach

1. **System Components**

   Inputs : Energy and matter that enter a system (e.g., solar radiation, precipitation, nutrients).

   Process : Mechanisms that transform inputs (e.g., photosynthesis, erosion, chemical weathering).

   Outputs : Energy and matter that leave the system (e.g., heat, water runoff, sediments).

2. **Types of Systems**

   Open System : Exchanges energy and matter with its surroundings (e.g., a river system).

   Closed System : Exchanges only energy but not matter with the surroundings (e.g., the Earth in terms of matter).

   Isolated System : No exchange of energy or matter (theoretically, but not applicable to natural systems).

3. **Feedback Mechanisms**

   Positive Feedback : Enhances or amplifies changes, leading to instability (e.g., global warming causing ice melt, which reduces albedo and increases warming).

   Negative Feedback : Counteracts changes, leading to stability (e.g., cloud formation cooling the Earth's surface).

4. **Equilibrium :**

   Static Equilibrium : No changes over time (rare in nature).

   Dynamic Equilibrium : Continuous adjustments while maintaining balance (e.g., coastal erosion and deposition).

   Metastable Equilibrium : Sudden shifts after surpassing a threshold (e.g., landslides due to excessive rainfall).

4.3 Application of System Approach in Environmental Geography

1. **Ecosystem Analysis :** The system approach helps in studying ecosystems by analyzing the flow of energy and nutrients. For example, the carbon cycle explains how carbon moves through the atmosphere, hydrosphere, lithosphere, and biosphere.

2. **Hydrological Cycle :** The movement of water through precipitation, evaporation, infiltration, and runoff is analyzed using the system approach, helping in water resource management and flood control.
3. **Climate Change Studies :** By understanding how different environmental components interact, scientists can model climate change impacts, such as rising sea levels, changing weather patterns, and biodiversity loss.
4. **Urban and Industrial Systems :** The approach is used to study human-environment interactions, such as pollution management, waste recycling, and sustainable urban planning.
5. **Natural Hazards and Disaster Management :** It helps in predicting and mitigating environmental hazards like earthquakes, tsunamis, and hurricanes by analyzing system feedback and thresholds.

4.4 Advantages of the System Approach

Provides a holistic understanding of environmental processes.

Helps in predicting changes and managing resources sustainably.

Facilitates interdisciplinary studies, integrating physical and human geography.

Useful in policy-making and environmental conservation.

4.5 Challenges of the System Approach

Complexity in analyzing multiple interactions.

Requires large datasets and computational modeling.

Uncertainties in predicting long-term environmental changes.

4.6 Conclusion

The system approach in environmental geography is essential fr understanding the dynamic relationships between natural and human-induced processes. It provides a structured method for analyzing environmental changes and developing sustainable solutions. By integrating physical, biological and human systems, this approach plays a crucial role in addressing contemporary environmental challenges.

Unit 5 ❑ Ecosystem: Concept, Structure and Functions

Structure

5.0 Objective

- The learners will identify with the different terms relating to Ecosystem and develop an overview of its functioning of the ecosystem.

5.1 Introduction

Concept of an Ecosystem:

Living organisms cannot live isolated from their non-living environment because the latter provides materials and energy for the survival of the former i.e. there is interaction between a biotic community and its environment to produce a stable system; a natural self-sufficient unit which is known as an ecosystem. An ecosystem is, therefore, defined as a natural functional ecological unit comprising of living organisms (biotic community) and their non-living (abiotic or physio chemical) environment that interact to form a stable self-supporting system. A pond, lake, desert, grassland, meadow, forest etc. are common examples of ecosystems.

The term ecosystem was coined in 1935 by the Oxford ecologist Arthur Tansley to encompass the interactions among biotic and abiotic components of the environment at a given site. The living and non-living components of an ecosystem are known as biotic and abiotic components, respectively. Ecosystem was defined in its presently accepted form by Eugene Odum as, "an unit that includes all the organisms, i.e., the community in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycles, i.e., exchange of materials between living and non-living, within the system".

Smith (1966) has summarized common characteristics of most of the ecosystems as follows:

1. The ecosystem is a major structural and functional unit of ecology.
2. The structure of an ecosystem is related to its species diversity in the sense that complex ecosystem have high species diversity.
3. The function of ecosystem is related to energy flow and material cycles within and outside the system.
4. The relative amount of energy needed to maintain an ecosystem depends on its structure. Complex ecosystems needed less energy to maintain themselves.
5. Young ecosystems develop and change from less complex to more complex ecosystems, through the process called succession.
6. Each ecosystem has its own energy budget, which cannot be exceeded.
7. Adaptation to local environmental conditions is the important feature of the biotic components of an ecosystem, failing which they might perish.
8. The function of every ecosystem involves a series of cycles, e.g., water cycle, nitrogen cycle, oxygen cycle, etc. These cycles are driven by energy. A continuation or existence of ecosystem demands exchange of materials/nutrients to and from the different components.

5.2 Structure and Function of an Ecosystem

Each ecosystem has two main components: (1) Abiotic (2) Biotic

(1) Abiotic Components: The non living factors or the physical environment prevailing in an ecosystem form the abiotic components. They have a strong influence on the structure, distribution, behaviour and inter-relationship of organisms.

Abiotic components are mainly of two types:

(a) Climatic Factors include rain, temperature, light, wind, humidity etc.

1. (b) Edaphic Factors include soil, topography, minerals etc. The functions of important factors in abiotic components are given below: Soils are much more complex than simple sediments. They contain a mixture of weathered rock fragments, highly altered soil mineral particles, organic matter, and living organisms. Soils provide nutrients, water, a home, and a structural growing medium for organisms. The vegetation found growing on top of a soil is closely linked to this component of an ecosystem through nutrient cycling. The atmosphere provides organisms found within ecosystems with carbon dioxide for photosynthesis and oxygen for respiration. The processes of evaporation, transpiration and precipitation cycle water between the atmosphere and the Earth's surface. Solar radiation is used in ecosystems to heat the atmosphere and to evaporate and transpire water into the atmosphere. Sunlight is also necessary for photosynthesis. Photosynthesis provides the energy for plant growth and metabolism, and the organic food for other forms of life. Most living tissue is composed of a very high percentage of water, up to and even exceeding 90%. The protoplasm of a very few cells can survive if their water content drops below 10%, and most are killed if it is less than 30-50%. Water is the medium by which mineral nutrients enter and are translocated in plants. It is also necessary for the maintenance of leaf turgidity and is required for photosynthetic chemical reactions. Plants and animals receive their water from the Earth's surface and soil. The original source of this water is precipitation from the atmosphere.(Singh, S, 2008)

(2) Biotic Components: The living organisms including plants, animals and micro-organisms (Bacteria and Fungi) that are present in an ecosystem form the biotic components.

On the basis of their role in the ecosystem the biotic components can be classified into three main groups:

(A) Producers (B) Consumers (C) Decomposers or Reducers.

(A) **Producers:** The green plants have chlorophyll with the help of which they trap solar energy and change it into chemical energy of carbohydrates using simple inorganic compounds namely water and carbon dioxide. This process is known as photosynthesis. As the green plants manufacture their own food they are known as Autotrophs

(i.e. auto = self, trophos = feeder) The chemical energy stored by the producers is utilised partly by the producers for their own growth and survival and the remaining is stored in the plant parts for their future use.

(B) **Consumers**: The animals lack chlorophyll and are unable to synthesise their own food. Therefore, they depend on the producers for their food. They are known as heterotrophs (i.e.heteros = other, trophos = feeder) The consumers are of four types, namely: (a) Primary Consumers or First Order Consumers or Herbivores: These are the animals which feed on plants or the producers. They are called herbivores. Examples are rabbit, deer, goat, cattle etc. (b) Secondary Consumers or Second Order Consumers or Primary Carnivores: The animals which feed on the herbivores are called the primary carnivores. Examples are cats, foxes, snakes etc. (c) Tertiary Consumers or Third Order Consumers:

These are the large carnivores which feed on the secondary consumers. Example are Wolves. (d) Quaternary Consumers or Fourth Order Consumers or top predators or Omnivores: These are the largest carnivores which feed on the tertiary consumers and are not eaten up by any other animal. Examples are lions and tigers.

(C) **Decomposers or Reducers**: Bacteria and fungi belong to this category. They breakdown the dead organic materials of producers (plants) and consumers (animals) for their food and release to the environment the simple inorganic and organic substances produced as by-products of their metabolisms. These simple substances are reused by the producers resulting in a cyclic exchange of materials between the biotic community and the abiotic environment of the ecosystem. The decomposers are known as Saprotrophs (i.e., sapros = rotten, trophos = feeder)

So an ecosystem has physical, chemical, and biological components along with energy sources and pathways of energy and materials interchange. The environment in which a particular organism lives is called its habitat. The role of an organism in a habitat is called its niche.

For the study of ecology it is often convenient to divide the environment into four broad categories.

1. Terrestrial environment - The terrestrial environment is based on land and consists of biomes, such as grasslands, one of several kinds of forests, savannas, or deserts.

2. Freshwater environment - The freshwater environment can be further subdivided between standing-water habitats (lakes, reservoirs) and running-water habitats (streams, rivers).
3. Oceanic marine environment - The oceanic marine environment is characterized by saltwater and may be divided broadly into the shallow waters of the continental shelf composing the neritic or sub-littoral zone where sunlight reaches the floor
4. Oceanic region - The deeper waters of the ocean that constitute the oceanic region where there is not enough light for photosynthesis.

5.3 Subdivision of modern ecology

Two major subdivisions of modern ecology are

- Ecosystem ecology - which views ecosystems as large units, and
- Population ecology - which attempts to explain ecosystem behaviour from the properties of individual units.

In practice, the two approaches are usually merged. Descriptive ecology describes the types and nature of organisms and their environment, emphasizing structures of ecosystems and communities and dispersions and structures of populations. Functional ecology explains how things work in an ecosystem, including how populations respond to environmental alteration and how matter and energy move through ecosystems. Ecosystems are broadly divided into natural and artificial. Natural ecosystems are those that are existing in nature; they are further classified into terrestrial and aquatic.

Terrestrial includes hot desert, grass land, tropical and temperate rainforest and aquatic includes ponds, river, streams, lakes, estuaries, oceans, mangroves, swamps and bays etc. However, these two ecosystems are self-regulating, open system with a free exchange of inputs and outputs with other systems. Artificial ecosystems are simple, human-made, unstable and subjected to human intervention and manipulation. Usually it is formed by clearing a part of the forest or grassland e.g. crop field, agricultural land.

5.4 Functions of an Ecosystem

Natural processes, in turn, are the result of complex interactions between biotic (living organisms) and abiotic (chemical and physical) components of ecosystems through the universal driving forces of matter and energy. Four primary groups of ecosystem functions are

(1) Regulatory functions, (2) habitat functions, (3) production functions and (4) information functions.

General characterization of ecosystem functions are

(1) **Regulatory functions**: This group of functions relates to the capacity of natural and semi-natural ecosystems to regulate essential ecological processes and life support systems through bio-geochemical cycles and other bio-spheric processes. In addition to maintaining the ecosystem (and biosphere health), these regulatory functions provide many services that have direct and indirect benefits to humans (i.e., clean air, water and soil, and biological control services).

(2) **Habitat functions:** Natural ecosystems provide refuge and a reproduction habitat to a variety of species, plants and animals and, thereby contribute to the conservation of biological and genetic diversity and the evolutionary process.

(3) **Production functions:** Photosynthesis and nutrient uptake by autotrophs converts energy, carbon dioxide, water and nutrients into a wide variety of carbohydrate structures which are then used by secondary producers to create an even larger variety of living biomass. This broad diversity in carbohydrate structures provides many ecosystem goods for human consumption, ranging from food and raw materials to energy resources and genetic material.

(4) **Information functions**: Since most of human evolution took place within the context of an undomesticated habitat, natural ecosystems contribute to the maintenance of human health by providing opportunities for recreation, cognitive development and aesthetic experience.

5.5 Components of an ecosystem

Acomplete ecosystem consists of four basic components such as producers, consumers, decomposers and abiotic components e.g. Pond. If anyone of these four components are lacking, then it is grouped under incomplete ecosystem e.g. ocean depth or a cave.

Productivity in the Environment: The productivity of an ecosystem is the rate at which solar energy is fixed by the vegetation of the ecosystem; it is further classified into primary productivity, secondary productivity and net productivity.

Primary productivity refers to the rate at which radiant energy is stored by photosynthetic and chemosynthetic activity of producers; it is further distinguished as gross primary productivity (GPP) and net primary productivity (NPP). It is expressed in terms of weight (g/m2 /yr) or energy (kcal/m2). Secondary productivity refers to the rates of energy storage at consumer levels.

An understanding of ecology is essential in the management of modern industrialized societies in ways that are compatible with environmental preservation and enhancement. The branch of ecology that deals with predicting the impacts of technology and development and, making recommendations such that these activities will have minimum adverse impacts, or even positive impacts, on ecosystems may be termed as Applied Ecology. It is a multidisciplinary approach.

Interactions among living organisms are grouped into two major groups viz.,

- Positive interactions
- Negative interactions

In positive interaction the populations help one another, the interaction being either one way or reciprocal. These include (i) commensalism, (ii) proto co-operation and (iii) mutualism.

1. **Commensalism**: In this, one species derives the benefits while the other is unaffected, e.g., (i) cellulolytic fungi produce a number of organic acids from cellulose which serve as carbon sources for non-cellulolytic bacteria and fungi, (ii) growth factors are synthesised by certain microorganisms and their excretion permits the proliferation of nutritionally complex soil inhabitants.

2. **Proto-cooperation:** It is also called as non-obligatory mutualism. It is an association of mutual benefit to the two species but without the co-operation being obligatory for their existence or for their performance of reactions, eg. N2 can be fixed by Azotobacter with cellulose as energy source provided that a cellulose decomposer is present to convert the cellulose to simple sugars or organic acids.
3. **Mutualism:** Mutually beneficial interspecific interactions are more common among organisms. Here both the species derive benefit. In such association, there occurs a close and often permanent and obligatory contact more or less essential for survival of each.

As examples, (i) pollination by animals, bees, moths, butterflies etc. derive food from hectar, or other plant product and in turn bring about pollination, (ii) symbiotic nitrogen fixation, legume - rhizobium symbiosis, bacteria obtain food from legume and in turn, fix gaseous nitrogen, making it available to plant.

II. **Negative interactions**:

Member of one population may eat members of the other population, compete for foods, excrete harmful wastes or otherwise interfere with the other population. It includes (i) competition, (ii) predation, (iii) parasitism and (iv) antibiosis.

(i) **Competition:** It is a condition in which there is a suppression of one organism as the two species struggle for limiting quantities of nutrients O_2 space or other requirements, e.g., competition between Fusarium oxysporum and Agrobacterium radiobacter.

(ii) **Predation** :A predator is free living which catches and kills another species for food. Most of the predatory organisms are animals but there are some plants (carnivorous) also, especially fungi, which feed upon other animals,eg. (i) grazing and browsing by animals on plants.

Carnivorous plants such as Nepenthes, Darligtoria, Drosera etc. consume insects and other small animals for food, protozoans feeding on bacteria.

(iii) **Parasitism** :A parasite is the organism living on or in the body of another organisms and deriving its food more or less permanently from their tissues. A typical parasite lives in its host without killing it, whereas the predator kills its upon which it feeds, eg.species of Cuscuta (total stem parasite) grow on other

plants on which they depend for nourishment. Parasitism may occur even with in the species. Hyperparasites which are chiefly fungi growing parasitically on other parasites, ie. parasite on a parasite.

(iv) **Antibiosis:** The phenomenon of the production of antibiotic is called as antibiosis. Antibiotic is an organic substance produced by one organism which in low concentration inhibits the growth of other organism, eg. streptomycin, penicillin etc.

5.6 Matter and cycles of matter

Biogeochemical cycles describe the circulation of matter, particularly, plant and animal nutrients, through ecosystems. These cycles are ultimately powered by solar energy, fine-tuned and directed by energy expended by organisms. In a sense, the solar-energy-powered hydrologic cycle acts as an endless conveyer belt to move materials essential for life through ecosystems.

Most biogeochemical cycles can be described as elemental cycles involving nutrient elements such as carbon, oxygen, nitrogen, sulfur and phosphorus. Many are gaseous cycles in which the element in question spends part of the cycle in the atmosphere – O_2 for oxygen, N_2 for nitrogen, CO_2 for carbon. Others, notably the phosphorus cycle, do not have a gaseous component and are called sedimentary cycles. All sedimentary cycles involve salt solutions or soil solutions that contain dissolved substances leached from weathered minerals that may be deposited as mineral formations or they may be taken up by organisms as nutrients. The sulfur cycle, which may have H_2S or SO_2 in the gaseous phase or minerals ($CaSO_4$, 2H2O) in the solid phase, is a combination of gaseous and sedimentary cycles.

Carbon Cycle:

Carbon, the basic building block of life molecules, is circulated through the carbon cycle. This cycle shows that carbon may be present as gaseous atmospheric CO_2, dissolved in groundwater as HCO_3 or molecular CO_2 (aq), in underlying rock strata as limestone ($CaCO_3$), and as organic matter, represented in a simplified manner as (CH_2O). Photosynthesis fixes inorganic carbon as biological carbon, which is a constituent of all life

molecules. An important aspect of the carbon cycle is that it is the cycle by which energy is transferred to biological systems. Organic or biological carbon, (CH_2O), is an energy-rich molecule that can react biochemically with molecular oxygen, O_2, to regenerate carbon dioxide and produce energy. This can occur in an organism as shown by the "decay" reaction or it may take place as combustion, such as when wood is burned.

Oxygen Cycle

The oxygen cycle involves the interchange of oxygen between the elemental form of gaseous O_2 in the atmosphere and chemically bound oxygen in CO_2, H_2O, and organic matter. Elemental oxygen becomes chemically bound by various energy yielding processes, particularly, combustion and metabolic processes in organisms. It is released during photosynthesis.

Nitrogen Cycle

Nitrogen, though constituting much less of biomass than carbon or oxygen, is an essential constituent of proteins. The atmosphere is 78% by volume elemental nitrogen, N_2 and constitutes an inexhaustible reservoir of this essential element. The N_2 molecule is very stable so that breaking it down to atoms that can be incorporated in inorganic and organic chemical forms of nitrogen is a limiting step in the nitrogen cycle. This does occur by high energy processes such as in lightning discharges when nitrogen chemically combines with hydrogen or oxygen to form ammonia or nitrogen oxides. Elemental nitrogen is also incorporated into chemically bound forms or fixed by biochemical processes mediated by microorganisms. The biological nitrogen is returned to the inorganic form during the decay of biomass by a process called mineralization.

Phosphorus cycle

The phosphorus cycle is crucial because phosphorus is usually the limiting nutrient in ecosystems. There are no common stable gaseous forms of phosphorus, so the phosphorus cycle is strictly sedimentary. In the geosphere, phosphorus is held largely in poorly soluble minerals, such as hydroxyapatite, a calcium salt. Soluble phosphorus from these minerals and other sources, such as fertilizers, is taken up by plants and incorporated into the nucleic acids of biomass. Mineralization of biomass by microbial decay returns phosphorus to the salt solution from which it may precipitate as mineral matter.

Sulfur cycle

The sulfur cycle is relatively complex. It involves several gaseous species, poorly soluble minerals, and several species in solution. It is involved with the oxygen cycle in that sulfur combines with oxygen to form gaseous sulfur di-oxide (SO_2) an atmospheric pollutant, and soluble sulfate ion, (SO_4^{2-}). Among the significant species involved in the sulfur cycle are gaseous hydrogen sulfide, H_2S; mineral sulfides, such as PbS; sulfuric acid, H_2SO_4, the main constituent of acid rain; and biologically bound sulfur in sulfur-containing proteins.

5.7 Energy and cycles of energy

Biogeochemical cycles and virtually all other processes on Earth are driven by energy from the sun. The sun acts as a blackbody radiator with an effective surface temperature of 5780 K (degree Celsius above absolute zero). It transmits energy to earth as electromagnetic radiation. The maximum energy flux of the incoming solar energy is at a wavelength of about 500 nanometers, which is in the visible region of the spectrum. One square meter area perpendicular to the line of solar flux at the top of the atmosphere receives energy at a rate of 1,340 watts/m^2, sufficient, for example, to power an electric iron. This is called solar flux.

In natural systems, energy is transferred by heat. Energy flows between two bodies as a result of their difference in temperature. Otherwise transfer of energy can happen by work that does not depend upon a temperature difference, as governed by the laws of thermodynamics. The first law of thermodynamics states that, although energy may be transferred or transformed, it is conserved and is not lost. Chemical energy in the food ingested by organisms is converted by metabolic processes to work or heat that can be utilized by the organisms, but there is no net gain or loss of energy overall. The second law of thermodynamics describes the tendency toward disorder in natural systems. It demonstrates that each time energy is transformed; some is lost in the sense that it cannot be utilized for work, so only a fraction of the energy that organisms derive from metabolizing food can be converted to work; the rest is dissipated as heat.

Energy Flow and Photosynthesis

Whereas materials are recycled through ecosystems, the flow of useful energy may be viewed as essentially a one-way process. Incoming solar energy can be regarded as high-

grade energy because it can cause useful reactions to occur, the most important of which in living systems is photosynthesis. Solar energy captured by green plants energizes chlorophyll, which in turn powers metabolic processes that produce carbohydrates from water and carbon dioxide. These carbohydrates represent stored chemical energy that can be converted to heat and work by metabolic reactions with oxygen in organisms. Ultimately, most of the energy is converted to low-grade heat, which is eventually reradiated away from Earth by infrared radiation.

Succession

Environment is always keep changing over a period of time due to (1) variations in climatic and physiographic factors, (2) the activities of the species of the communities themselves. These influences bring about marked changes in the dominants of the existing community, which is thus sooner or later replaced by another community at the same place. This process continues and successive communities develop one after another over the same area until the terminal final community again becomes more or less stable for a period of time. It occurs in a relatively definite sequence. This orderly change in communities is referred to as succession. Odum called this orderly process as ecosystem development/ ecological succession. Succession is an orderly process of community development that involves changes in species structure and community processes with time and it is reasonably directional and therefore predictable. Succession is community controlled even though the physical environment determines the pattern.

Causes of succession

Succession is a series of complex processes, caused by (i) initial/initiating cause, both climatic as well as biotic, (ii) ecesis continuing process ecesis, aggregation, competition reaction etc, (iii) stabilizing cause as a stabilization of the community. Climate is the chief cause of stabilization and other factors are of secondary value.

Types of succession

- **Primary succession:** Starts from the primitive substratum where there no living matter exists in earlier time. The first group of organisms establishing there is known as the pioneers, primary community/primary colonizers. Very slow is the series of community changes that takes place in disturbed areas that have not been totally stripped of their soil and vegetation.

- **Secondary succession:** Starts from previously built up substrata with already existing living matter. Action of external force, as a sudden change in climatic factors, biotic intervention, fire etc, causes the existing community to disappear. Thus area becomes devoid of living matter but its substratum, instead of primitive is built up. Such successions are comparatively more rapid.
- **Autogenic succession:** A community as a result of its reaction with the environment, modifies its own environment and thus causing its own replacement by new communities. This course of succession is autogenic succession.
- **Allogenic succession:** Replacement of the existing community is caused largely by any other external condition and not by the existing organisms.
- **Autotrophic succession**: Characterized by early and continued dominance of autotrophic organisms like green plants. Gradual increase in organic matter content supported by energy flow.
- **Heterotrophic succession:** Characterized by early dominance of heterotrophs, such as bacteria, actinomyces, fungi and animals. There is a progressive decline in the energy content.
- **General Process of succession**: Nudation- development of barren area without any form of life.

*Cause of nudation***:**It may be due to (a) topographic soil erosion by wind, (b) climatic - storm, frost etc., (c) biotic - man, disease and epidemics, (d) invasion-successful establishment of a species in a barren area. This species actually reaches this new site from any other area by (i) migration, (ii) ecesis and (iii) aggregation.

- **Retrogressive succession:** Continuous biotic influences have some degenerating influence on the process. Due to destructive effects of organisms, the development of disturbed communities does not occur. Process of succession, instead of progressive, it becomes retrogressive, e.g., forest may change to shrubby or grassland community.
- **Deflected succession:** Sometimes due to changes in local conditions as soil character or microclimate the process of succession becomes deflected in a different direction than that presumed under climatic conditions of the area. Thus the climax communities are likely to be different from the presumed climatic climax

community. In India, with a monsoon type of climate, in some habitats like temporary ponds, pools etc., it is common to observe each year, the development of different kinds of communities in different seasons of the year - seasonal succession. But such changes are simply recurrent and not developmental and should not be designated as successful. Species do not remain unchanged indefinitely. In course of time many species become extinct and disappeared forever. Or a species may form one or more new species that differ from the original one. All these changes are result of evolution, i.e., by the process of evolution organism arise by modification from ancestral forms of life.

5.8 Summary and Conclusion

Ecosystems are made up of abiotic (non-living, environmental) and biotic components, and these basic components are important to nearly all types of ecosystems. Ecosystem ecology looks at energy transformations and biogeochemical cycling within the ecosystems.

Energy is continually is added into an ecosystem in the form of light energy, and some energy is lost with each transfer to a higher trophic level. Nutrients, on the other hand, are recycled within an ecosystem, and their supply normally limits biological activity. So, "energy flows, elements cycle".

Energy is moved through an ecosystem via a foodweb, which is made up of interlocking food chains. Energy is first captured by photosynthesis (primary production). The amount of primary production determines the amount of energy available to higher trophic levels.

The study of how chemical elements cycle through an ecosystem is termed biogeochemistry. A biogeochemical cycle can be expressed as a set of stores (pools) and transfers, and can be studied using the concepts of "stoichiometry", "mass balance", and "residence time".

Ecosystem function is controlled mainly by two processes, "top-down" and "bottom-up" controls.

A biome is a major vegetation type extending over a large area. Biome distributions are determined largely by temperature and precipitation patterns on the Earth's surface.

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Unit 6 ❑ Wetland ecosystem with special reference to East Kolkata Wetlands

Structure

6.1 Objectives

- to understand a wetland ecosystem
- to understand the types and characteristics of wetlands
- to understand why wetlands are a unique ecosystem

6.2 Introduction

Wetlands have been described as lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. The importance of wetlands lie in the fact that it maintains the food chain, ecological balance and absorb pollution, treat sewage and fulfills the requirement of fishes.

6.3 Ramsar Convention

It is an international convention came in force in 1975. The convention provides the framework for international cooperation for the conservation and wise use of wetland habitats. The United Nations Educational, Scientific and Cultural Organisation (UNESCO)

serves as the Depositary for the Convention, and its secretariat, the Ramsar Bureau, is in Gland, Switzerland. India became signatory to this convention in 1981. The Convention aims to halt the loss of wetlands and to ensure the conservation of fauna and flora and their ecological processes. Obligations of parties include:

- designating one or more wetlands for inclusion in the list of Wetlands of International Importance (e.g. six Ramsar wetlands in India).
- promoting judicious use of wetlands including mangroves.
- promoting conservation of wetlands through establishment of nature reserves.
- promoting training in the field of wetland research, managing and warding.
- consulting with other parties about implementation of the convention, especially with regard to trans frontier wetlands, shared water systems, shared species, and development of wetland projects.

East Calcutta Wetlands (ECW), are the combination of natural and human-made wetlands lying at the east of the city of Calcutta (Kolkata), of West Bengal in India. It includes salt marshes, and agricultural fields, sewage farms and settling ponds. The wetlands are also used to treat Kolkata's sewage, and the nutrients contained in the wastewater sustain fish farming and agriculture. The name East Kolkata Wetlands was coined by Drubojyoti Ghosh. As an engineer of the Government of West Bengal's Water and Sanitation Department, he reached this neglected part of the city and tried to find an answer to a question what happens to the city sewage? He found the answer from the local fishermen and farmers who devised their own means of solutions in the form of wetlands that served as the natural sewage treatment plant for the city.

The wetlands to the east of Calcutta (220 27'N 880 27'E) comprises a large number of water bodies distributed across the districts of South and North 24 Parganas. The multifunctional wetland ecosystem is spread over 12,500 hectares. It has, along with the wetlands, 264 sewage-fed fisheries, agriculture and solid waste farms and some built up areas. The resource recovery system developed by the local people over many years using waste water from the city is the largest and the only one of its kind in the world. It also helps in water treatment and is home to waterfowl and a large biodiversity. In August, 2002, 12,500 hectares of the East Calcutta Wetland area was included in the 'Ramsar-List' making it a wetland of International Importance. The Ramsar Bureau List was established under Article 8 of the Ramsar Convention.

Historical aspects of ECW.

The earliest known accounts (year 1748) of the wetlands picture it as marshy Salt Lakes teeming with fish and birds. The Lakes were spread over a vast area, stretching from the vicinity of River Hooghly to about 5-6 km. to the east. According to these early accounts, the circumference of the lakes was much bigger than it is at present. From the late 18th century, the edge of the lakes receded about one and a half kilometers. The loss of head water feed from the river Hooghly, the gradual deterioration of the River Bidyadhari (within the wetland area), the ever expanding city of Calcutta with its increasing demands for drainage and waste disposal led to rapid silting and reclamation of the East Calcutta Wetlands. Human interventions have played a decisive role in the shrinking of the East Calcutta Wetland to their present size. The East Calcutta Wetlands have an interesting hydrological history. The area had been a brackish water lagoon swamp but as fresh drainage water came out of Calcutta it became suitable for raising fish. Local farmers stocked some of the ponds and then dug more. Currently, there are 300 or so large fish farms and ponds cover a total area of 3,500 hectares, some individual ponds extend to 70ha. Landlords, many of them absentee, let the majority of ponds to commercial managers, some others are managed by the government and some have been given to fishermen's groups and cooperatives. Vegetable production is a household activity with people renting small plots or sub-letting smaller plots for their own household sustenance and income. Apart from those people, there are porters, auctioneers, traders, retailers and people raising fish seed, making nets, maintaining drainage canals and reinforcing the banks. A large number of people, many of them poor, depend on the Wetlands for their livelihoods. Many more, in Calcutta city, depend on the fish and vegetables produced; 13,000 tonnes of fish are produced annually in ponds managed for wastewater aquaculture and 150 tonnes vegetables per day are harvested from smallscale horticultural plots irrigated with wastewater. But there are a number of problems. The salt lake to the East of Calcutta have been for the abundance of fish fauna, which up to few years ago consisted mainly of brackish water forms (Gupta 1908).Latex calcifer(Bloch) which is commonly known as "Bhetki" and Mughal persii (Ham) known as "perse". Hilisahilisa(Ham) was also known not uncommon when the lakes were fed by water from the tidal river, Bidyadhari which of late has siltedup. There is at present no ingress of saline water into the salt Lake from this source.

Sewell (1934) in studying the fauna of the Salt Lake also remarked on the rapid deterioration of the river Bidyadhari owing to deposition of salt and silt during the flood tides. The natural process of delta formation and the consequent change in the river system, as also engineering construction, such as bridges and canals, have also been instrumental in bringing the present moribund condition of the river.Several fish culture ponds have been started in the villages bordering in the Salt Lake, and the Lakes themselves are being more and more bunded up into small reservoirs or "bheris" as time passes(Gupta 1908). Farmers around Calcutta developed a technique of using domestic sewage for fish culture almost a century ago. This technique is widely used to meet the growing demand for fish in this thickly populated city.

The technique is considered to be unique and is the largest operational system in the world to convert waste to consumable products. The large scale usage of sewage for fish culture began in 1930s. Early success of fish culture in stabilized sewage ponds, which were used as a source of water for growing vegetables provided stimulus for the large scale expansion of sewage fed fish culture system. The area under this unique system of culture peaked at 12,000 hectare, but in recent years there has been a steep decline in the area due to the increasing pressure of urbanization.

6.4 What the Wetlands offer?

Fish: The city of Calcutta gets its huge volumes of daily sewage treated at no expense and gets in addition a substantial daily supply of highly edible freshwater fish (essential protein supplement for the local people in their daily food). In fact, Calcutta City receives about one third of its daily requirement of fish from the sewage-fed fisheries (about 11,000 metric tones annually.)

Garbage: Calcutta generates roughly 2,500 metric tons of garbage (solid waste) a day which is collected and dumped at designated sites in the wetlands. The garbage filled areas are extensively used to raise a variety of vegetables. The city receives roughly 150 metric tons of vegetable everyday from its garbage farms.

Foodgrains: The paddy fields in the wetlands (many of which are irrigated by the effluent water of the fisheries) produce 15,000 metric tons of paddy annually.

Air purification: It is claimed by environmentalists that these wastewater bodies and fisheries act as a carbon-dioxide sink and help to improve the quality of air of Kolkata and

its environs. Any loss of the wetlands, therefore, will have a negative impact on the overall environmental condition of the area. So, the role and importance of the wetland in relation to its surroundings cannot be undermined.

6.5 The East Calcutta Wetlands Serves to:

(a) absorb and treat in a most efficient, economical and natural way the huge volume of sewage and wastewater and urban solid and air wastes generated by Calcutta at no cost to the city;

(b) fulfill substantially the requirement of fish, vegetables and foodgrains in the city;

(c) absorb the pollution from, and purify the air that citizens breathe;

(d) absorb and pass to downstream creeks and the sea the flood waters that the monsoon brings to the city;

(e) provide a habitat for a variety of flora and fauna and living organisms endemic to wetlands;

(f) provide the food chain and waste-to-wealth recycling so unique and essential to this city;

(g) maintain the micro-climatic condition of the region;

(h) maintain the delicate ecological balance in a fragile environment and eco-system;

(i) provide livelihood support for thousands of local villagers who also have the unique skill of using wastewater to grow fish and vegetable and thereby help sustain a stable urban fringe.

6.6 The East Calcutta Wetlands face several problems or threats from different quarters:

1) **Threats of encroachment from real estate developers**: The East Calcutta Wetlands represent vast areas of shallow filled land in the fringe areas of the bustling metropolis of Calcutta which are easily reclaimable by filled up and act as magnet for "land sharks". Before the current realization of the importance of the wetlands several "development" schemes also made in-roads in the area, leading to a gradual shrinkage in

the total area of the wetlands. Solution : legal measures The conservation area boundary for the East Calcutta Wetlands and waste-recycling region was mapped in 1985 by the State Planning Board, Government of West Bengal. This wetland area is protected by order of the Calcutta High Court in 1992, which prohibits change in land use. High Court directed the State Government to take recourse to statutory cover, if required, to prevent any private alienation of land. Recently, the Director of land and Land Records, Govt. of West Bengal has issued a fresh order prohibiting any conversion of land use within the conservation area boundary and declaring all such conversions, that have taken place since 1992, as void. Filling up of water bodies in this area is not permissible under West Bengal Town and Country (Planning and Development) Act, 1979 as well as under the West Bengal Inland Fisheries Act, 1984 (with amendment in 1993).

2) **Metal deposition**

Metal deposition in the canal sludge rendering the waste water incapable of ensuring the edible quality of the fish and vegetable grown in the wetland is another recent threat. Indiscriminate dumping of untreated solids and hazardous industrial wastes like heavy metals, without ascertaining the assimilative capacity of the wetland, may lead to severe pollution of the wetlands and adverse health impact to local population. Some unscrupulous businessmen do not run effluent treatment plants efficiently and directly discharge untreated effluents from factories and sewage into the East Calcutta Wetlands through Bagjola, Bhangar and Tiljola Canals. The water of these canals gets further mixed with water from the Dhapa dump yard through leaching. Heavy metals released from effluents after reaching Wetland Water are transferred to vegetables and fishes and finally to human beings through food chain.

Solution :

1. Tougher enforcement of environmental laws. 2. Use of water hyacinths which accumulate heavy metals in their body. By applying water hyacinths and benthos in polluted water it is observed that heavy metallic pollution decreased unto 8-10%. Water hyacinths accumulate heavy metals in their body.

2) Workers' Problems:

A. **Loss of income during non crop seasons**

a) Handicraft training for women, b) Setting up of co-operatives, c) Development of Eco tourism/amusement parks in or around the bheris, will solve the problem.

B. **Lack of proper education**

Literacy level is not impressive in this area. Most of the women folks are illiterate. Scope of higher education is also very limited. Government initiatives could be taken to set up schools both at primary as well as secondary level. These schools must be set up in locations from where they are easily accessible to the students. Care must be taken to motivate the students and their family members to pursue education in order to reduce the drop out rates. To accomplish this income level of the family members must be increased so that they do not stop their child's education due to crunch for money.

C. **Indebtedness of labourers**:

A serious issue that must be given adequate attention is the indebtedness of the labourers, especially those working for recycling firms. Many bheri workers also become indebted to the bheri owners. As a result they reach the status of bonded labourers.

Measures must be taken to relieve them from this bondedness. Micro finance and micro-credit schemes can be developed so that they can save small amounts and borrow from the banks at low rates. Several NGOs active in these areas pursue micro finance schemes and have helped many families, to earn a steady source of income. The women and families who work as garbage pickers have shown good response to such schemes. But with the help of the government, this scheme can be strengthened.

D. **Health Hazard:** Though the fishermen working for long hours rarely develop any disease related to wastewater, their household members do complain of diaohrrea, dysentery and other waterborne diseases. Garbage picking for the recycling and compost production also adds to the health hazards of the workers. The following actions could resolve the issue.

1) provision for better sanitation facilities including better quality of drinkingwater;

2) better access to medical facilities;

3) better protective area and awareness.

6.7 Importance and Sustainability of the wetlands

1. Fish and vegetable production and supply providing food security and nutrition. Fertiliser and pesticides are not required. 2. Recycling process of sewage waste water fed aquaculture with recycling of solid waste controls pollution and improves environment with

more oxygen. It protects bioregion. 3. It provides employment, income for other casual workers and provide better living standards. 4. Preservation of biodiversity. East Kolkata wetlands provide a blue and green buffer to between urban and rural areas.

5. It helps ground water recharge and monsoon flood control due to climate change. 6. Improved irrigation and agriculture 7. Indigenous process and recycling instead of expensive wastewater treatment plants can purify waste water with exposure to sun in photosynthesis process with phytoplankton. 8. It is cost effective, it helps recover materials. 9. It provides recreation, ecotourism etc. 10. Ecosystem services of Wetlands are more valuable compared to rivers, lakes, forests and grasslands.

6.8 Summary and Conclusion

East Calcutta wetlands serve as one of the best examples to the world on concepts of integrated resource recovery systems and water recycling using peripheral wetlands around cities. It is the largest ensemble of sewage for fish ponds in one place in the world. But it is being lost due to the urban expansion without consideration of the ecological, environmental and economic benefits of the sewage fed aquaculture system. There is necessity to understand the science behind the management practices evolved by fishermen themselves. Costanza et al (1997), when estimating the value of the world's ecosystem services, estimated that

wetlands are 75% more valuable than lakes and rivers, 15 times more valuable than forests, and 64 times more valuable than grasslands and rangelands. Steps must be taken to protect the East Calcutta Wetlands and to improve the living standards of the people residing in most interior parts of the wetland. Focused and directed developmental programmes must be evolved. Areas and target groups must be decided, specific needs must be chalked out according to priorities before any developmental funds are allocated for these areas with stakeholders' participation in the programmes.

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Unit 7 ❑ Environmental pollution and degradation: Land, water and air

Structure

7.0 Objectives

- This unit introduces pollution and degradation of environmental quality as an example of the interactions between natural and human systems. It will enable learners to understand environmental problems, looking at causal linkages between pollution sources, exposure pathways and impacts to environmental quality and human health.
- Students will learn how to assess pollution sources, study exposure pathways, and evaluate consequences of human exposure to pollution and its impacts to environmental quality.

7.1 Introduction

Environment can be defined as the physical surrounding of man/woman of which he/she is a part and on which he/she is dependent for his/her activities like physiological functioning, production and consumption. This physical environment stretches from air,

water and land to natural resources like energy carriers, soil and plants, animals and ecosystems. The relationship between physical environment and the well-being of individuals and societies is multi-fold and multi-faceted with a qualitative as well as a quantitative aspect to it. The availability and use of natural resources have a bearing on the outcome and the pace of development process. For an urbanized society, a large part of environment is man-made. But, even then the artificial environments (building, roads) and implements (clothes, automobiles) are based on an input of both labour and natural resources. The term 'Environment' is commonly restricted to ambient environment. In that view, the indoor environment (home, work place) is regarded as isolated piece of environment to be treated on its own terms. The indoor environment usually is under the jurisdiction of the Public Health authorities. Health risks are mainly linked to space heating, cooking and lighting. Low grade fuels, insufficient ventilation are often the main problems. Additionally, there may be problems connected with moisture, light, hazardous substances from building materials, lacquers and paints. Problems with drinking water, sewage and waste are not linked to the dwelling as such but rather to lack of appropriate infrastructure.

7.2 Environmental pollution

It is not a new phenomenon, yet it remains the world's greatest problem facing humanity, and the leading environmental causes of morbidity and mortality. Man's activities through urbanization, industrialization, mining, and exploration are at the forefront of global environmental pollution. Both developed and developing nations share this burden together, though awareness and stricter laws in developed countries have contributed to a larger extent in protecting their environment. Despite the global attention towards pollution, the impact is still being felt due to its severe long-term consequences.

Pollution is a very serious worldwide problem.It results in the deterioration of the quality of natural biotic and abiotic factors. Water pollution is a very big problem especially in developing countries in the world. The groundwater scarcity is quite a common phenomenon in the developing nations. Water is an indispensable resource for human activities including water for drinking and irrigation, recreational opportunities and habitat for economically important fisheries and all urban and rural amenities. Pollution poses a serious risk to life, as polluted waters are potent agents of diseases such as cholera,

typhoid, and tuberculosis. Water pollution is the contamination of water bodies, usually as a result of human activities, in such a manner that negatively affects its legitimate uses.

Environmental degradation is a process through which general health of the natural environment is compromised. It is the deterioration of the environment through consumption of assets, like, air, water and soil. Air pollution, water pollution, garbage accumulation, and pollution of the natural environment are all challenges for India. According to World Bank experts, India has made one of the fastest progresses in the world, in addressing its environmental issues and improving its environmental quality between 1995 and 2010. Still, India has a long way to go to reach environmental quality similar to those enjoyed in developed economies. Pollution remains a major challenge for India.

It is one of the ten threats officially cautioned by the high-level PaneI on Threats, Challenges and Change of the United Nations. The United Nations International Strategy for Disaster Reduction defines environmental degradation as "the reduction of the capacity of the environment to meet social and ecological objectives, and needs". When natural habitats are destroyed or natural resources are depleted, the environment is degraded. Efforts to counteract this problem include environmental protection and environmental resources management.

7.3 Causes of Environmental Degradation

The major causes of the environmental degradation are modern urbanization, industrialization, population growth, deforestation etc. Environmental pollution refers to the degradation of quality and quantity of natural resources. Various types ofthe human exercises are the fundamental reasons of environmental degradation. The smoke radiated by the vehicles and processing plants expands the measure of toxic gases noticeable all around affecting every single living being. These waste items and smoke radiated by vehicles are the fundamental driver of contamination. Spontaneous urbanization and industrialization have caused water, air and sound pollution. So the smoke discharged by vehicles and industrial ventures like Chlorofluorocarbon, nitrogen oxide, carbon monoxide and other particles pollute air.

7.4 Land degradation

Land degradation is a worldwide problem. Land is a vital resource to humankind, like air and water. Land degradation, the deterioration or loss of the productive capacity of the

soils for present and future, is a global challenge that affects everyone through food insecurity, higher food prices, climate change, environmental hazards, and the loss of biodiversity and ecosystem services. Land degradation is happening at an alarming pace, contributing to a dramatic decline in the productivity of croplands and rangelands worldwide.

Land degradation is one of the world's most pressing environmental problems and it will worsen without rapid remedial action. Globally, about 25 percent of the total land area has been degraded. When land is degraded, soil carbon and nitrous oxide is released into the atmosphere, making land degradation one of the most important contributors to climate change. Scientists recently warned that 24 billion tons of fertile soil was being lost per year, largely due to unsustainable agriculture practices. If this trend continues, 95 percent of the Earth's land areas could become degraded by 2050.

Globally, 3.2 billion people are affected by land degradation, especially rural communities, small farmers, and the very poor. The world population is projected to increase by about 35 percent to 9.7 billion in 2050, with rising demands for agricultural products including food, feed, fiber, and fuel. However, pressure on the global land resource is increasing due to other factors as well, such as agricultural production systems made less resilient by the loss of biodiversity, and natural factors such as climate variability and extreme weather events. Climate change exacerbates variations in yields and income from agriculture, threatening the resilience of agro-ecosystems and stability of food production systems.

The problems are particularly severe in the driest parts the planet. Dryland landscapes cover approximately 40 percent of the world's land area and support two billion people. The vast majority of people who depend on drylands live in developing countries, where women and children are most vulnerable to the impacts of land degradation and drought.

7.5 Water Pollution

Water pollution is defined as, 'Any direct or indirect alteration of the physical, thermal, chemical, biological, radioactive properties of any part of the environment by, discharge, emission or deposit of wastes so as to affect any beneficial use adversely or to cause a condition, which is hazardous to public health, safety or welfare of animals, birds, wildlife, aquatic life or to plants of every description' (Environment Act of 1980).

Water pollution occurs when harmful substances—often chemicals or microorganisms—contaminate a stream, river, lake, ocean, aquifer, or other body of water, degrading water

quality and rendering it toxic to humans or the environment.

Causes of Water Pollution

Water is uniquely vulnerable to pollution. Known as a "universal solvent," water is able to dissolve more substances than any other liquid on earth. It is also why water is so easily polluted. Toxic substances from farms, towns, and factories readily dissolve into and mix with it, causing water pollution.

Categories of Water Pollution

Groundwater

When rain falls and seeps deep into the earth, filling the cracks, crevices, and porous spaces of an aquifer (basically an underground storehouse of water), it becomes groundwater, one of our least visible but most important natural resources. Nearly 40 percent of Americans rely on groundwater, pumped to the earth's surface, for drinking water. For some folks in rural areas, it is their only freshwater source. Groundwater gets polluted when contaminants from pesticides, fertilizers and wastes leached from land fills and septic systemsmake their way into an aquifer, rendering it unsafe for human use. Ridding groundwater of contaminants can be difficult to impossible, as well as costly. Once polluted, an aquifer cannot be used for decades, or even thousands of years. Groundwater can also spread contamination far from the original polluting source as it seeps into streams, lakes, and oceans.

Surface water

Covering about 70 percent of the earth, surface water is what fills our oceans, lakes, rivers, and all those other blue bits on the world map. Surface water from freshwater sources (that is, from sources other than the ocean) accounts for more than 60 percent of the water delivered to American homes. But a significant pool of that water is in peril. According to the most recent surveys on national water quality from the U.S. Environmental Protection Agency, nearly half of our rivers and streams and more than one-third of our lakes are polluted and unfit for swimming, fishing, and drinking. Nutrient pollution, which includes nitrates and phosphates, is the leading type of contamination in these freshwater sources. While plants and animals need these nutrients to grow, they have become a major pollutant due to farm waste and fertilizer runoff. Municipal and industrial waste discharges contribute their fair share of toxins as well. There is also all the random junk that industry and individuals dump directly into waterways.

Ocean water

Eighty percent of ocean pollution (also called marine pollution) originates on land, whether along the coast or far inland. Contaminants such as chemicals, nutrients, and heavy metals are carried from farms, factories, and cities by streams and rivers into our bays and estuaries; from there they travel out to sea. Meanwhile, marine debris, particularly plastic, is blown in by the wind or washed in via storm drains and sewers. Our seas are also sometimes spoiled by oil spills and leaks and are consistently soaking up carbon pollution from the air. The ocean absorbs as much as a quarter of man-made carbon emissions.

Point source

When contamination originates from a single easily identified source, it is called point source pollution. Examples include wastewater (also called effluent) discharged legally or illegally by a manufacturer, oil refinery, or wastewater treatment facility, as well as contamination from leaking septic systems, chemical and oil spills, and illegal dumping. The EPA regulates point source pollution by establishing limits on what can be discharged by a facility directly into a body of water. While point source pollution originates from a specific place, it can affect miles of waterways and ocean.

Nonpoint source

Nonpoint source pollution is contamination derived from diffuse sources. These may include agricultural or stormwater runoff or debris blown into waterways from land. Nonpoint source pollution is the leading cause of water pollution, but it is difficult to regulate, since there is no single, identifiable culprit.

Transboundary

Water pollution cannot be contained by a line on a map. Transboundary pollution is the result of contaminated water from one country spilling into the waters of another. Contamination can result from a disaster, like an oil spillor the slow, downriver creep of industrial, agricultural, or municipal discharge.

The Most Common Types of Water Contamination

Agricultural

The agricultural sector is the biggest consumer of global freshwater resources. With farming and livestock production this sector uses about 70 percent of the earth's surface water supplies. But it is also a serious water polluter. Around the world, agriculture is

the leading cause of water degradation. In the United States, agricultural pollution is the top source of contamination in rivers and streams, the second-biggest source in wetlands, and the third main source in lakes. It's also a major contributor of contamination to estuaries and groundwater. Every time it rains, fertilizers, pesticides, and animal wastes from farms and livestock operations wash nutrients and pathogens into waterways. Nutrient pollution, caused by excess nitrogen and phosphorus in water or air, is the number-one threat to water quality worldwide and can cause algal blooms, a toxic soup of blue-green algae that can be harmful to people and wildlife.

Sewage and wastewater

Used water is wastewater. It comes from our sinks, showers, and toilets and from commercial, industrial, and agricultural activities (metals, solvents, and toxic sludge). The term also includes stormwater runoff, which occurs when rainfall carries road salts, oil, grease, chemicals, and debris from impermeable surfaces into our waterways

More than 80 percent of the world's wastewater flows back into the environment without being treated or reused, according to the United Nations. In some least developed countries, the figure tops 95 percent. In the United States, wastewater treatment facilities process about 34 billion gallons of wastewater per day. These facilities reduce the amount of pollutants such as pathogens, phosphorus, and nitrogen in sewage, as well as heavy metals and toxic chemicals in industrial waste, before discharging the treated waters back into waterways. That is when all goes well. But according to EPA estimates, our nation's aging and easily overwhelmed sewage treatment systems also release more than 850 billion gallons of untreated wastewater.

Oil pollution

Big spills may dominate headlines, but consumers account for the vast majority of oil pollution in our seas, including oil and gasoline that drips from millions of cars and trucks every day. Moreover, nearly half of the estimated 1 million tons of oil that makes its way into marine environments each year comes not from tanker spills but from land-based sources such as factories, farms, and cities. At sea, tanker spills account for about 10 percent of the oil in waters around the world, while regular operations of the shipping industry through both legal and illegal discharges contribute about one-third. Oil is also naturally released from under the ocean floor through fractures known as seeps.

Radioactive substances

Radioactive waste is a type of hazardoud waste that contains radioactive material. It emits radiation. It is generated by uranium mining, nuclear power plants, and the production and testing of military weapons, as well as by universities and hospitals that use radioactive materials for research and medicine. Radioactive waste can persist in the environment for thousands of years, making disposal a major challenge. In decommissioned Hanford nuclear weapons production site in Washington, the clean up of 56 million gallons of radioactive waste is expected to cost more than $100 billion and last through 2060. Accidentally released or improperly disposed of contaminants threaten groundwater, surface water, and marine resources.

What Are the Effects of Water Pollution?

On human health

Water pollution kills. Contaminated water can also make people ill. Every year, unsafe water sickens about 1 billion people. Low-income communities are disproportionately at risk because their homes are often closest to the most polluting industries.

Waterborne pathogens, in the form of disease-causing bacteria and viruses from human and animal waste, are a major cause of illness from contaminated drinking water. Diseases spread by unsafe water include cholera, giardia, typhoid, hepatitis and various other diseases. Even in wealthy nations, accidental or illegal releases from sewage treatment facilities, as well as runoff from farms and urban areas, contribute harmful pathogens to waterways.

On the environment

In order to thrive, healthy ecosystems rely on a complex web of animals, plants, bacteria, and fungi, all of which interact, directly or indirectly, with each other. Harm to any of these organisms can create a chain effect, imperiling entire aquatic environments.

When water pollution causes an algal bloom in a lake or marine environment, the proliferation of newly introduced nutrients stimulates plant and algae growth, which in turn reduces oxygen levels in the water. This dearth of oxygen, known as eutrophication, suffocates plants and animals and can create “dead zones,” where waters are essentially devoid of life. In certain cases, these harmful algal blooms can also produce neurotoxins that affect wildlife, from whales to sea turtles.Chemicals and heavy metals from industrial and municipal wastewater contaminate waterways as well. These contaminants are toxic to aquatic life, most often reducing an organism’s life span and ability to reproduce.

Marine ecosystems are also threatened by marine debris, which can strangle, suffocate, and starve animals. Much of this solid debris, such as plastic bags and soda cans, gets swept into sewers and eventually drains out to sea, turning our oceans into trash soup and sometimes consolidating to form floating garbage patches. Discarded fishing gear and other types of debris are responsible for harming more than 200 different species of marine life.

Meanwhile, ocean acid infication is making it tougher for shellfish and coral to survive. Though they absorb about a quarter of the carbon pollution created each year by burning fossil fuels, oceans are becoming more acidic. This process makes it harder for shellfish and other species to build shells and may impact the nervous systems of sharks, clownfish, and other marine life.

Prevention of Water Pollution

It is easy to disapprove the oil company with a leaking tanker, but we are all accountable to some degree for today's water pollution problem. Fortunately, there are some simple ways that can prevent water contamination.

Plastic consumption should be reduced.

Chemical cleaners, oils, and non-biodegradable items should be properly disposed.

Car should not leak oil.

Every yard should come under landscaping that reduces runoff without apply in gpesticides and herbicides.

7.6 Air Pollution

Air is essential for life it self; without it we could survive only a few minutes. It constitutes immediate physical environment of living organisms. It is a mixture of various gases like nitrogen, oxygen and carbon dioxide, and others in traces; along with water vapor perceptible as humidity and suspended solids in particulate form. The atmosphere is layered in to four distinct zones of contrasting temperature due to differential absorption of solar energy. The four atmospheric layers are: Troposphere, stratosphere, mesosphere, and thermosphere. Understanding how these layers differ and what creates them helps us understand atmospheric function.

Air pollution may be defined as any atmospheric condition in which certain substances are present in such concentrations that they can produce undesirable effects on man and

his environment. These substances include gases (SO_2, NO_2, CO, HCs, etc) particulate matter (smoke, dust, fumes, aerosols) radioactive materials and many others. Most of these substances are naturally present in the atmosphere in low (background) concentrations and are usually considered to be harmless. Thus, a particular substance can be considered as an air pollutant only when its concentration is relatively high compared with the back ground value and causes adverse effects. Air pollution is a problem of obvious importance in most of the world that affects human, plant and animal health. For example, there is good evidence that the health of 900 million urban people suffers daily because of high levels of sulfur dioxide concentrations.

Air pollution is one of the most serious environmental problems in societies at all level of economic development. Air pollution can also affect the properties of materials (such as rubber), visibility, and the quality of life in general. Industrial development has been associated with emission to air of large quantities of gaseous and particulate emissions from both industrial production and from burning fossil fuels for energy and transportation. When technology was introduced to control air pollution by reducing emissions of particles, it was found that the gaseous emissions continued and caused problems of their own. Currently efforts to control both particulate and gaseous emissions have been partially successful in much of the developed world, but there is recent evidence that air pollution is a health risk even under these relatively favourable conditions.

In societies that are rapidly developing sufficient resources may not be invested in air pollution control because of other economic and social priorities. The rapid expansion of the industry in these countries has occurred at the same time as increasing traffic from automobiles and trucks, increasing demands for power for the home, and concentration of the population in large urban areas called mega cities. The result has been some of the worst air pollution problem in the world. In many traditional societies, and societies where crude household energy sources are widely available, air pollutionis a serious problem because of inefficient and smoky fuels used to heat buildings and cook. This causes air pollution both out door and indoors. The result can be lung disease, eye problems, and increased risk of cancer. The quality of air indoors is a problem also in many developed countries because buildings were built to be airtight and energy efficient. Chemicals produced by heating and cooling systems accumulate indoors and create a pollution problem.

Types of Air pollution

i) Primary pollutant: Pollutants that are emitted directly from the human or natural activities are known as primary pollutant. For example, CO2, SO2, NOx, particulate matter, hydrocarbons etc.

ii) Secondary pollutant: When primary pollutants react with atmospheric moisture content, a new category of pollutants forms. These are known as secondary pollutants. For example, carbonic acid, nitric acid, sulphuric acid etc.

Cause of Air pollution

a) Urbanization

b) Population growth

c) Deforestation

d) Industrialization

e) Vehicle emission

Major Air pollutants and their effects

a) The concentration of carbon dioxide increases in atmosphere due to emission from vehicles, burning of fossil fuel, emission from volcano, industries, agricultural activity etc. It increases green house effect which causes global warming and climate change.

b) Carbon monoxide releases after incomplete combustion of fossil fuel or other product. The source of CO is vehicle emission, burning of coal, biomass combustion etc. CO causes headache, dizziness, heart failure (in blood CO combines with oxygen which reduced the affinity of haemoglobin towards oxygen), etc.

c) Sulphur dioxide releases from oil refineries, volcanic eruption, and chemical industries etc. Sulphur dioxide reacts with moisture to form secondary pollutant which causes eye irritation. It can also cause allergic reaction and asthma.

d) Tetraethyl lead is used as anti-knocking agents in petrol, gasoline and jet fuel for smooth function. Lead particles are coming out from the exhaust of vehicle and mixed with air. It causes injurious effect on kidney and liver. It also lowers down the intelligence power in children.

e) Nitrogen oxide releases from vehicle exhausts, volcanic eruption, lighting etc. It also reacts with moisture content present in atmosphere and causes eye irritation. Techniques used for prevention of Air pollution

i) Filters remove particulate matter from the gas stream. Bag house filter system is the most common and it is made up of cotton fibers. When polluted gas passed through it, polluted gases are deposited on cotton fibers.

ii) Electrostatic scrubber: The emitting dust is charged with ions and ionized particulate matter is collected on oppositely charged surface. The collected particles are removed by shaking the surface.

iii) Scrubbers are wet collectors. They remove aerosol from a stream of gas either by collecting wet particle on a surface.

7.7 Summary and Conclusion

The quality of air at various locations is monitored regularly by government and other agencies. We can use this data to generate awareness about air pollution among friends and neighbours. There is a need to switch over to alternative fuels instead of the fossil fuels for our energy requirements. These could be solar energy, hydropower and wind energy.Small contributions on our part can make a huge difference in the state of the environment.

7.8 References

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7.9 Model Questions

1. What are the different ways in which water gets contaminated ?

2. At an individual level, how can you help reduce air pollution?
3. Clear, transparent water is always fit for drinking. Comment.
4. You are a member of the municipal body of your town. Make a list of measures that would help your town to ensure the supply of clean water to all its residents.
5. Explain the differences between pure air and polluted air.
6. Explain circumstances leading to acid rain. How does acid rain affect us?
7. Which of the following is not a greenhouse gas? (a) Carbon dioxide (b) Sulphur dioxide.(c) Methane (d) Nitrogen
8. Describe the 'Green House Effect' in your own words.
9. Describe the threat to the beauty of the Taj Mahal.
10. Why does the increased level of nutrients in the water affect the survival of aquatic organisms?

Unit 8 ❑ Space–time hierarchy of environmental problems: Local, regional and global

Structure

8.0 Objective

- The learners will know about the environmental problems that occur globally. As economic growth and development continues, the environmental impacts increases from local to regional, national, international and even global scale.

8.1 Introduction

Human activities in past decades have raised serious issues related to environment and its conservation. Air pollution, poor management of its waste, growing water scarcity, falling ground water tables, water pollution, waste disposal, desertification, endangered species, preservation and quality of forest, biodiversity loss, and land/soil degradation, global climate change, pollution, environmental degradation, global warming, greenhouse effect, acidification, ozone depletion and other local, regional and global level environmental problems. Genetically modified foods are the current environment problem that make us vulnerable to disasters and tragedies now and in the future. In this chapter the essential aspects of environmental problems, causes, effects will be reviewed with some prescribed solutions to overcome from the environmental issues.

The scale of spatial resolution is also important. Often the early models of the environment developed in the 1960s and 1970s were aspatial, i.e., no geographical dimensions were explicitly incorporated into their structure. With the development of more powerful computers and software packages it has become possible to include spatial disaggregation into modelling efforts. The development of Geographical Information Systems (GIS) is based essentially on relational databases with an explicit geographical set of co-ordinates that has been a major development in modeling spatial aspects of the "real world". Today, many models do include spatial dissaggregated data and can display the information at local, regional, national, international and global levels of resolution.

8.2 What is Environment?

The word environment refers to all ecological units which are naturally present on earth in the form of land, water, air, soil, forest, sunlight, minerals, living organisms etc. This earth is full of natural surroundings, some are biotic and some are non-biotic. Biotic elements are those elements like human, birds, animals, plants, and microorganisms. Whereas non-biotic elements are those which have no life like air, sunlight, water, land, soil, minerals etc., furthermore, it is also divided among four different spheres viz. biospheres, lithosphere, atmosphere and hydrosphere. Hydrosphere is the largest part on the earth among all life on earth.

Currently, the situation of environment is very poor that could never be imagined by our ancestor in earlier time. We have endlessly spoilt our environment by using its resources in a very wrong way. We can see that every day and everywhere pollution is rapidly increasing on earth where it is air, land, water or soil pollution, deforestation, acid rain, and other dangerous disasters that have been created by the humans through technological advancement. Use of natural resources should be carefully planned and executed for providing a better and healthy life to our forth coming generation.

8.3 Environmental issues

An environmental problem occurs when there comes a change in quality or the quantity of the environmental factors that directly or indirectly affect everything on earth. "Environmental issues are defined as problems within the planet system (air, water, soil etc.) that have developed as a result of human interference or mistreatment of the planet." A

variety of environmental problems now affect our entire world. As globalization continues and the earth's natural processes transform local problems into international issues. Some largest problems now affecting the world are: acid rain, air pollution, global warming, hazardous wastes, ozone depilation, smog, water pollution, overpopulation and rain forest destruction. It is related to not only environment but also with everyone that lives in the planet. It affects every human, animal, and nation on this planet. Human have faced poor environmental conditions throughout history, but what we think of as environmental problems become more common and apparent with industrialization and urbanization. In the United States for example, air and water pollution from the factories and dense urban living conditions attracted growing attention throughout the last centuries, and by the 1960s become recognized as significant problems. Air and water pollution rapidly spread to a range of other conditions- soil erosion, pesticides contamination, deforestation, declining animal population and species and so on. Environmental scientists, activists, and policy-makers constantly alerted over the issues.

Finally, a global environmental problem is greenhouse effect. Whoever introduces carbon dioxide and other gases into the atmosphere, the source causes atmospheric increase of such gases everywhere. Right now carbon dioxide concentration is over 400 ppm and still increasing. This is a global problem.

These diverse concerns gradually merge into environmental problems, and the 1970 Earth Day in United States and then the 1972 United Nation Conference on the Human Environment in Stockholm helped turn "Environmental Quality" into a major international issue. By the time of the United Nation Conference on Environment and Development in Rio De Janeiro in 1992, significant "Green Parties" had been formed in Europe and environmental problems were the subject of citizen and governmental attention worldwide. Environmentalist, a social and environmental movement addresses environmental issues through advocacy, education and activism.

The environmental issues can occurs at three levels, local, regional and global.

Local environmental issues-

Some major local environmental issues are given below-1. Pollution, 2. Waste Disposal, 3. Desertification, 4. Water Scarcity, 5. Endangered Species

1. Pollution: Pollution can be defined as an undesirable addition of constituents to water, land, air which adversely affect human life, species, living conditions and will deteriorate our resources. Pollution can be classified mainly into four categories air

pollution, water pollution, soil pollution, noise pollution. The pollution occurs at the local and also global level.

Air pollution: Air pollution refers to any physical, chemical and biological change in the air. It is the contamination of air by harmful gases, dust and smoke which affect plants, animals, and humans drastically. There is a certain percentage of gases present in the atmosphere.

Major air pollutants, their sources and their impact:

Carbon monoxide (CO): Its main source is fuel combination from engines and vehicles. It reduces the amount of oxygen, aggravate heart disease, chest pain.

Lead (Pb): It releases from metal refineries and other metal industries, waste incinerators. It impacts on our nervous system, results in IQ loss, cardiovascular and renal effects in adult, effects related to an aemia.

Nitrogen oxide: It is released in environment by fuel combustion, wood burning. It mainly enhances lung diseases leading to respiratory symptoms that increase susceptibility to respiratory infection.

Sulphur dioxide (SO_2): It is released by fuel combustion as well as natural occurrences like volcanoes. It causes asthma and breathing difficulty. Air pollution control: The techniques employed to reduce or eliminate the emission into the atmosphere of substances that can harm the environment or human health. Different types of methods are in use for the air pollution control –control of particulates airborne particles can be removed form a polluted airstream by a variety of physical process. Some common types of equipment for collecting fine particulates includes cyclones, scrubbers, electrostatic precipitators, and baghouse filters. Once collected, particulates adhere to each other, forming agglomerates that can readily be removed from equipment and disposed of, usually in landfill. Control of gases- gaseous criteria pollutants, as well as volatile organic compounds (VOCs) and other gaseous air toxics, are controlled by means of three basic techniques, absorption, adsorption and incineration. These techniques can be employed singly or in combination. They are effective against the major greenhouse gases as well. In addition, a fourth technique, known as carbon sequestration, is in development as a means of controlling carbon dioxide levels.

b) **Water pollution**: Water pollution is the contamination of pollutants in water bodies like lakes, rivers, oceans, aquifers and groundwater without treatment very often by human activities that lead to harmful effects.

Source of water pollution:

Natural sources: These include decay and decomposition of plants and animals, volcanic eruptions, coastal, cliff erosion, landslides and soil erosion.

Anthropogenic sources: This includes industry, urban, agricultural and cultural sources.

Effect of water pollution:

Death of aquatic animals.

Irrigation by polluted water affects plants resulting in yellowish coloration and defoliation.

Diseases- hepatitis, cholera, typhoid, jaundice, diarrhoea and skin diseases. Disruption of food chains. Destruction of ecosystems.

Control measure of water pollution:

1.Water pollution, to a larger extent, can be controlled by a variety of methods. Rather than releasing sewage waste in water bodies, it is better to treat them before discharge. Practicing this can reduce the initial toxicity and the remaining substances can be degraded by the water bodies itself. If the secondary treatment of water has been carried out, then this can be reused in sanitary systems and agricultural fields.

Some chemical methods that help in the control of water pollution are precipitation, the ion exchange process, reverse osmosis and coagulation. As an individual, reusing, reducing, and recycling wherever possible will advance a long way in overcoming the effects of water pollution.

2. **Waste Disposal**: Waste disposal is the collection, processing and recycling or deposition of waste material of human society. Waste is classified by source and composition. Waste materials are either liquid or solid in form, and their components may be either hazardous or inert in their effects on health and environment. We used plastic bag, broken glass, obsolete cell phone, or used battery cells. These are all used products that require appropriate disposal to limit their harm to the environment. The term waste is typically applied to solid waste, sewage, hazardous waste, and electronic waste.

Sources of waste: Medical or clinical sources of wastes include the surgical items, pharmaceuticals, blood, body parts, wound dressing materials, needles, syringes.

- **Agricultural sources of wastes:** Wastes generated by agricultural activities, include horticulture, livestock breeding, market gardens and seedling nurseries.

- **Industrial sources of wastes:** These are released from manufacturing and processing industries like chemical plants, cement factories, power plants, textile industries, petroleum industries.

Wastes from construction or demolition are concrete debris, wood, huge package boxes. Some other sources such as commercial sources, mining sources, radioactive sources, electronic sources are also the big sources of waste pollution.

Waste disposal problems: Production of too much waste, one of the major problems, related to disposal is attributed to the generation of too much waste. Mumbai and Delhi generate about 11,000 and 8,700 tones of solid waste per day, respectively. India is getting buried under mounds of garbage as the country has been generated more than 1.50 lakh metric tonnes of solid waste every day. Most of the waste is toxic and harmful for the human beings and the environment. The majority of the states and local authority legislations are generally lax on regulating toxic industrial products that end up getting thrown away after use. Most of the products contain hazardous and health threatening chemicals. This chemical causes majority of water pollution, soil pollution. Landfills are a problem as well. Most landfills lack proper on-site waste management, thereby contributing to additional threats to the environment. In long term, landfills leak and pollute ground water and other neighbouring environment habitat making waste disposal very difficult. They also release potentially unsafe gases.

8.4 Solution to Waste Disposal: Eco responsibility –"reduce, reuse, recycle"

Eco-responsibility pertains to the "**three Rs"** mantra of reuse, reduce and recycle. Local communities' authorities and state need to put more efforts towards the education of waste management. Effective waste disposal and management ensures a gradual improvement of new and cost- effective facilities which aim to encourage higher environmental protection standards. Landfills are generally located to ease waste collection, transfer, and monitoring or recycling. Thousand of tonnes of construction and demolition materials are generated by various local construction industries. In most of the cases, a large portion of these waste materials can be re used, reclaimed or recycled. With the control and monitoring of land filling and fly tipping activities in the area of public work, constructions and demolition materials can be resourcefully reclaimed, reused or recycled in other projects such as landscaping, village houses, recreation facilities, car parks, and roads.·

Waste diversion plans- A multifaceted approach on waste transfer and diversion in terms of more hygienic and efficient waste disposal management can offer tremendous solution to waste problems. Improvement of thermal waste treatment has been proved not to be 100% green as they are normally pronounced. Therefore, to mitigate the problems that come with thermal waste treatment issues such as emission of toxic gases with organic compounds such as furans, PAHs, and dioxins, states and researches as well as green groups and academicians can explore the possible developments with regards to advanced thermal waste treatment techniques.

2. Desertification– Desertification is a type of land degradation in dry lands in which biological productivity is lost due to natural processes or induced by human activities by which fertile areas become increasingly more arid. It is the spread of arid areas caused by a variety of factors, such as through climate change and through the overexploitation of soil through human activity.

Various causes of desertification-

- Overgrazing – if there are too much animals that that are overgrazing in certain spots it makes it difficult for the plant to grow back, which hunts the biome and make it loss its former green glory.
- Deforestation- wood extraction, and infrastructure expansion such as road building and urbanization contribute to the problems related to desertification.
- Farming practice- some farmers do not know how to use the land effectively. They may essentially strips the land of everything that it has, before moving the another plot of land. By stripping the soil of its nutrients, desertification becomes more of a reality for the area that is being used for the farming.
- Excessive use of fertilizers and pesticides- the use of excessive amount of fertilizer and pesticides to maximize to their crop yields in the short term often lead to significant damages for the soil. In the long run, this may turn from arable into arid land over time and not suitable for the farming.
- Over drafting of ground water is a process in which groundwater is extracted in excess of the equilibrium yield of the aquifer that is pumping or pulling excessive groundwater from underground aquifers. Its depletion causes desertification.
- Climate change plays a huge role in desertification. As the days get warmer and periods of drought become more frequent, desertification becomes more and more eminent. Unless climate change is slowed down, huge areas of land will become desert.

- There are also some reasons such as natural disasters, soil pollution, overpopulation and excessive consumptions, mining etc.that cause desertification.

Effects of desertification-

- Farming becomes next to impossible. It is impossible to grow sustainable crops without special technologies. This can cost a lot of money to try.So many farmers will have to sell their desert land.

  Flooding is a lot more imminent. Not all desert are dry; those that are wet could experience a lot of flooding because there is nothing to stop the water from gathering and going all over the place.
- Biodiversity loss: Endangerment and extinction of species, the destruction of habitats and desertification may also contribute to a loss of biodiversity. Many species will not be able to adjust to the altered environmental conditions and may suffer from serious decline in population.
- Migration: When large areas of land that were used for farming will no longer be suitable for farming due to many reasons results in serious migration movements.

Solution to desertification:

- Policy change related to how much people can farm and how much they can farm on a certain area could be put into place to help reduce the problems that are often associated with farming and desertification.
- Education: In developing countries, education is an incredibly important tool that needs to be utilized in order to help people to understand the best way to use the land that they are farming on. By educating them on sustainable practices, more land will be saved from becoming desert.

  Research and application of the latest technology can limit the desertification process.
- Mining often implies the destruction of large area of land.

  Therefore, it should be regulated by governments to keep the nature reserves intact and protect the natural habitats of animals, plants and micro-organisms. Thus, the desertification issues can be mitigated to a certain extent.

Reforestation: The area that have been subject to deforestation in past should be considered for reforestation. Planting trees in those areas are quite important since they are natural carbon dioxide storage spaces; they slow down the global warming and contribute

to maintaining a natural balance. Therefore, planting trees in the affected areas not only prevents desertification but also fight against additional environmental issues.

4**. Water Scarcity:** Water scarcity involves water crisis, water shortage, water deficit or water stress. Water scarcity can be due to physical water scarcity and economic water scarcity. Physical water scarcity refers to a situation where natural water resources are unable to meet a region's demand while economic water scarcity is a result of poor management of water resources. "Water scarcity is the lack of sufficient available water resources to meet the demands of water usage within a region. Almost two thirds of the world's population experience severe water crisis for at least one month each year. More than 1.2 billion people lack access to clean drinking water.

Causes of water scarcity:

- Overuse of water is a huge issue that a lot of people are dealing with. It may be overused on people, animals, land or many other numbers of things.
- Pollution of water can occur from a variety of sources. Pollution comes from oil, carcasses, chemicals, industrial wastes, and from municipality waste.
- Global warming: Increase of average air temperature may contribute to drying up of water bodies due to rising evaporation rate.
- Illegal dumping: Industries frequently dispose of their industrial garbage into near by river and lakes since it is an easy and cheap way to get rid of this waste. It leads to serious water pollution, which may result in water scarcity for local people.
- Natural disasters like tsunamis, floods may also cause serve water shortages for local people since important public infrastructure may be destroyed.
- Drought is a prolonged period of abnormally low rainfall, leading to a shortage of water. Some areas are in a perpetual drought, whereas other areas may be dealing with drought on occasion. It can last for months or years. It has substantial impact on the ecosystem and agriculture of the affected region.

Effects of water scarcity:

Lack of access to drinking water is the biggest problem that may occur due to water scarcity. People are not able to get fresh, clean drinking water.

- Hunger and poverty: Water scarcity has a direct impact on rain-fed and irrigated agriculture as well as livestock. It leads to food shortages which in turn stuck People in hunger and poverty as well.
- Diseases and sanitation issues: Access to clean water is necessary to get rid of water-borne diseases.
- Destruction of habitats and loss of biodiversity: Water is crucial for all life forms on our planet. If water scarcity persists over a longer period, it leads to the destruction of whole habitats. Animals and plants may no longer be able to get enough water and may therefore die or have to move to other regions. Some animals become extinct. They no longer be able to grow and reproduce in a sufficient manner causing serious biodiversity loss.

Solutions to control water scarcity

- Save water whenever possible: This could mean limiting the use of water, the use of washing machines, taking short showers instead of full baths.
- Recycle water:There are plenty of technologies available that allow to recycle rainwater and other water that can be used in residential areas. Not only does it help to prevent scarcity, but it can save some money as well. Water can be conserved using advance technology.
- Improve practices related to farming: Farming and irrigation are often a huge culprit when it comes to water scarcity. Because of that, we need to improve practices so that we don't use as much water and those who are using water are using it to fullest potential.
- Less use of chemical in farming: At present, excessive levels of chemical fertilizers and pesticides are used to maximize crop yields. It leads to serious soil pollution, which in turn translates into groundwater pollution and contributes to the water scarcity issue. It is crucial that farmers reduce the use of chemicals for farming to ensure clean water and reduced water shortage problem.
- Improve sewage systems: Clean drinking water starts with a good sewage system. Without proper sanitation, the water in an area becomesridden with disease and any number of other problems. By improving thesewage systems, we canprevent water scarcity from becoming worse.

- Better water distribution infrastructure: Many people worldwide, especially in poor developing countries, are still not connected to the public water infrastructure. These people are at high risk to suffer from severe water shortages. By connecting these people to the public water supply, water scarcity risk could be greatly reduced.

8.5 Summary and Conclusion

All of us are inheritors of common global environment.All of us are responsible for its growing deterioration. If the deterioration exceeds alimit, it shall be a dangerous place to live in.Pollution, ozone-hole, greenhouse effect, desertification, loss of biodiversity, oil spills,nuclear disasters, hazardous waste management, are some of the global environmentalproblems that need immediate collective attention. Increased human activity, urbanisation, industrialisation are led to rapid deteriorationof the environment. This has severely affected the life supporting system.

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8.7 Model Questions

1. Why do you think environmental issues are of global significance?
2. Enumerate at least 3 environmental issues that confront us today.
3. Define global warming.
4. Why is green-house effect called so?
5. Which kind of radiations are not reflected back out of atmosphere causing greenhouse effect?
6. Name four green-house gases.

Module-2

Principles and Management

Unit 9 ❑ Urban environmental issues with special reference to waste management and rural environmental issues with special reference to sanitation and public health

Structure

9.0 Objective

- The learners will get an overview of the urban and rural environmental problem.

9.1 Introduction

Urban areas are considered as the cradles of human civilization and culture. These are also considered as centres for consumption and products of emissions, solid waste and sewage because population in urban centres is growing day by day not only in India but also all over the world.

Urban Environmental issues are harmful effects of mankind on the biophysical environment. Environmental degradation, pollution, climate change, noise from traffic or neighbours, congestion, shortage of basic amenities, health problems etc., are some environmental problems in urban areas. These urban areas have their characteristic problems such as explosive increases in population, gross inadequacy of infrastructural

facilities and services, overcrowding and traffic congestion, crumbling old city centres, neighbourhood degradation, etc. They are also congested, chaotic, squalid and unpleasant. At the same time they provide better employment opportunities, higher income levels, better education, health and social services. Various types of problems like shortage of housing and sanitation, growth and expansion of slums, environmental pollution, urban poverty, lack of pure drinking water, unemployment, poor public transport, improper treatment of sewage, uncollected solid waste, etc. are at present people are facing due to urbanization. These problems are not all of recent making and becoming threats to people's present and future wellbeing.

According to Census 2011, India's Urban population is 377 million and world's urban population is 3.6 Billion. The proportion of urban population raised from 28% to 31% during 2001-2011, while the proportion of rural population declined from 72% to 69%. Thisrapid urban population growth exerts more pressure on environment. In developing countries like India, natural population increase and rural to urban migration are significant factors in the growth of towns/ cities. Improved medical felicities, better sanitation and improved food supplies are the reasons for population to grow, whereas migration caused by poverty drives people from the rural to urban areas in search of employment, food, shelter and education. In rural areas, people become victims of unpredictable weather conditions like drought and floods, which can affect their livelihood. Due to this, many farmers from villages move to cities in search of jobs and other facilities. In contrast, cities offer job opportunities and other services.

9.2 Some important environmental problems in urban areas

a. Solid waste : Urban areas consume large quantities of materials and release a lot of garbage. It includes domestic, municipal and industrial solid waste. Stagnation of solid wastes for many days releases poisonous gases with pungent smell that causes different vector borne diseases.

b. Depletion of natural resources :The consumption of natural resources is very high in urban areas creating shortage of electricity, drinking water, Space etc..

c. Destruction of Habitats: A lot of agricultural and forest lands are decreasing due to expansion of towns and cities eliminating habitats to many animals and birds.

d. Water pollution :Ground water contamination occurs due to sewage obtained from domestic, commercial and industrial buildings. Water containing lead can cause serious damage to the brain, kidneys, nervous system and red blood cells. Chemicals, gasoline, oil etc. get into the groundwater and become unsafe for human use.

e. Air pollution: Most of the urban areas are prone to air pollution due to automobiles, industries and human induced activities. Automobiles emit gases like carbon monoxide, carbon dioxide, hydrocarbons, oxides of Nitrogen and Sulphur, toxic substances as fine particles and vapors of organic compounds. There are more adverse effects of these pollutants on wellness and environment. Ozone is a concern of air pollution which damage in the upper atmosphere. Chloro-Fluro carbons are responsible for ozone depletion. Fluorinated greenhouse gases (F-gases) are powerful greenhouse gases that trap heat in the atmosphere and contribute to global warming.

f. Sound pollution: Sound pollution is the propagation of noise that has become a part of urban life. Sound in urban areas produced by automobiles, social functions industries etc. creates noise pollution. This pollution causes psychological and physical health hazards. Noise can increase stress, which over the long period can lead to heart disease, high blood pressure, stroke, deafness etc.

g. Rise in Temperature: Temperature increases drastically in urban areas due to unplanned construction of apartments and large buildings. These buildings absorb and emit solar radiation which causes many health problems.

h. Growth of Slums : Rapid growth of urbanization and industrialization has resulted the growth and spread of slums. These are densely populated areas where living conditions are not good. The expansion of slums happens due to migration of rural population to urban areas for employment.

Human interactions with the environment: Human activities have always resulted in waste production. As population and purchasing power of people increases worldwide, more goods are produced to meet increasing demand, thereby leading to the production of more waste. These continuous flows of waste resulting from human activities, overburdened the environment.

Proper planning is required to prevent the negative impact of waste on the environment. Thus waste management particularly of solid waste management has become an essential task needed to safeguard the urban environment.

Provision of an efficient solid waste management system is now as important as other essential amenities such as electricity, airports, and highways. Due to the increasing volume of waste the continuous disposal of waste to landfill is unsustainable. Hence, the processing of waste is a necessary step needed to safeguard public health.

9.3 Waste management or waste disposal

Waste management or waste disposal includes the activities and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process and waste-related laws, technologies, economic mechanisms.

Waste can be solid, liquid, or gaseous and each type has different methods of disposal and management. Waste management deals with all types of waste, including industrial, biological and household. In some cases, waste can pose a threat to human health. Health issues are associated with the entire process of waste management. Health issues can also arise indirectly or directly, directly through the handling of the waste and indirectly through the consumption of contaminated water, soil and food. Waste is produced by human

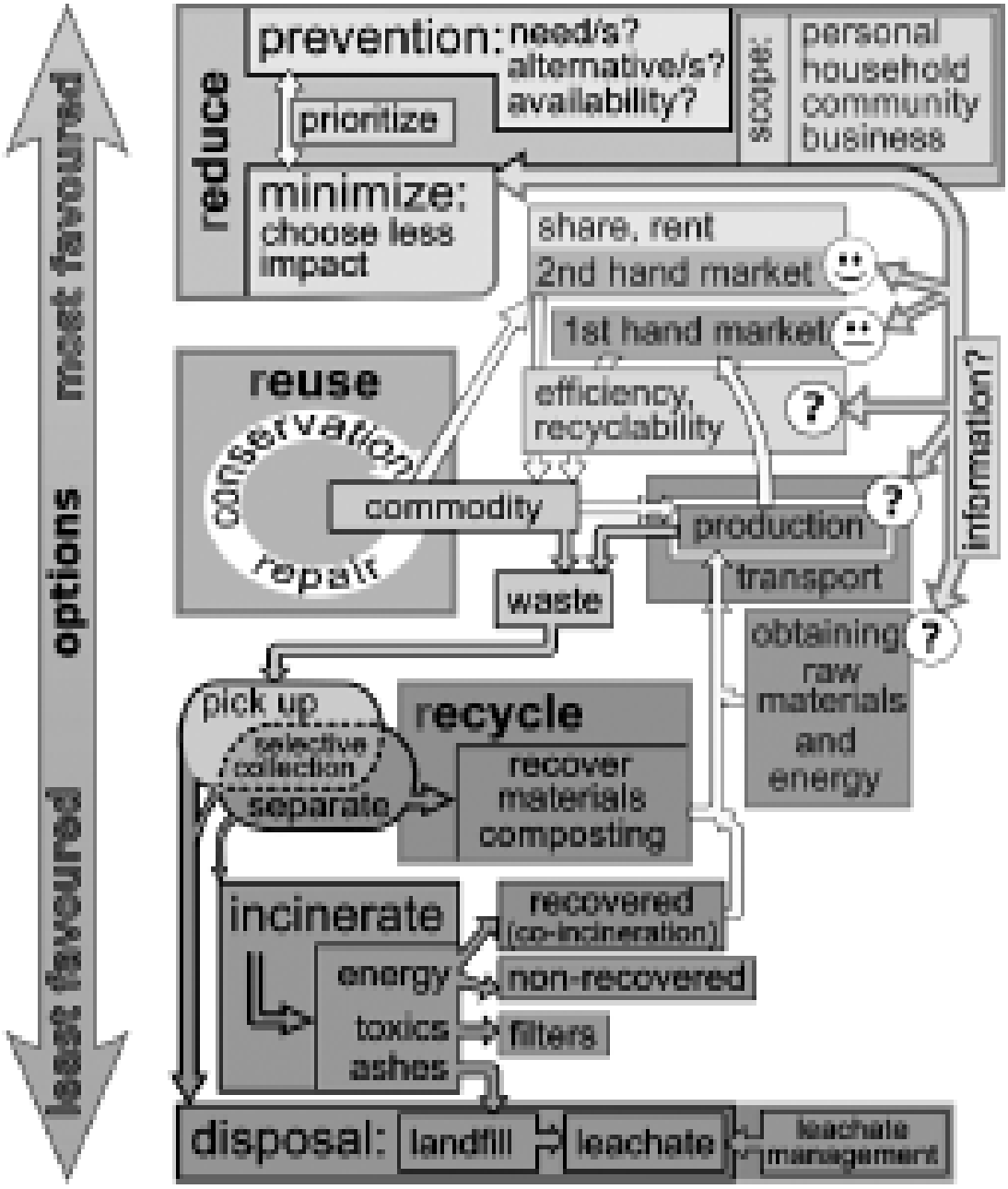
activities. Waste management is intended to reduce adverse effects of waste on human health, the environment, planetary resources and aesthetics.

Waste management practices are not uniform among countries. The developed and developing nations, the urban and rural areas, and the residential and industrial sectors can take different approaches. Proper management of waste is important for building sustainable cities, but it remains a challenge for cities of many developing countries. A report found that effective waste management is relatively expensive, usually comprising 20%–50% of municipal budgets. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported.Large portion of waste management practices deal with municipal solid waste (MSW) which is the bulk of the waste that is created by household, industrial, and commercial activity. Measures of waste management include measures for integrated techno-economic mechanisms of a circular economy, effective disposal facilities, export and import control and optimal sustainable design of products that are produced.

Principles of Waste Management

Waste hierarchy

The waste hierarchy refers to the "3 Rs" Reduce, Reuse and Recycle, which classifies waste management strategies according to their desirability in terms of waste minimisation. The waste hierarchy is the cornerstone of most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of end waste i.e. resource recovery. The waste hierarchy is represented as a pyramid. The policies should promote measures to prevent the generation of waste. The next preferred action is to seek alternative uses for the waste that has been generated i.e. by re-use. The next step is recycling which includes composting. Following this step is material recovery and coversion of waste-to-energy. The final action is disposal in landfills or through incineration without energy recovery. This last step is the final resort for waste which has not been prevented, diverted or recovered. The waste hierarchy represents the progression of a product or material through the sequential stages of the pyramid of waste management. The hierarchy represents the latter parts of the life-cycle for each product.



Life-cycle of a product

The life-cycle begins with design, then proceeds through manufacture, distribution, and primary use and then follows through the waste hierarchy's stages of reduce, reuse and recycle. Each stage in the life-cycle offers opportunities for policy intervention, to rethink

the need for the product, to redesign to minimize waste potential, to extend its use. Product life-cycle analysis is a way to optimize the use of the world's limited resources by avoiding the unnecessary generation of waste.

Resource efficiency

Resource efficiency reflects the understanding that global economic growth and development can not be sustained at current production and consumption patterns. Globally, humanity extracts more resources to produce goods than the planet can replenish. Resource efficiency is the reduction of the environmental impact from the production and consumption of these goods, from final raw material extraction to the last use and disposal.

Polluter-pays principle

The polluter-pays principle mandates that the polluting party pays for the impact on the environment. With respect to waste management, this generally refers to the requirement for a waste generator to pay for appropriate disposal of the unrecoverable material.

Waste Handling

Waste collection methods vary widely among different countries and regions. Domestic waste collection services are often provided by local government authorities, or by private companies for industrial and commercial waste. Some areas, especially those in less developed countries, do not have formal waste-collection systems.

Waste handling practices

Curbside collection is the most common method of disposal in most European countries, Canada, New Zealand, United States, and many other parts of the developed world in which waste is collected at regular intervals by specialised trucks. This is often associated with curb-side waste segregation. In rural areas, waste may need to be taken to a transfer station. Waste collected is then transported to an appropriate disposal facility. In some areas, vacuum collection is used in which waste is transported from the home or commercial premises by vacuum along small bore tubes. Systems are in use in Europe and North America.

In some jurisdictions unsegregated waste is collected at the curb-side or from waste transfer stations and then sorted into recyclables and unusable waste. Such systems are

capable of sorting large volumes of solid waste, salvaging recyclables, and turning the rest into bio-gas and soil conditioner. Other businesses such as Waste Industries use a variety of colors to distinguish between trash and recycling cans. In addition, in some areas of the world the disposal of municipal solid waste can cause environmental strain due to official not having benchmarks that help measure the environmental sustainability of certain practices.

Waste segregation

This is the separation of wet waste and dry waste. The purpose is to recycle dry waste easily and to use wet waste as compost. When segregating waste, the amount of waste that gets landfilled reduces considerably, resulting in lower levels of air and water pollution. Waste segregation should be based on the type of waste. This also makes it easier to apply different processes to the waste, like composting, recycling and incineration.

Segregated waste is also often cheaper to dispose of because it does not require as much manual sorting as mixed waste. There are a number of important reasons why waste segregation is important such as legal obligations, cost savings and protection of human health and the environment. Institutions should make it as easy as possible for their staff to correctly segregate their waste. Labeling is especially important when dealing with medical and nuclear wastes.

Recommended colour coding of containers

- Yellow- for infectious waste
- Brown- for chemical and pharmaceutical waste
- Black- for general waste

Disposal methods

Landfill

A landfill compaction vehicle in action.

incineration plant in Vienna

A landfill is a site for the disposal of waste materials by burial. Landfill is the oldest form of waste treatment, although the burial of the waste is modern; historically, refuse was simply left in piles or thrown into pits. Landfills must be open and available to users every day. While the majority of its customers are municipalities, commercial and construction companies, residents are also allowed to use the landfill in most cases. Historically, landfills have been the most common method of organized waste disposal and remain so in many places around the world.

Incineration

Incineration is a disposal method in which solid organic wastes are subjected to combustion so as to convert them into residue and gaseous products. This method is useful for disposal of both municipal solid waste and solid residue from waste water treatment. This process reduces the volumes of solid waste by 80 to 95 percent. Incineration and other high temperature waste treatment systems are sometimes described as "thermal treatment". Incinerators convert waste materials into heat, gas, steam, and ash.

Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous waste. It is recognized as a practical method of disposing of certain hazardous waste materials (such as biological medical waste). Incineration is a controversial method of waste disposal, due to issues such as emission of gaseous pollutants including substantial quantities of carbon dioxide.

Recycling

Steel crushed and baled for recycling

Recycling is a resource recovery practice that refers to the collection and reuse of waste materials such as empty beverage containers. This process involves breaking down and reusing materials that would otherwise be gotten rid of as trash. There are numerous benefits of recycling, and with so many new technologies making even more materials recyclable, it is possible to clean up the Earth. Recycling not only benefits the environment but also positively effects the economy. The materials from which the items are made can be made into new products. Materials for recycling may be collected separately from general waste using dedicated bins and collection vehicles, a procedure called kerbside collection. In some communities, the owner of the waste is required to separate the materials into different bins (e.g. for paper, plastics, metals) prior to its collection. In other communities, all recyclable materials are placed in a single bin for collection, and the sorting is handled later at a central facility. The latter method is known as "single-stream recycling."

A recycling point in Finland

The most common consumer products recycled include aluminium such as beverage cans, copper such as wire, steel from food and aerosol cans, old steel furnishings or equipment, rubber tyres, polyethylene and PET bottles, glass bottles and jars, paperboard cartons, newspapers, magazines and light paper, and corrugated fiberboard boxes.

Polyvinyl Chloride (PVC), low density polythylene (LDPE), polypropylene(PP),and polystyrene(PS) are also recyclable. These items are usually composed of a single type of

material, making them relatively easy to recycle into new products. The recycling of complex products (such as computers and electronic equipment) is more difficult, due to the additional dismantling and separation required.

The type of material accepted for recycling varies by city and country. Each city and country has different recycling programs that can handle the various types of recyclable materials based on the resale value of the material once it is reprocessed. Some of the types of recycling include waste paper and cardboard, plastic recycling, metal recycling, electronic devices, wood recycling, glass recycling, cloth and textile and so many more. In July 2017, the Chinese government announced an import ban of 24 categories of recyclables and solid waste, including plastic, textiles and mixed paper, placing tremendous impact on developed countries globally, which exported directly or indirectly to China.

Re-use

Biological reprocessing

An active compost heap.

Recoverable materials that are organic in nature, such as plant material, food scraps, and paper products, can be recovered through composting and digestion processes to decompose the organic matter. The resulting organic material is then recycled as mulch or compost for agricultural or landscaping purposes. In addition, waste gas from the process such as methane can be captured and used for generating electricity and heat. There are different types of composting and digestion methods and technologies. They vary in complexity from simple home compost heaps to large scale industrial digestion of mixed domestic waste.

Energy recovery

Energy recovery from waste is the conversion of non-recyclable waste materials into usable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolyzation, anaerobic digestion, and landfill gas recovery. This process is often called waste-to-energy. Energy recovery from waste is part of the non-hazardous waste management hierarchy. Using energy recovery to convert non-recyclable waste materials into electricity and heat, generates a renewable energy source and can reduce carbon emissions by offsetting the need for energy from fossil sources as well as reduce methane generation from landfills. Globally, waste-to-energy accounts for 16% of waste management.

The energy content of waste products can be harnessed directly by using them as a direct combustion fuel, or indirectly by processing them into another type of fuel. Thermal treatment ranges from using waste as a fuel source for cooking or heating and the use of the gas fuel (see above), to fuel for boilers to generate steam and electricity in a turbine. Pyrolysis and gasification are two related forms of thermal treatment where waste materials are heated to high temperatures with limited oxygen availability. The process usually occurs in a sealed vessel under high pressure. Pyrolysis of solid waste converts the material into solid, liquid and gas products. The liquid and gas can be burnt to produce energy or refined into other chemical products (chemical refinery). The solid residue (char) can be further refined into products such as activated carbon. Gasification and advanced Plasma arc gasification are used to convert organic materials directly into a synthetic gas (syngas) composed of carbon monoxide and hydrogen. The gas is then burnt to produce electricity and steam. An alternative to pyrolysis is high temperature and pressure supercritical water decomposition (hydrothermal monophasic oxidation).

Pyrolysis

Pyrolysis is often used to convert many types of domestic and industrial residues into a recovered fuel. Different types of waste input (such as plant waste, food waste, tyres) placed in the pyrolysis process potentially yield an alternative to fossil fuels. Pyrolysis is a process of thermo-chemical decomposition of organic materials by heat in the absence of stoichiometric quantities of oxygen; the decomposition produces various hydrocarbon gases. Slow pyrolysis produces gases and solid charcoal. Pyrolysis hold promise for conversion of waste biomass into useful liquid fuel. Pyrolysis of waste wood and plastics

can potentially produce fuel. The solids left from pyrolysis contain metals, glass, sand and pyrolysis coke which does not convert to gas. Compared to the process of incineration, certain types of pyrolysis processes release less harmful by-products that contain alkali metals, sulphur, and chlorine.

Resource recovery

Resource recovery is the systematic diversion of waste, which was intended for disposal, for a specific next use.It is the processing of recyclables to extract or recover materials and resources, or convert to energy. These activities are performed at a resource recovery facility. Resource recovery is not only environmentally important, but it is also cost-effective. It decreases the amount of waste for disposal, saves space in landfills, and conserves natural resources.

Application of rational and consistent waste management practices can yield a range of benefits including:

1. Economic – Valuable materials can be recovered for reuse. Improving economic efficiency and creating markets for recycles can produce new jobs and new business opportunities.
2. Social – By reducing adverse impacts on health by proper waste management practises, the resulting consequences can lead to new sources of employment and lift communities out of poverty especially inpoorer countries.
3. Environmental – Reducing or eliminating adverse impacts on the environment through reducing, reusing and recycling, and minimizing resource extraction can result in improved air and water quality and help in the reduction of greenhouse gas emissions.
4. Inter-generational Equity – Effective waste management practises can provide subsequent generations a more robust economy, a fairer and more inclusive society and a cleaner environment.

Sustainability

The management of waste encourages companies to improve their environmental efficiencies each year by eliminating waste through resource recovery practices.

Wastes are a direct result of human interaction and activities. Nevertheless, there seems to be several opinions as to what constitute a waste. Several researchers however

agreed that wastes are materials whose owners no longer have a need for. Therefore, it is obvious that wastes is indeed subjective in meaning, as the term is open to several interpretations and also influenced by personal opinion. Nevertheless, it is important to provide a definition or at least a guide for the purposes of policies and legislations. This is evident from the fact that, it is the knowledge of what specifically constitute a waste and the categories of wastes that determines how wastes are dealt with or managed. Waste management involves a process whereby wastes are collected, transported and disposed of in the best possible way of limiting or eliminating the harmful effect of wastes. This aspect of environmental management is as important as other public amenities or infrastructures without which the life of contemporary man would be extremely difficult. This is because studies have shown a direct link between air, water and land pollution and diseases such as lung cancer, heart disease, cholera and hepatitis. In addition, climate change and eutrophication are a direct result of water and air pollution. Little wonder why there is a huge disparity in the life expectancy of people in developed and developing countries. Since factors such as population increase lead to increase waste generation. Efforts should be directed towards making projections far ahead in order to ensure that new and existing settlements are adequately planned so as to accommodate possible increase in the volume of waste generation in future. Effective planning ahead will prevent indiscriminate disposal and other harmful practices so as to prevent the build-up of open dumps and breeding ground for rats and other vermin which pose health risks.

9.4 Rural Environmental Issues

Sustainable Development Goal calls for adequate and equitable sanitation for all. The target (6.2) is tracked with the indicator of “safely managed sanitation services”.

Sanitation and health

Some 827 000 people in low- and middle-income countries die as a result of inadequate water, sanitation, and hygiene each year, representing 60% of total diarrhoeal deaths. Poor sanitation is believed to be the main cause. Diarrhoea remains a major killer but is largely preventable. Better water, sanitation, and hygiene could prevent the deaths of 297 000 children aged under 5 years each year.

Open defecation perpetuates a vicious cycle of disease and poverty. The countries where open defection is most widespread have the highest number of deaths of children aged under 5 years as well as the highest levels of malnutrition and poverty.

Benefits of improving sanitation

Benefits of improved sanitation extend well beyond reducing the risk of diarrhoea. These include:

- reducing the spread of intestinal worms, schistosomiasis and trachoma, which are neglected tropical diseases that cause suffering for millions;
- reducing the severity and impact of malnutrition;
- promoting dignity and boosting safety, particularly among women and girls;
- promoting school attendance: girls' school attendance is particularly boosted by the provision of separate sanitary facilities; and
- potential recovery of water, renewable energy and nutrients from faecal waste.

A WHO study in 2012 calculated that for every US$ 1.00 invested in sanitation, there was a return of US$ 5.50 in lower health costs, more productivity, and fewer premature deaths.

Challenges

In 2013, the UN Deputy Secretary General issued a call to action on sanitation that included the elimination of open defecation by 2025. Achieving universal access to a basic drinking water source appears within reach, but universal access to basic sanitation will require additional efforts.

Environmental sanitation is a major public health issue in India. Recent interventional studies on environmental sanitation in India highlighted the importance of prioritizing control strategies. Research related to the appropriate costeffective intervention strategies and their implementation in Indian context is a big challenge. This paper discusses various intervention strategies related to environmental sanitation in India and emphasizes to prioritize it according to the need of the country.

In 2010, the UN General Assembly recognized access to safe and clean drinking water and sanitation as a human right, and called for international efforts to help countries to provide safe, clean, accessible and affordable drinking water and sanitation.

The situation of the urban poor poses a growing challenge as they live increasingly in mega cities where sewerage is precarious or non-existent and space for toilets and removal of waste is at a premium. Inequalities in access are compounded when sewage removed from wealthier households is discharged into storm drains, waterways or landfills, polluting residential areas of poor people.

Limited data available on this topic suggests that a large proportion of wastewater in developing countries is discharged partially treated or untreated directly into rivers, lakes or the ocean.

Environmental sanitation envisages promotion of health of the community by providing clean environment and breaking the cycle of disease. It depends on various factors that include hygiene status of the people, types of resources available, innovative and appropriate technologies according to the requirement of the community, socioeconomic development of the country, cultural factors related to environmental sanitation, political commitment, capacity building of the concerned sectors, social factors including behavioral pattern of the community, legislative measures adopted, and others. India is still lagging far behind many countries in the field of environmental sanitation.

Improvement in sanitation requires newer strategies and targeted interventions with follow-up evaluation. The need of the hour is to identify the existing system of environmental sanitation with respect to its structure and functioning and to prioritize the control strategies according to the need of the country. These priorities are particularly important because of issue of water constraints, environment-related health problems, rapid population growth, inequitable distribution of water resources, issues related to administrative problems, urbanization and industrialization, migration of population, and rapid economic growth. Lack of safe water supply, poor environmental sanitation, improper disposal of human excreta, and poor personal hygiene help to perpetuate and spread diarrheal diseases in India.

While no comprehensive study on equity issues relating to water supply, sanitation, and health has been conducted for the country as a whole, common equity issues that plague the sector in most developing countries also hold true for India. In addition, comprehensive studies on the economic value of the water and sanitation sector in India also do not exist.

Implementation of low-cost sanitation system with lower subsidies, greater household involvement, range of technology choices, options for sanitary complexes for women, rural drainage systems, involvement of NGOs and local groups, availability of finance, human resource development, and emphasis on school sanitation are the important areas to be considered. Appropriate forms of private participation and public private partnerships, evolution of a sound sector policy in Indian context, and emphasis on sustainability with political commitment are prerequisites to bring the change.

As the international authority on public health, World Health Organization (WHO) leads global efforts to prevent transmission of diseases, advising governments on health-based regulations.On sanitation, WHO monitors global burden of disease and the level of sanitation access and analyses what helps and hinders progress. Such monitoring gives Member States and donors global data to help decide how to invest in providing toilets and ensuring safe management of wastewater and excreta.

WHO works with partners on promoting effective risk assessment and management practices for sanitation in communities and health facilities through the WHO guidelines on sanitation and health, safe use of wastewater, recreational water quality and promotion of sanitation safety planning. WHO also supports collaboration between “water, sanitation and hygiene (WASH) and health programmes such as neglected tropical diseases, cholera, polio and antimicrobial resistance.

9.5 Summary and Conclusion

Environmental issues need to be addressed through environmental education, advocacy and activism. We need to understand the scale of urban environmental problems,

from the micro to the macro. Counter urbanization is also needed. Policy should relate to proper urban planning / master planning where city planning will consist of operational, developmental and restorative planning. Proper implementation of such plans is crucial in the regulated development of urban areas, which in turn have resulted in mushrooming of slums and squatters, unauthorized and haphazard development and above all environmental degradation and transportation problems within and around the urban areas. Increase urban parks and greenery for better health as it promotes natural cooling. Further, the development plans / master plans are mostly documents prepared with limited forecasting capabilities without capturing the entire dynamics and are generally not responsive to dynamic problems and responsive to policy changes. It is therefore necessary to enable the administrators and planners to graduate and equip with better understanding, methods and tools to tackle the environmental issues of urban areas. Studies are also essential to understand growth of slums, slum population and their quality of life.

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Unit 10 ❑ Environmental policies—Club of Rome, Earth Summits (special reference to Stockholm, Rio, Johannesburg)

Structure

10.0 Objective

The learners will aquaint themselves with the different environmental policies which are related with the protection of the environment.

10.1 Introduction

Environmental policy is the commitment of an organization or government to the laws, regulations, and other policy mechanisms concerning environmental issues. These issues generally include air and water pollution, waste management, ecosystem management, maintenance of biodiversity, the management of natural resources, wildlife and endangered species. The implementation of an energy policy at a global level is of utmost importance to address the issues of global warming and climate changes.

Policies concerning energy or regulation of toxic substances including pesticides and many types of industrial waste are part of the topic of environmental policy. This policy can

be deliberately taken to influence human activities and thereby prevent undesirable effects on the biophysical environment and natural resources, as well as to make sure that changes in the environment do not have unacceptable effects on humans**.**

10.2 Environmental policy, conservation and management

Environmental policy, conservation and management of natural resources were once the function of appointed officials in the public sector. More recently, environmental policy and management has been constructed as a broader project, requiring the direct involvement of communities, individuals, nongovernment organizations, and the corporate sector. Thus, a tendency has emerged for responsibility for environmental protection and management in support of the public interest to be assigned more broadly.

Environmental policy is primarily concerned with how to govern the relationship between humans and the natural environment in a mutually beneficial manner. Traditionally, it has been defined in terms of the problems it addressed, such as controlling pollution and waste flows and limiting habitat loss. However, policy makers have begun to appreciate that environmental policy will only be genuinely successful when it is sensitively integrated with other sectors and policy areas. Politically speaking, 'environmental policy integration' represents a new but potentially difficult stage in the continuing metamorphosis of environmental policy into a much wider policy supporting sustainable human development.

Non-Governmental organizations (NGOs) have the greatest influence on environmental policies. These days, many countries are facing huge environmental, social, and economic impacts of rapid population growth, development, and natural resource constraints. As NGOs try to help countries to tackle these issues more successfully, a lack of understanding about their role in civil society and the public perception that the government alone is responsible for the well-being of its citizens and residents makes NGOs tasks more difficult to achieve. NGOs such as Greenpeace and World Wildlife Fund can help tackling issues by conducting research to facilitate policy development, building institutional capacity, and facilitating independent dialogue with civil society to help people live more sustainable

lifestyles. The need for a legal framework to recognize NGOs and enable them to access more diverse funding sources, high-level support/endorsement from local figureheads, and engaging NGOs in policy development and implementation is more important as environmental issues continue to increase.

International organizations have also made great impacts on environmental policies by creating programmes such as the United Nations Environment Programme and hosting conferences such as the United Nations Earth Summit to address environmental issues.

Though the Clean Air Act 1956 in response to London's Great Smog of 1952 was a historical step forward, and the Air Pollution Control Act 1955 was the first U.S. federal legislation that pertained to air pollution, the 1960s marked the beginning of modern environmental policy making. The publication of Rachel Carson's New York Times bestseller Silent Spring in 1962strengthened environmental movement. Earth Day founder Gaylord Nelson, then a U.S. Senator from Wisconsin, after witnessing the ravages of the 1969 massive oil spill in Santa Barbara, California, became famous for his environmental work. Administrator Ruckelshaus was confirmed by the Senate on December 2, 1970, which is the traditional date used as the birth of the United States Environmental Protection Agency (EPA). Five months earlier, in July 1970, President Nixon had signed Reorganization Plan No. 3 calling for the establishment of EPA. At the time, Environmental Policy was a bipartisan issue and the efforts of the United States of America helped spark countries around the world to create environmental policies. During this period, legislation was passed to regulate pollutants that go into the air, water tables, and solid waste disposal. President Nixon signed the Clean Air Act in 1970 which set the US as one of the world leaders in environmental conservation. The world's first minister of the environment was the British Politician Peter Walker from the Conservative Party in 1970.

In the European Union, the very first Environmental Action Programme was adopted by national government representatives in July 1973. Since then an increasingly dense network of legislation has developed to all areas of environmental protection including air pollution control, water protection and waste policy. EU environmental policy has thus become a core area of European politics.

It may be mentioned here that ISO 14001 Environmental Management System(EMS) is a systematic framework to manage the immediate and long term environmental impacts

of an organization's products, services and processes.EMS ensures compliance with relevant environmental legislation.

10.3 Club of Rome

The Club of Rome was founded in April 1968 by Aurelio Peccei, an Italian industrialist, and Alexander King, a Scottish scientist. It was formed when a small international group of people from the fields of academia, civil society, diplomacy, and industry met at Villa Farnesina in Rome, Italy.

The Club of Rome consists of one hundred full members selected from current and former heads of state and government, UN administrators, high-level politicians and government officials, diplomats, scientists, economists, and business leaders from around the globe. It stimulated considerable public attention in 1972 with the first report to the Club of Rome, *The Limits to Growth.* Economic growth could not continue indefinitely because of resource depletion. Since 1 July 2008 the organization has been based in Winterthur, Switzerland.

The major objectives of the Club of Rome are:

1) To examine the nature and configuration of the profound imbalances that define today's problematique throughout the world, and to attempt to determine the dynamics of the interactions which seemingly exacerbate the situation as a whole.
2) To develop an initial "model" or models of this dynamic situation. These models will reveal those components that are most critical and most dangerous for the future.
3) To construct a "normative" overview from the foregoing models and to clarify the action implications regarding political, social, economic, technological, institutional consequences.
4) Such findings might stimulate the conception of new lines of policy that would be effective in coping with our situation's overall dynamics and its world-wide dimensions.
5) To persuade governments to convene a World Forum,* with an aim at developing the needed operational "macro-models" conducive to endeavors at integrated

policy-planning and to the development of new institutions within whose frame of competence such work could be carried out.

These objectives have been set with the full knowledge that many governments and international organizations are beginning to recognize the dangers with which our present situation is fraught. Thus on the international level bodies such as NATO or OECD are now undertaking detailed work on many individual issues, while the United Nations is planning a world conference on the problems of the "Environment" in 1972. These moves are welcome and should add greatly to our recognition and understanding of the grave matters that are facing the whole of mankind.

This international society of politicians, business leaders, and scientists, appeal for mutual tolerance, understanding, and solidarity in relation to the real problems of the world, and the environmental problems in the first place. The members of the Club prescribe the setting of limits to human expansion over nature. Recently, these ideas of the Club of Rome have been criticized by economists, philosophers, and politicians, being described as "environmental alarmism", i.e. the inevitability of ecological crisis and its devastating consequences for humanity. However, the global environmental crisis is already an undeniable fact and requires a thorough study of the ethical standards of the human behaviour, which are often rooted in moral phenomena such as consumerism, irresponsibility, insensitivity or even selfishness. Nature cannot be only considered as a source of natural resources or benefits to people. The moral motive of nature conservation, despite the power of modern science, is one of the main ideas of the founders and followers of the case of the Club of Rome. It concerns the future where the respect for the value of nature is a new moral principle.

10.4 Earth Summits (special reference to Stockholm, Rio, Johannesburg)

The Earth Summits are decennial meetings of world leders, organized since 1972 with the help of the United Nations, to define ways to stimulate sustainable development at global level. The first summit took place in Stockholm (Sweden) in 1972, the second in Nairobi

(Kenya) in 1982, third in Rio de Janeiro (Brazil) in 1992 and the fourth in Johannesburg (South Africa). The last summit, called Rio+20 took place in Rio de Janerio in 2012.

The Declaration of the United Nations Conference on the Human Environment UNCHE), or Stockholm Declaration, was adopted in 1972 to recognize the right to a healthy environment. In the declaration, the nations agreed to accept responsibility for any environmental effects caused by their actions.

The document opens with seven proclamations covering the global nature of environmental problems and stating that they will require extensive cooperation among nations to resolve. These proclamations conclude that efforts for environmental preservation and improvement will benefit all people and their posterity. The declaration then states twenty-six principles to guide the nations through their responsibilities. The action plan split into three categories includes an environmental assessment called Earthwatch, environmental management, and 109 supporting measures.

The UNCHE is also called the Stockholm Conference. The Declaration of the Conference noted that population growth, developing economies, and technological and industrial advancements harmed the environment. The Declaration asserted that every human has the right to a clean and healthy environment. The declaration stated that humans have the responsibility to manage wildlife and their ecosystems. It sought an end to the discharge of pollution into the environment. It also requested that industrialized nations provide financial and technological support to developing nations. Such support would enable developing nations to grow their economies in an environmentally responsible manner.

The action plan of the Stockholm Conference contained 109 specific recommendations for achieving the goals. The action plan recommended continued scientific research into the effect of pollutants on the environment. A network of pollution monitoring agencies would monitor pollution levels across the world. The United Nations founded the United Nations Environment Programme (UNEP) in 1972 largely to implement initiatives in the action plan and to provide financial and technical support to developing nations on environmental issues.

The United Nations World Summit on Sustainable Development, also called Earth Summit 2002, was held in Johannesburg, South Africa (https://www.encyclopedia.com)

This Earth Summit 2002 produced the Johannesburg Declaration on Sustainable Development. The Johannesburg Declaration reiterates most of the proposals from the Rio Declaration on Environment and Development and Agenda 21, international agreements from Earth Summit 1992. Numerous environmental organizations have criticized Earth Sumit 2002 for not producing any new, substantive international agreements.

Historical Background and Scientific Foundations

The international environmental policies established by Earth Summit 2002 were a direct result of ideas produced by previous international environmental conferences. The most notable of these previous conferences are the United Nations Conference on the Human Environment, United Nations World Commission on Environment and Development, and United Nations Conference on Environment and Development.

In 1983 the United Nations General Assembly established the World Commission on Environment and Development (WCED), also called the Brundtland Commission. The Brundtland Commission addressed three major environmental issues. First, the commission examined critical environmental and sustainable developmental issues. The commission then devised proposals for addressing these issues. Second, the commission proposed new ways in which the international community could cooperate on environmental and sustainable development issues.

In 1987 the Brundtland Commission issued *Our Common Future,* a report of its findings and recommendations. *Our Common Future* asserted that sustainable development must be addressed by any international environmental initiative. *Our Common Future* defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Since *Our Common Future,* every UN conference on the environment has made sustainable development a core aspect of international environmental policy.

Our Common Future asserted that the international community could only resolve the interlocking crises of environmental preservation, economic development, and energy production through a comprehensive sustainable development plan. The Brundtland Commission stated that governments cannot manage these interlocking crises on a local or

national scale. Instead, *Our Common Future* stated that the only viable solution to environmental issues is an international approach that simultaneously addresses all three crises. *Our Common Future* contained specific recommendations for promoting environmental preservation through sustainable development.

10.5 The Rio Declaration

The United Nations Conference on Environment and Development (UNCED), also known as the Rio de Janeiro Earth Summit, the Rio Summit and the Rio Conference was a major United Nations conference held in Rio de Janeiro in 1992.Representatives from 172 countries met in Rio de Janeiro, Brazil for the U.N. Conference on Environment and Development (UNCED), also called Earth Summit 1992. The gathering resulted in several seminal international environmental law conventions that continue to shape international action on environmental issues. The Rio Declaration on Environment and Development and Agenda 21 are the most notable reports produced by Earth Summit 1992.

The Rio Declaration on Environment and Development calls on nations to implement environmental and energy stewardship plans. The declaration further defines national rights and responsibilities in the areas of environmental protection and sustainable development. The Rio Declaration affirms the sovereign right of nations to exploit natural resources within their borders, but only if their actions do not harm the environment in other nations. It also requests that all levels of government devise and execute environmental preservation plans.

Agenda 21 is a comprehensive environmental and sustainable development plan that requires cooperation from intergovernmental agencies, national and local governments, and NGOs. It addresses four topics: Social and Economic Dimensions, Conservation and Management of Resources for Development, Strengthening the Role of Major Groups, and Means of Implementation. The United Nations Commission on Sustainable Development is responsible for executing the principles of Agenda 21.

Earth Summit was created as a response for member states to cooperate together internationally on development issues after the Cold War. Due to issues relating to sustainability being too big for individual member states to handle, Earth Summit was

held as a platform for other member states to collaborate. Since the creation, many others in the field of sustainability show a similar development to the issues discussed in these conferences, including non-governmental organizations (NGOs).

The issues addressed included:

- systematic scrutiny of patterns of production — particularly the production of toxic components, such as lead in gasoline, or poisonous waste including radioactive chemicals
- alternative sources of energy to replace the use of fossil fuels which delegates linked to global climate change
- new reliance on public transportation systems in order to reduce vehicle emissions, congestion in cities and the health problems caused by polluted air and smoke
- the growing usage and limited supply of water

An important achievement of the summit was an agreement on the Climate Change Convention which in turn led to the Kyoto Protocol and the Paris Agreement. Another agreement was to "not to carry out any activities on the lands of indigenous peoples that would cause environmental degradation or that would be culturally inappropriate".

The Convention on Biological Diversity was opened for signature at the Earth Summit, and made a start towards redefinition of measures that did not inherently encourage destruction of natural ecoregions and so-called uneconomic growth.

Although President George H.W. Bush signed the Earth Summit's Convention on Climate, his Administrator in Environmental Protection Agency (EPA) William K. Reilly acknowledges that U.S. goals at the conference were difficult to negotiate and the agency's international results were mixed, including the U.S. failure to sign the proposed Convention on Biological Diversity.

Twelve cities were also honoured by the Local Government Honours Award for innovative local environmental programs. These included Sudbury in Canada for its ambitious program to rehabilitate environmental damage from the local mining industry, Austin in the United States for its green building strategy, and Kitaky?sh? in Japan for incorporating an international education and training component into its municipal pollution control program.

The Earth Summit resulted in the following documents:

- Rio Declaration on Environment and Development
- Agenda 21
- Forest Principles

Moreover, important legally binding agreements (Rio Convention) were opened for signature:

- Convention on Biological Diversity
- Framework Convention on Climate Change (UNFCCC)
- United Nations Convention to Combat Desertification

In order to ensure compliance to the agreements at Rio (particularly the *Rio Declaration on Environment and Development* and *Agenda 21*), delegates to the Earth Summit established the *Commission on Sustainable Development* (CSD). In 2013, the CSD was replaced by the *High-level Political Forum on Sustainable Development* that meets every year as part of the Economic and Social Council (ECOSOC) meetings, and every fourth year as part of the General Assembly meetings.

Critics point out that many of the agreements made in Rio have not been realized regarding such fundamental issues as fighting poverty and cleaning up the environment.

Green Cross International was founded to build upon the work of the Summit.

The first edition of Water Quality Assessments, published by WHO/Chapman & Hall, was launched at the Rio Global Forum.

Impacts and Issues

In August and September 2002, representatives from 193 nations attended the World Summit on Sustainable Development in Johannesburg, South Africa, the ten-year follow-up conference to Earth Summit 1992. The United States controversially did not participate in the World Summit on Sustainable Development. Many participants and NGOs consider this summit, also called Earth Summit 2002, less successful than Earth Summit 1992, because it did not produce any groundbreaking international environmental agreements.

10.6 The Johanesberg Declaration

The main agreement produced by Earth Summit 2002, the Johannesburg Declaration on Sustainable Development, merely reiterates many of the goals contained in the Rio Declaration and Agenda 21. The Johannesburg Declaration also does not contain many specific proposals for preserving the environment or promoting sustainable development. Instead, the Johannesburg Declaration addresses the environment and sustainable development in more general terms. The Johannesburg Declaration also requests that nations implement measures to eliminate or minimize all threats to sustainable development, including drug use, terrorism, corruption, ethnic intolerance, and the effects of natural disasters.

Earth Summit 2002 produced more than 300 partnership initiatives on the environment and sustainable development. Partnership initiatives are not multi-lateral international treaties; they are agreements between two or more governments, non-governmental organizations,or private sector participants. These Earth Summit 2002 partnership initiatives pledged more than $200 million to various environmental and sustainable development projects in the areas of water and sanitation, energy, health, agriculture, biodiversity protection, and ecosystem management.

The Johannesburg Declaration was the main outcome of the Summit; however, there were several other international agreements.

It laid out the Johannesburg Plan of Implementation as an action plan

Instead of new agreements between governments, the Earth Summit was organized mostly around almost 300 “partnership initiatives” known as Type II, as opposed to Type I Partnerships which are the more classic outcome of international treaties. These were to be the key means to achieve the Millennium Development Goals. But the absence of the United States rendered the summit partially impotent.

The United Nations Conference on the Human Environment, was first held in Stockholm, Sweden, in June 1972, and marked the emergence of international environmental law. The Declaration on the Human Environment also known as the Stockholm Declaration set out the principles for various international environmental issues, including human rights, natural resource management, pollution prevention and the relationship between the environment and development. The conference also led to the creation of the United Nations Environment Programme.

The Brundtland Commission set up by Gro Harlem Brundtland, the pioneer of sustainable development, provided the momentum for Earth Summit 1992. This Summit was also headed by Maurice Strong, who had been a prominent member of the Brundtland Commission – and also for Agenda 21.

South Africa's first National Conference on Environment and Development entitled, "Ecologise Politics, Politicise Ecology" was held at the University of the Western Cape in conjunction with the Cape Town Ecology Group and the Western Cape Branch of the World Conference on Religion and Peace in 1991. Prominent persons involved in this conference were Ebrahim Rasool, Cheryl Carolus, Faried Esack, and Julia Martin.

Poverty eradication, changing unsustainable patterns of production and consumption and protecting and managing the natural resource base of economic and social development are essential requirements for sustainable development.

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Unit 11 ❑ Global initiatives for environmental management (special reference to Montreal, Kyoto, Paris)

Structure

11.0 Objective

- To understand the issues of environment protection
- To know about protection and conservation the environment
- To understand the key areas where all the countries have to look upon and work

11.1 Introduction

Margaret Mead, the American anthropologist, said that "*We won't have a society if we destroy the environment"*. Indeed it is true and we can see the effects of exploitation in the changing environment.

The main reasons for the protection are:

- Ozone depletion, greenhouse effect and global warming–

Ozone is a thick layer which acts as a shield to protect the earth from the ultraviolet radiations coming from the sun. This layer has great importance. Any depletion in this layer

will result in more penetration of ultraviolet radiations to the earth. The concern arises towards the environment when this layer starts depleting. It is now a prevalent and significant issue which should be tackled within a timeframe, otherwise it can cause a lot of problems to the environment as well as to humans (K. Kundlani).

Exemplary effects are skin cancer, premature ageing, eye damage, weak immune system etc. The main reason affecting the ozone layer is Chlorofluorocarbons (CFCs) which are mostly produced by the industries discharging chemicals and can also be found in household products. The ozone layer depletion is linked to the greenhouse effect and also with global warming.

Greenhouse effect- It is caused by the emissions of the pollutant gasses like methane, CFCs etc. When these gases are released the atmosphere, it results in temperature rise and this is known as global warming.

- Desertification–

In simpler terms, this issue means land degradation. The destruction of the potentiality of the land which ultimately at the end results in a drought-like situation.

The example of land degradation is deforestation, change in climate etc. Where this kind of a situation arises, it forces the people residing there to migrate to another place.

- Deforestation–

It is a recurrent issue which every country faces. Deforestation not only affects climate but also affects the animals living in the forests. It is an alarming issue which is every country has to deal with.

- Loss of biodiversity–

It is related to the extinction of species from the earth and the reason is deforestation. Biodiversity means the variety of life on earth. Many of the species have already become extinct from earth. Extinction of species disturbs the balance of the ecosystem as well as disturbs the balance of the living species and also human beings. Earth's biodiversity provides various sources from which we can get food and also medicinal plants. Besides deforestation, the other reasons for the loss of biodiversity are use of chemical fertilizers, pesticides, overexploitation of the available resources.

- Disposal of wastes–

Disposing the waste is also an important and alarming issue. The major portion of waste is contributed by the industries and household. These industries or household wastes are either dumped in water or in empty unused land.

As a result, the water gets contaminated and spreads many diseases like diarrhoea, typhoid etc. Industrial wastes consist of chemicals, metal compounds, nuclear waste etc. These wastes cause serious health hazards and endanger the environment and life.

11.2 Treaties and conventions for the improvement and protection of the environment

11.2.1 Montreal Protocol (1987)

It was finalized and adopted in the year 1987. It is a multilateral environmental agreement and this protocol is the UN treaty till date which was initially approved by only 46 countries but now it is ratified by all 197 UN member countries. This protocol regulates the production and consumption of man-made chemicals which can deplete the ozone layer.

This treaty was made for the reason that certain substances or chemicals when released in the atmosphere that damages the stratospheric ozone layer which is earth's protective shield that protects humans as well as the environment from the harmful levels of ultraviolet radiations of the sun. The stratospheric layer in fact filters out the harmful radiation. If it doesn't get filtered then there are increasing chances of having skin cancer and cataracts, and also reduces the agricultural productivity and damages the marine ecosystems.

Under this treaty, the developed and developing countries have equal but differentiated responsibilities towards the ozone-depleting substances (ODS) and both groups of countries have binding, time-targeted and measurable commitments. All countries have been given specific responsibilities relating to the curtailment of ozone-depleting substances.

The Montreal Protocol sits under the Vienna Convention for the Protection of the Ozone Layer (the Vienna Convention). The Vienna Convention was adopted in 1985

following international discussion of scientific discoveries in the 1970s and 1980s highlighting the adverse effect of human activity on ozone levels in the stratosphere and the discovery of the 'ozone hole'. Its objectives are to promote cooperation on the adverse effects of human activities on the ozone layer. The Montreal Protocol is widely considered as the most successful environment protection agreement. It sets out a mandatory timetable for the phase out of ozone depleting substances. The United Nations Industrial Development Organization (UNIDO) became an implementing agency of the Montreal Protocol in 1992 and is proud to be associated with its success. Since then UNIDO has recognized the significance of meeting the global environmental challenge of ozone depletion while observing national priorities, and of making meaningful technological adjustments resulting in a higher standard of living. The Montreal Protocol has proven to be innovative and successful, and is the first treaty to achieve universal ratification by all countries in the world. Leveraging worldwide participation, the Montreal Protocol has sent clear signals to the global market and placed the ozone layer, which was in peril, on a path to repair. Full implementation of the Montreal Protocol is expected to result in avoidance of more than 280 million cases of skin cancer, approximately 1.6 million skin cancer deaths, and more than 45 million cases of cataracts in the United States alone by the end of the century, with even greater benefits worldwide. The Montreal Protocol's Scientific Assessment Panel estimates that with implementation of the Montreal Protocol a near complete recovery of the ozone layer is expected by the middle of the 21st century.

India became the signatory member of this treaty on 19th June 1992.

Hydrochlorofluorocarbons (HCFCs) is the gas which is used worldwide. It is present in the refrigerator, air-conditioners etc. It is very harmful and powerful than carbon dioxide.

The Montreal protocol has taken steps to control this harmful substance.

On 15th October 2016, parties of the Montreal Protocol adopted the Kigali amendment to curtail the consumption and production of the hydrofluorocarbons (HFCs). Countries have agreed to add HFCs to the list of controlled substances. The Kigali Amendment came into force on 1 January 2019 for those countries that have confirmed to this amendment.

11.2.2 Kyoto Protocol (1997)

The Kyoto Protocol was adopted in Kyoto, Japan on 11 December 1997. There are 192 Parties to the Kyoto Protocol. This Convention encouraged industrialized countries to stabilize GHG emissions. The Kyoto Protocol is an international agreement within the United Nations Framework Convention on Climate Change (UNFCCC). This treaty commits state parties to reduce the greenhouse gas emissions.

The Kyoto Protocol enlisted six greenhouse gases: Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur hexafluoride (SF6). So the main goal of the Kyoto Protocol was to control emissions of the anthropogenic (human-emitted) greenhouse gases (GHGs).It sets a timetable starting in 2006 for negotiations to establish emission reduction commitments for a second commitment period. The first period emission reduction commitments expired on 31 December 2012.

The ultimate objective of the UNFCCC is the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would stop dangerous anthropogenic interference with the climate system".

11.2.3 Paris Agreement (2015)

It is an agreement within the United Nations Framework Convention on Climate Change (UNFCC) which focuses on reducing the greenhouse gas emissions. It is replaced by its predecessor, the Kyoto protocol which is also the international treaty for similar purposes and its second commitment expires in 2020. The Paris Agreement came into force on 4th November 2016 and has been signed by 197 countries. India has also given its consent to this agreement. In the whole world, India stands at third after China and the US when it comes to the emission of the greenhouse effect according to May 2019. The primary motive of this agreement is to fight back against climate change. This agreement also aims to curb the emission of the greenhouse to a certain level. The United States withdrew from the agreement in 2020 but rejoined in 2021.

11.4 Summary and Conclusion

It can be said that a proper understanding of the theissues of environment protection

is very much essential to protect and conserve the environment. This can be achieved with proper understanding of the key areas leading to conservation of the environment.

- To understand the key areas where all the countries have to look upon and work

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Unit 12 ❑ Environmental Impact Assessment and Environmental Management Planning

Structure

12.0 Objective

- The unit is aimed at providing the learners can understanding of a systematic process of identifying future consequences of a current or proposed action.

12.1 Introduction

Enviromental Impact Assessment (EIA) as well as Environmental Management Planning (EMP) is normally considered a planning tool which is usually accepted asan integral

component of sound decision making. It provides the environment its due place in the decision-making process by clearly evaluating the environmental consequences of a proposed project before start of its implementation. Early identification and characterization of critical environmental impacts allow the regulatory authorities and the public to be aware of the environmental acceptability of a proposed project and the actions which are planned to be taken by the project authorities to mitigate or to reduce the risks and the impacts.

12.2 Environmental Impact Assessment (EIA)

The rapid growth of population, improvements in standards of living and concomitant growth of infrastructure have altered the environment, sometimes beyond its power of resilience. These changes have resulted in ecological crisis and have become a matter of grave concern to managers and decision makers throughout the world. The issues both at national and global levels are focussing concern of nodal agencies (Regulatory Departments, Ministries and Boards) to support sustainable development and curb and restrain such acts which tend to produce adverse impacts on living conditions of human, animals, plants and geographical environment.

EIA is required to provide a comprehensive account of the state of existing environment, the stresses produced by diverse activities and the impacts these will have on various components of environment. The proponents of the development projects also need to suggest and provide the measures to mitigate the adverse effects.

Thus, EIA is a tool used to assess the positive and negative environmental, economic, and social impacts of a project. This is used to predict the environmental impacts of a project in the pre-planning stage itself so that decisions can be taken to reduce the adverse impacts.

12.3 Evolution & History of EIA

Environment Impact Assessment or EIA can be defined as the study to predict the effect of a proposed activity/project on the environment. A decision making tool, EIA

compares various alternatives for a project and seeks to identify the one which represents the best combination of economic and environmental costs and benefits. EIA systematically examines both beneficial and adverse consequences of the project and ensures that these effects are taken into account during project design. It helps to identify possible environmental effects of the proposed project, proposes measures to mitigate adverse effects and predicts whether there will be significant adverse environmental effects, even after the mitigation is implemented. By considering the environmental effects of the project and their mitigation early in the project planning cycle, environmental assessment has many benefits, such as protection of environment, optimum utilisation of resources and saving of time and cost of the project. Properly conducted EIA also lessens conflicts by promoting community participation, informing decision makers, and helping lay the base for environmentally sound projects. Benefits of integrating EIA have been observed in all stages of a project, from exploration and planning, through construction, operations, decommissioning, and beyond site closure.

EIA is one of the successful policy innovations of the 20th Century for environmental conservation. Thirty-seven years ago, there was no EIA but today, it is a formal process in many countries and is currently practiced in more than 100 countries. EIA as a mandatory regulatory procedure originated in the early 1970s, with the implementation of the National Environment Policy Act (NEPA) 1969 in the US. A large part of the initial development took place in a few high-income countries, like Canada, Australia, and New Zealand (1973-74). However, there were some developing countries as well, which introduced EIA relatively early e.g. Columbia (1974), Philippines (1978). The EIA process really took off after the mid-1980s. In 1989, the World Bank adopted EIA for major development projects, in which a borrower country had to undertake an EIA under the Bank's supervision

The Ministry of Environment and Forest (MoEF) in India recently notified new EIA legislation in September 2006. The notification makes it mandatory for various projects such as mining, thermal power plants, river valley, infrastructure (road, highway, ports, harbours and airports) and industries including very small electroplating or foundry units to get environment clearance. However, unlike the EIA Notification of 1994, the newlegislation has put the oneself clearing projects on the state government depending on the size/ capacity of the project. Certain activities permissible under the Coastal Regulation Zone

Act, 1991 also require similar clearance. Additionally, donor agencies operating in India like the World Bank and the Asian Development Bank (ADB) have a different set of requirements for giving environmental clearance to projects that are funded by them.

The EIA process: The stages of an EIA process will depend on the requirements of the country or donor. However, most EIA processes have a common structure. The environment impact assessment consists of eight steps with equal importance in determining the overall performance of the project.

The eight steps of the EIA process are presented in brief below:

- Screening: is the first stage. It determines whether the proposed project, requires an EIA and if it does, then the level of assessment required.
- Scoping: This stage identifies the key issues and impacts that should be further investigated. This stage also defines the boundary and time limit of the study.
- Impact analysis: This stage identifies and predicts the environmental and social impact of the proposed project and evaluates the significance.
- Mitigation: This step recommends the actions to reduce and avoid the potential adverse environmental consequences of development activities.
- Reporting: This stage presents the result of EIA in a form of a report to the decision-making body and other interested parties.
- Review of EIA: It examines the adequacy and effectiveness of the EIA report and provides the information necessary for decision-making.
- Decision-making: It decides whether the project is rejected, approved or needs further change.
- Post monitoring: This stage comes into play once the project is commissioned. It checks to ensure that the impacts of the project do not exceed the legal standards and implementation of the mitigation measures are in the manner as described in the EIA report.

12.4 Forms of impact assessment

There are various forms of impact assessment such as Health Impact Assessment (HIA) and Social Impact Assessment (SIA) that are used to assess the health and social

consequences of development so that they are taken into consideration along with the environmental assessment. One of the forms of impact assessment is strategic environment assessment, is briefly discussed below:

i. Strategic environment assessment: Strategic Environment Assessment (SEA) refers to systematic analysis of the environmental effects of development policies, plans, programmes and other proposed strategic actions. This process extends the aims and principles of EIA upstream in the decision-making process, beyond the project level and when major alternatives are still open. SEA represents a proactive approach to integrating environmental considerations into the higher levels of decision-making.

12.5 Objectives of Environmental Impact Assessment are

1. Identifying, predicting, and evaluating economic, environmental, and social impacts of development activities.
2. Providing information on the environmental consequences for decision making.
3. Promoting environmentally sound and suitable development by identifying appropriate alternatives and mitigation measures.

12.6 Environmental Impact Assessment (EIA) Process

The table below will mention the EIA Process in brief**:**

Environmental Impact Assessment (EIA) Process

Process	Details in Brief
Screening	Which projects need a full or partial assessment study is decided in this stage
Scoping	• Which impacts are necessary to be assessed is decided in this stage. While doing so, legal requirements, international conventions, expert knowledge, and public engagement are also considered.

	• Alternative solutions that avoid or at least reduce the adverse impacts of the project are also studied in this stage • Investigation of alternate designs or sites that avoid or mitigate impact takes place
Assessment & Evaluation of Impacts and Development of Alternatives	Environmental impacts of the proposed project are analyzed and light is thrown upon the alternatives present to such projects
EIA Report also called Environmental Impact Statement (EIS)	An environmental management plan (EMP) and also a non-technical summary of the project's impact is prepared for the general public in this stage
Decision Making	The fate of the project is decided. Whether the project is to be given approval or not and if it is to be given, under what conditions
Monitoring, compliance, enforcement and environmental auditing	Monitoring whether the predicted impacts and the mitiga tion efforts happen as per the EMP

12.7 Importance of Environmental Impact Assessment

1. EIA is a good tool for prudent environment management.
2. It is government-policy that any industrial project in India has to secure EIA clearance from the Environment Ministry before approval for the project itself.

12.8 Environmental Impact Assessment In India

- EIA started in India in 1976-77 when the Planning Commission directed the Department of Science & Technology to assess the river valley projects from the point of view of the environment. This was extended for all those projects that required approval from the Public Investment Board.

- Till 1994, environmental clearance from the Central Government was an administrative decision and lacked legislative support. On 27 January 1994, the Union Ministry of Environment and Forests (MEF), Government of India, under the Environmental (Protection) Act 1986, promulgated an EIA notification making Environmental Clearance (EC) mandatory for expansion or modernisation of any activity or for setting up new projects listed in Schedule 1 of the notification. Since then there have been 12 amendments made in the EIA notification of 1994.

- Then, in 1986, the government enacted the Environment (Protec-tion) Act which made EIA statutory. The other main laws in this regard are the Indian Wildlife (Protection) Act (1972), the Water Act (1974), the Air (Prevention and Control of Pollution) Act (1981), and the Biological Diversity Act (2002).
- In 1982, the Ministry of Environment, Forest and Climate Change set up the Environmental Information System (ENVIS) to collect, collate, storing, retrieving and disseminating information related to the environment sector. This serves as a web-based distributed network of subject-specific databases. The chief purpose of the ENVIS is to integrate all countrywide efforts to collect, store, disseminate, and use environment-information for better managing environmental assessment activities.

Current EIA Reports – India

EIA Notification 2020 draft has been made public. Once the EIA Notification 2020 will be published in the Official Gazette, it will replace EIA notification 2006.

Few important terms/agencies concerning EIA notification 2020 which aspirants should know:

1. Accredited Environment Impact Assessment Consultant Organization (ACO)
2. Central Pollution Control Board
3. Certificate of Green Building
4. Corporate Environment Responsibility
5. Eco-Sensitive Area/ Eco-Sensitive Zone

12.9 Environment Management

Environment Management is a comprehensive term which involves conservation of natural resources and energy (energy and resource saving), Pollution prevention, disposal of treated effluents (Waste regularization), Solid waste disposal, environmental audit and concept of green cities**.**

The Environmental Management System (EMS) is designed to provide a process to ensure the Project's compliance with the applicable national and international laws and regulations.

This EMP is a key component of the Environmental Management System, outlining Hunter Water's environmental objectives and targets to fulfil the commitments established in the Community and Environment Policy. As a key component of the EMS, it will drive organisational improvement over the life of the plan. The plan has twenty -two environmental objectives that address the responsibilities to the community and the environment. Each objective has actions and targets required to manage environmental performance over the next two years. In simple terms these actions will manage significant environmental aspects associated with the supply of water, waste water and stormwater services to the community. Achieving the targets that are set in this plan will reduce environmental risks and pursue environmental opportunities by being embedded broadly across business processes.

Environment Management and Planning

Concept of Environmental Management

It is an attempt to control human impact on and interaction with the environment in order to preserve natural resources. Environmental management focuses on the improvement of human welfare for present and future generations.

Thus it involves environmental planning, conservation of resources, environmental status evaluation and environmental legislation and administration.

Characteristics of EMP

It deals with world affected by humans;

It supports sustainable development

It demands a multidisciplinary approach;

It has to integrate different development view points;

The time-scale involved extends the short term and concern ranges from local to global;

It seeks to integrate natural & social science, policy making & planning.

This Environmental management implies an element of conscious choice from a variety of alternative proposals. Such a choice involves purposeful commitment for recognized and desired objectives.

12.10 Significance

Cities and megacities are playing an increasingly important role in supporting and sustaining the global population. For the first time in human history, more than half of all people are living in cities, and as our cities grow, so does their environmental impact. Although cities occupy less than three percent of the Earth's surface, they consume a staggering 75 percent of global energy consumption and 80 percent of greenhouse gas (GHG) emissions.

Much of this urban growth has occurred without any planning, leading to ancillary problems associated with lack of infrastructure and overcrowding. Nevertheless, our urban areas provide real opportunities for improvements in sustainability, driving innovation and leading the way towards a more sustainable future.

There are several drivers and unique challenges associated with this record breaking urbanization:

Unregulated construction and land development – A large influx of people can lead to unregulated construction and pressure for development in disaster-prone areas, leaving people vulnerable to flooding, sea level rise, earthquakes, and resulting destruction to life and property.

Overcrowding and the proliferation of poverty – Migration to cities without proper infrastructure can lead to the proliferation of impoverished neighbourhoods and unsanitary conditions. People residing in these areas are more susceptible to disease outbreaks, which can impede their ability to work productively.

Further, inequality can lead to social instability, driving companies near these areas to transfer their operations. Closing businesses exacerbates unemployment and poverty, creating a cycle that leads to further instability in the society and economy.

Inadequate infrastructure – With an increase in employment, rising incomes can lead to a greater number of households owning cars. However, this growth typically exceeds the city's ability to expand the roadway infrastructure, causing traffic congestion, which takes a toll on businesses through higher fuel costs and delays in the delivery of goods and services.

Heavy traffic congestion can also be detrimental to workers. Enduring long hours of heavy traffic while commuting can leave employees tired and unproductive once they reach their workplaces. And, in extending the workday with a lengthy commute, workers may have to cut back on their sleeping hours, which can also have negative effects on their health and productivity.

Impact on ecosystems – Cities have extreme effects on the lives and relationships of plants and animals, both directly within the urban space and indirectly elsewhere through their ecological footprint. Poor air quality is estimated to cause over 1 million premature deaths each year.

Water and waste management – Water, the world's most threatened essential resource, is a major challenge for cities, where the risk of pollution is high and urbanization can affect rainfall patterns. Improper disposal of municipal waste can have

adverse effects on everything from soil fertility and the health of plant life to the safety of drinking water.

12.11 Environmental initiatives in India

- For the protection of environment and to control pollution several measures have been undertaken both by government and NGOs.
- Even before independence, some laws have been enacted for the protection of environment. In Indian Penal Code of 1860, Articles 268, 290, 291, 426, 430, 431 and 432 are related with environment. Similarly, Article 277 was related with water pollution and 278 with Air pollution.
- National Environmental policy, 2006- It the first initiative in strategy formulation for environmental protection in a comprehensive manner. It undertakes a diagnosis of the causative factors of land degradation with a view to flagging the remedial measures required in this direction. It recognizes that the relevant fiscal, tariffs and sectoral policies need to take explicit account of their unintentional impacts on land degradation.

As the quality of life improves, demand for better quality services and products also increases. Customers all over the world and at all times demand that they be assured and satisfied that the product or services as anticipated. However, inspection is not a satisfactory way of giving assurance that the product will perform as desired during its life. It is generally agreed that the required level of quality can be built into the product only through the use of a proper quality management system.

A set of international standards, which bring world-wide focus on the environment, encourage a cleaner, safer, healthier world for all of us. The existence of these standards allows organizations to focus their environmental on the basis of internationally accepted criteria. At present many countries and regional groupings are generating their own requirements for environmental issues, and these vary between the groups. A single standard will ensure that there are no conflicts between regional interpretations of good environmental practice.

12.12 Summary and Conclusion

When city governments promote sustainability, using their position to build sustainable infrastructure, they also make their city a safe and attractive place to live and work. When citizens and local organizations create initiatives that complement city governments' sustainability efforts, they also contribute to improving their own health and livelihoods. By focusing on infrastructure, policy, and stakeholders' involvement, environmental planning supports a healthy and dynamic relationship between a city's people and its environments. With an increasing number of cities around the world, searching for innovative ways to implement environmental planning and sustainability remains the main challenge.

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12.14 Model Questions

Q 1. What is EIA?

Q 2. When did EIA start in India?

Q 3. Who is responsible for EIA in India?

Q 4. What is the main aim of EIA?

Q 5. Is EIA only for developed countries?

Unit 13 ❑ Overview of principal environment-related regulations of India. Review of their achievements

Structure

13.0 Objective

The learners will get an overview of principal environment-related regulations of India and also become aware of some of the achievements.

13.1 Introduction

Pollution is one of the greatest causes of premature deaths and morbidity in the world, and this burden of pollution is disproportionately borne by the lower and middle income countries such as India, home to more than one-sixth of humanity. In India, due to the compound effect of its large population and high levels of environmental pollution, the human cost of pollution is among the highest in the world. The environmental degradation is partly a consequence of the development model pursued after independence in 1947 based on large-scale industrialization and exploitative resource utilization, with scant consideration for sustainability.

Moreover, it is also due to the failure of the environmental administration, governance, and regulatory infrastructure to keep pace with the magnitude and pace of economic growth in India since economic liberalization in 1991. Ironically, India was also one of the early pioneers of integrating environmental considerations into its legislative and policy-

making process beginning in the early 1970s. The federal and state environmental regulation and policy framing institutions set up during this era, along with environmental legislation such as the Environment (Protection) Act 1986, are comparable in design, stringency, and comprehensiveness to other contemporary environmental regulatory regimes in many industrially developed economies. However, the widening gap between de jure expectations of environmental compliance and the de facto state of affairs has been a great concern for environmental governance in the country. The ongoing debates discuss several mechanisms to address the regulatory failures. The first is a greater emphasis on strengthening institutions and mechanisms that foster transparency and public disclosure by pollution sources with the intent to increase access to and credibility of information on pollution. Proponents argue that this will help to mobilize groups such as non-governmental organizations (NGOs) and the general public to pressure the industry and government to improve regulatory enforcement. Second, there have been calls for wider adoption of market-based instruments that are more efficient than the traditional approaches on which India relies.

Again, information is a prerequisite for the functioning of such market-based regulatory mechanisms. Third, the legal infrastructure to facilitate expedited hearing of environmental litigation is being created. With the establishment of the National Green Tribunal in 2010, India is one of only three other countries in the world to have an exclusive judicial body to hear environmental cases. This is potentially a significant step in providing greater access to environmental justice. An emerging view, however, argues that the prevailing economic development model is incompatible with ensuring sustainable development and requires a radical rethink.

13.2 Need for Protection

The need for protection and conservation of environment and sustainable use of natural resources is reflected in the constitutional framework of India and also in the international commitments of India. The Constitution under Part IVA (Art 51A-Fundamental Duties) casts a duty on every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures.

Further, the Constitution of India under Part IV (Art 48A-Directive Principles of State Policies) stipulates that the State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country.

Several environment protection legislations existed even before Independence of India. However, the true thrust for putting in force a well-developed framework came only after the UN Conference on the Human Environment (Stockholm, 1972). After the Stockholm Conference, the National Council for Environmental Policy and Planning was set up in 1972 within the Department of Science and Technology to establish a regulatory body to look after the environment-related issues. This Council later evolved into a full-fledged Ministry of Environment and Forests (MoEF).

MoEF was established in 1985, which today is the apex administrative body in the country for regulating and ensuring environmental protection and lays down the legal and regulatory framework for the same. Since the 1970s, a number of environment legislations have been put in place. The MoEF and the pollution control boards, Central Pollution Control Board(CPCB), and State Pollution Control Boards (SPCB) together form the regulatory and administrative core of the sector.

Some of the important legislations for environment protection are as follows:

- The Water (Prevention and Control of Pollution) Act, 1974
- The Air (Prevention and Control of Pollution) Act, 1981
- The Environment Protection Act, 1986
- The National Green Tribunal Act, 2010
- The Hazardous Waste Management Regulations, etc.

The National Green Tribunal Act, 2010

The National Green Tribunal Act(NGT Act), 2010 has been enacted with the objectives to provide for the effective and expeditious disposal of cases relating to environment protection and conservation of forests and other natural resources. It also includes enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and other related matters.

The Act deals with all environmental laws relating to air and water pollution, the Environment Protection Act, the Forest Conservation Act and the Biodiversity Act as have been set out in Schedule I of the NGT Act.(https://greentribunal.gov.in › sites › files › act_rules)

Consequent to enforcement of the National Green Tribunal Act, 2010, the National Environment Tribunal Act, 1995 and the National Environment Appellate Authority Act, 1997 stand repealed, vide notification number So 2570(E) dated October 18,2010.(https://www.iitr.ac.in › environment › NETA_1995)

The Air (Prevention and Control of Pollution) Act, 1981

The Air (Prevention and Control of Pollution) Act, 1981 is an act to provide for the prevention, control and abatement of air pollution and for the establishment of Boards at the Central and State levels with a view to carrying out the aforesaid purposes.

To counter the problems associated with air pollution, ambient air quality standards were established under the Air Act. The Air Act seeks to combat air pollution by prohibiting the use of polluting fuels and substances, as well as by regulating appliances that give rise to air pollution. The Air Act empowers the State Government, after consultation with the SPCBs, to declare any area or areas within the Sate as air pollution control area or areas. Under the Act, establishing or operating any industrial plant in the pollution control area requires consent from SPCBs. SPCBs are also expected to test the air in air pollution control areas, inspect pollution control equipment, and manufacturing processes.

The Water (Prevention and Control of Pollution) Act, 1974

The Water (Prevention and Control of Pollution) Act, 1974 has been enacted to provide for the prevention and control of water pollution and to maintain or restore wholesomeness of water in the country. It further provides for the establishment of Boards for the prevention and control of water pollution with a view to carry out the aforesaid purposes. The Water Act prohibits the discharge of pollutants into water bodies beyond a given standard, and lays down penalties for non-compliance. At the Centre, the Water Act has set up the CPCB which lays down standards for the prevention and control of water pollution. At the State level, SPCBs function under the direction of the CPCB and the State Government.

Further, the Water (Prevention and Control of Pollution) Cess Act was enacted in 1977 to provide for the levy and collection of a cess on water consumed by persons operating and carrying on certain types of industrial activities. This cess is collected with a view to augment the resources of the Central Board and the State

Boards for the prevention and control of water pollution constituted under the Water Act, 1974.

The Environment Protection Act, 1986

The Environment Protection Act, 1986 (the "Environment Act") provides for the protection and improvement of environment. The Environment Protection Act establishes the framework for studying, planning and implementing long-term requirements of environmental safety and laying down a system of speedy and adequate response to situations threatening the environment. It is an umbrella legislation designed to provide a framework for the coordination of central and state authorities established under the Water Act, 1974 and the Air Act, 1981. The term "environment" is understood in a very wide term under s 2(a) of the Environment Act. It includes water, air and land as well as the interrelationship which exists between water, air and land, and human beings, other living creatures, plants, micro-organisms and property.

Under the Environment Act, the Central Government is empowered to take measures necessary to protect and improve the quality of environment by setting standards for emissions and discharges of pollution in the atmosphere by any person carrying on an industry or activity; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare. From time to time, the Central Government issues notifications under the Environment Act for the protection of ecologically-sensitive areas or issues guidelines for matters under the Environment Act.

In case of any non-compliance or contravention of the Environment Act, or of the rules or directions under the said Act, the violator will be punishable with imprisonment up to five years or with fine up to Rs 1,00,000, or with both. In case of continuation of such violation, an additional fine of up to Rs 5,000 for every day during which such failure or contravention continues after the conviction for the first such failure or contravention, will be levied. Further, if the violation continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to seven years.

Hazardous Wastes Management Regulations

Hazardous waste means any waste which, by reason of any of its physical, chemical, reactive, toxic, inflammable, explosive or corrosive characteristics, causes

danger to health or environment, whether alone or when in contact with other wastes or substances.

There are several legislations that directly or indirectly deal with hazardous waste management. The relevant legislations are the Factories Act, 1948, the Public Liability Insurance Act, 1991, the National Environment Tribunal Act, 1995 and rules and notifications under the Environmental Act. Some of the rules dealing with hazardous waste management are discussed below:

- **Hazardous Wastes (Management, Handling and Transboundary) Rules, 2008**, brought out a guide for manufacture, storage and import of hazardous chemicals and for management of hazardous wastes.
- **Biomedical Waste (Management and Handling) Rules, 1998**, were formulated along parallel lines, for proper disposal, segregation, transport, etc, of infectious wastes.
- **Municipal Solid Wastes (Management and Handling) Rules, 2000**, aim at enabling municipalities to dispose municipal solid waste in a scientific manner.

In view of the short-comings and overlapping of some categories causing inconvenience in implementation of the Biomedical Waste (Management and Handling) Rules, 1998 as well as the Municipal Solid Wastes (Management and Handling) Rules, 2000, the Ministry of Environment, Forest and Climate Change has formulated the draft Bio-Medical Waste (Management & Handling) Rules, 2015 (Draft BMW Rules) and the draft Solid Waste Management Rules, 2015 (Draft SWM Rules) and sought comments on the draft Rules.

The Draft BMW Rules are to replace the Biomedical Waste (Management and Handling) Rules, 1998, and the Draft SWM Rules are to replace the Municipal Solid Waste (Management and Handling) Rules, 2000. The objective of the Draft BMW Rules is to enable the prescribed authorities to implement the rules more effectively, thereby, reducing the bio- medical waste generation and also for its proper treatment and disposal and to ensure environmentally sound management of these wastes, and the Draft SWM Rules aim at dealing with the management of solid waste including its segregation at source, transportation of waste, treatment and final disposal.

- **E - Waste (Management and Handling) Rules, 2011** have been notified on May 1, 2011 and came into effect from May 1, 2012, with primary objective to reduce the use of hazardous substances in electrical and electronic equipment by specifying threshold for use of hazardous material and to channelize the e-waste generated in the country for environmentally sound recycling. The Rules apply to every producer, consumer or bulk consumer, collection centre, dismantler and recycler of e-waste involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components as detailed in the Rules.
- **Batteries (Management & Handling) Rules, 2001** deal with the proper and effective management and handling of lead acid batteries waste. The Act requires all manufacturers, assemblers, re-conditioners, importers, dealers, auctioneers, bulk consumers, consumers, involved in manufacture, processing, sale, purchase and use of batteries or components thereof, to comply with the provisions of Batteries (Management & Handling) Rules, 2001.

In addition, there are many other laws relating to environment, namely –

The Wildlife Protection Act, 1972

The Wild Life (Protection) Act, 1972 was enacted with the objective of effectively protecting the wild life of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The Act was amended in January 2003 and punishment and penalty for offences under the Act have been made more stringent. The Ministry has proposed further amendments in the law by introducing more rigid measures to strengthen the Act. The objective is to provide protection to the listed endangered flora and fauna and ecologically important protected areas.

The Forest Conservation Act, 1980

The Forest Conservation Act, 1980 was enacted to help conserve the country's forests. It strictly restricts and regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of Central Government. To this end the Act lays down the pre-requisites for the diversion of forest land for non-forest purposes.

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, recognises the rights of forest-dwelling Scheduled Tribes and other traditional forest dwellers over the forest areas inhabited by them and provides a framework for according the same.

The Indian Forest Act, 1927 consolidates the law relating to forests, the transit of forest-produce and the duty leviable on timber and other forest-produce.

Public Liability Insurance Act, 1991

The Public Liability Insurance Act, 1991 was enacted with the objectives to provide for damages to victims of an accident which occurs as a result of handling any hazardous substance. The Act applies to all owners associated with the production or handling of any hazardous chemicals.)

The Biological Diversity Act, 2002

The Biological Diversity Act 2002 was born out of India's attempt to realise the objectives enshrined in the United Nations Convention on Biological Diversity (CBD), 1992 which recognises the sovereign rights of states to use their own Biological Resources. The Act aims at the conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner. The National Biodiversity Authority in Chennai has been established for the purposes of implementing the objects of the Act.

Coastal Regulation Zone Notification,2011

The Ministry of Environment and Forests had issued the Coastal Regulation Zone Notification,2011 *vide* Notification no. S O. 19(E), dated January 06, 2011 with an objective to ensure livelihood security to the fishing communities and other local communities living in the coastal areas, to conserve and protect coastal stretches and to promote development in a sustainable manner based on scientific principles, taking into account the dangers of natural hazards in the coastal areas and sea level rise due to global warming.

13.3 Review of the achievements

India has an impressive number of environmental regulations. Have they been a success? While initiatives such as catalytic converters for cars have reduced air pollution, there has been far less success in tackling water pollution. It argues that regulators will only be effective when they are given enough power and legitimacy.

Around the world, environmental regulation is one of the key public services that governments provide to their citizens. While these regulations impose costs on businesses

and households for disposal of pollution in a responsible way, in return they promise better health, a cleaner environment and other related benefits.

India is no exception. The original Water Act of 1974 and Air Act of 1981 have dealt with increasingly hazardous pollution levels. Moreover, India has an extensive network of government offices (both at the national and state level) that are designed to implement these regulations.

Yet public opinion on the effectiveness of these regulations has not always been positive. There are countless newspaper articles or reports detailing the ineffectiveness of these regulations. Accusations of the mismanagement of funds earmarked for these purposes, ranging from underuse and incorrect reporting to diversion of funds have also been reported.

While these reports provide insight into the functioning and challenges of implementing effective environmental regulation in India and elsewhere, what has been missing is systematic evidence on whether the regulations have succeeded in their intended purpose: to reduce air and water pollution. Moreover, these reports do not provide any insight into the overall benefits of the regulations (in terms of pollution reductions and lives saved). For example, even if one policy brings about a large improvement in people's health, the cost may be so high that the money could have been better spent on other health interventions that lead to even larger effects.

In recent research new evidence on the effectiveness of these regulations in accomplishing their basic goal of reducing pollution has been recorded(Greenstone and Hanna 2012) withdetail annual data on air pollution for 124 cities and water pollution for 424cities. This way of evaluating policy sheds light on the causal impact of these regulations on pollution levels. The interesting fact is that air pollution has been falling over time. It is about 17% from 1987-1990 to 2004-2007. This change is evident in all the cities in the studied sample. The mandatory adoption of catalytic converters for cars reversed worsening trends in particulate matter and sulfur dioxide concentrations and led to sharp declines in these dangerous forms of air pollution. The Supreme Court Action Plan, implemented in Delhi and other 17 cities helped reduce nitrogen dioxide (which is a precursor of ozone).

Were the same successes seen in the water pollution arena? More specifically, would water pollution have been worse if the regulations had not been adopted? The study shows the effect of the National River Conservation Plan (NRCP), which is the cornerstone of

water pollution regulation in India. All the measures of water pollution failed to find any effect from the programme.

Cleaner air but dirtier water

Now the question is why the air pollution policy was more successful than the water policy. The history of the regulations provides some insights. The legitimacy of the regulations appears to be a predictor of success. Air pollution policies were often driven by citizen complaints and Supreme Court. This ensures the enforcement of the regulations. In contrast, the water pollution policies were less community driven than the air pollution policies. These policies were undermined by the fact that no institutional body was given the power, resources, and institutional mandate to implement them successfully.

13.4 Summary and Conclusion

It can be concluded that environmental regulations in India can be successful at reducing pollution concentrations but only when regulators are sufficiently empowered and motivated. However, the deeper question on the optimal level of environmental regulation remains to be answered. This would require developing reliable estimates of the costs that regulations impose on businesses and households and then comparing them to the benefits to society of pollution reductions in terms of health and other areas. It is also critical to experiment with market-based forms of regulation that can achieve pollution reductions at lower costs.

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13.6 Model Questions

1. What are Environmental legislations and how are they important for environmental improvement and conservation?
2. What are National Legislations and International Legislations? How are they are different from each other?
3. Describe in brief some pollution related acts.
4. What are Ramsar Convention and Montreal Protocol? Describe in brief.
5. Describe the Environmental Protection Act, 1986
6. What is main aim of biodiversity act and its salient features?
7. What are the main objectives of climate convention?
8. Write short note on (a) Water Act (b) Air Act, (c) Wildlife Act, (d) Forest Act

Unit 14 ❑ Principles of wasteland management with special reference to West Bengal

Structure

14.0 Objective

- Learners will come to know about the concept of wasteland management
- The principles of wasteland management

14.1 Introduction

Agriculture continues to be the main economic activity in rural areas of the developing world in spite of a steady diversification of their economic base during the preceding decades. Agriculture will continue to dominate rural economy of these areas for a long time to come. It is natural, therefore, that the availability of land, and its use pattern in agriculture would remain issues of extreme importance to policy planners. Land is not only a highly scarce resource but is also a non-reproducible means of production. In India, population pressures, and ever declining land : man ratio, preponderance of small and fragmented holdings, highly iniquitous land distribution structure, etc., has tremendous significance on land-population balance.

Further, the limited capability of the urban-industrial sector to absorb the expanding rural labour force would keep a vast majority of work-seekers tagged to land, principally in agricultural activities, and to some extent, in diverse non-farm jobs in and around the

villages. From every conceivable angle, therefore, the most crucial and most vexatious issue in rural India would be of land availability. In a broad sense, the availability of land and its pattern of use in agriculture by itself would set the future pattern of India's development, most ostensibly the farm non-farm linkages, the rural-urban migration, the incidence of rural-urban poverty, and so on.

The problem of declining land: man ratio gets exasperated through the increasing incidence of wastelands. Both nature and man-induced factors are at work in pushing more and more of cultivable area out of use for agricultural production, food supply and rural well-being. Inadequate property rights (most crucially access to land), poverty, population pressure and declining land-man ratio, inappropriate government policies, and lack of access to markets, credit, and technologies appropriate for sustainable agricultural development, etc., are the more glaring among such factors. Nature also contributes sizeable to the process of wasteland formation, in many different ways. For example, the continuous wind erosion takes away the top soil. Rill and gulley erosion leads to ravine formation. Floods lead to sand deposition which affects fertility status of the soil and in certain cases, renders land unfit for cultivation (Singh, et al., 1988). Desert, snow covered areas, glacial areas with unassorted sediments, impeded natural drainage and poor soils, barren and rocky surface, and steep sloping areas, etc., are all manifestation of nature's hand work in restricting man's access to cultivable land.

Thus, Wasteland is that land which is presently lying unused or which is not being used to its optimum potential due to some constraints.

14.2 Classification

National wastelands development board classifies wastelands into two categories: 1. Cultivable wastelands (Left uncultivated for more than five years)

2. Uncultivable wastelands which cannot be used for vegetation. The cultivable wastelands have been classified into

a. Gullied and/or ravenous lands

b. Undulating land without shrubs

c. Surface waterlogging land and marsh

d. Salt affected land

e. Shifting cultivation area

f. Degraded forestland

g. Degraded pasture / grazing land

h. Degraded forest plantations

i. Strip lands

j. Sand dunes

k. Mining / industrial wastelands

Uncultivable wastelands are classified as a) Brown rocky / stony / shut of rocks b) Steep sloppy areas c) Snow covered and / or glacier lands

National remote Sensing Agency (NRSA) estimates put wastelands at 16.21% of the total land area of the country amounting to 129.57mha. The maximum waste lands are found in Jammu and Kashmir(60%).

14.3 Causes of Wasteland Formation

a) Deforestation b) Over-cultivation c) Over grazing d) Unskilled irrigation e) Improper developmental activities such as dumping of wastes, mine wastes

The main principles of wasteland management are:

Utilizing land according to its capacity.

- Putting adequate vegetal cover on the soil.
- Conserving as much rainwater as possible at the place where it falls both at farmlands and common property resources
- In-situ conservation.

The major activities taken up under the scheme are:

- In situ soil and moisture conservation measures like terracing, bunding, trenching, vegetative barriers and drainage line treatment.
- Planting and sowing of multi-purpose trees, shrubs, grasses, legumes and pasture land development.

- Encouraging natural regeneration.
- Promotion of agro-forestry & horticulture.
- Wood substitution and fuel wood conservation measures.
- Awareness raising, training & extension programmes.
- Encouraging people's participation through community organization and capacity building.
- Drainage Line treatment by vegetative and engineering structures
- Development of small water Harvesting Structures.
- Afforestation of degraded forest and non forest wasteland.
- Development and conservation of common Property Resources.

14.4 Wasteland Management in West Bengal

West Bengal Wasteland Development Corporation Ltd.

The primary objective of the West Bengal Wasteland Development Corporation Ltd. (WBWDC Ltd). was greening of wasteland and degraded land in the State of West Bengal along with allied forestry activities. Starting with the creation of plantations on waste land and supply of organic fertilisers to forest divisions, it gradually started diversifying into activities such as landscaping, creation of green shelter belts, timber harvesting, creation of theme parks, building nature interpretation centre and aesthetically appealing animal enclosures and roadside beautification.(W.B Forest.gov.in)

Objective

- The overall objectives of WBWDCL is to develop wastelands through appropriate technology and financial support for productive use. Within this framework the pertinent part would consist of treatment of wasteland through raising variety of plantations to meet economic as well as environmental needs to be raised in wasteland. The plantations not only to ensure easy availability of firewood, timber, fodder, bamboo, fruits and associated forest product but also help in improvement of soil and moisture regime, the two basic physical inputs for increasing land productivity.

- To acquire, purchase or obtain by lease, on contract, gift or otherwise wasteland from the Govt. of West Bengal together with other assets, properties, rights and liabilities of whatsoever nature of the Govt. appertaining to or in any way concerning such land and all rights, obligations and liabilities of the Govt. under the contract or agreement entered into by the Governor of West Bengal with any person, firm or company in relation to the said land or assets firstly in the districts of Bankura, Purulia, western part of Medinipur and other within the areas of West Bengal.
- To expeditiously develop wasteland by raising plantations.

Tall Tree Nursery

Tall Tree Nursery which is spread over 7 Acres at Rajarhat is a joint venture between West Bengal Housing Infrastructure Development Corporation Ltd. and West Bengal Wasteland Development Corporation Ltd. The objective of creation of this nursery is to provide adequate number of tall saplings of 2 years and more in age and about 4 Ft. and above in height for plantation along boulevards, roadsides and in organisations in and around Kolkata. This nursery will also provide high quality seedlings to purchase by various private organisations and individuals. It has been an endeavour to make the entire process of sale online for easier transactions and transparency.

The present West Bengal Government has undertaken wasteland management through bamboo plantation on an experimental basis in Birbhum district.

Funded by the Union Science and Technology and Biotechnology department, the pilot project is being implemented in tribal-dominated Rajnagar block in Birbhum district by the scientists of the West Bengal State Council of Science and Technology (WBSCST) with the help of the local women Self-Help Group in collaboration with Birbhum Zilla Parishad.

14.5 Summary and Conclusion

In general, it has been realised that wasteland development at present should be treated as an indispensable part of total economic planning instead of looking at it as a special problem area. The objective of wastelands development must be to achieve a

sustainable development through its integration with statutory rural development planning system. To attain the objective, new policies are necessary for covering the gaps of existing policies, which cover a wide range of aspects of wasteland development, like - (i) demarcation of waste lands, (ii) formulation of integrated land use plan and (iii) identification of specific area for promulgation of Act and rules for control and regulation of the land use in wastelands. Framing detail action level policies on these aspects are important tasks for the Government for making wastelands development programme a success story.

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Unit 15 ❑ Principles of forest management with special reference to West Bengal

Structure

15.0 Objectives

- To have an understanding of the forests in India, which are mostly state owned, and how they are managed for various purposes, namely productive, protective, recreational and bio-aesthetic**.**

15.1 Introduction

Definition: Forest management is defined as the practical application of the scientific, technical and economic principles of forestry. Not a basic subject in itself, forest management is concerned with practical application of science, technology and economics to a forest estate for achievement of certain objectives. The subjects on which forest management is grounded are Silviculture, Ecology, Geology, Soil Science, Botany, Mensuration, Pathology, Economics, Finance etc.

15.2 Functions and scope

It follows from the definition that forest management aims to achieve three main functions, namely, (1) Control of composition and structure of growing stock; (2)

Harvesting and marketing of forest produce; (3) Administration of forest property and personnel. It is the job of forest managers to constantly manage the growing stock to achieve given objects of management. The scope of management encompasses a wide range of activities. Some major activities are

- Site adaptation;
- Choice of species;
- Manipulation of stands;
- Harvesting the produce;
- Regeneration;
- Protection;
- Transportation and communication;
- Marketing data;
- Sale of produce;
- Value addition;
- Revenue;
- Distribution of benefits;
- Forest organization;
- Management of personnel;
- Monitoring and evaluation of works;
- Financial management and efficiency
- Integration in rural development.

15.3 Principles of Forest Management

The objects of forest management in the regional and local level should be so formulated that they are in perfect harmony with the fundamental principles of forest management as embodied in National Forest Policy (1988). It defines the job of conservation as one which includes preservation, maintenance, sustainable utilisation, restoration, and enhancement of the natural environment.

According to this Policy, the ESSENTIALS OF FOREST MANAGEMENT will be—

- Existing forests and forest lands should be fully protected and their productivity should be improved. Forest and vegetal cover should be increased rapidly on hill slopes, in catchment areas of rivers, lakes and reservoirs and ocean shores and, on semi-arid, and desert tracts.
- Diversion of good and productive agricultural lands to forestry should be discouraged in view of the need for increased food production.
- For the conservation of total biological diversity, the network of national parks, sanctuaries, biosphere reserves and other protected areas should be strengthened and extended adequately.
- Provision of sufficient fodder, fuel and pasture, specially in areas adjoining forest, is necessary in order to prevent depletion of forests beyond the sustainable limit. Since fuelwood continues to be the predominant source of energy in rural areas, the programme of afforestation should be intensified with special emphasis on augmenting fuelwood production to meet the requirement of the rural people.
- Minor forest produce provides sustenance to tribal population and to other communities residing in and around the forests. Such produce should be protected, improved and their production enhanced with due regard to generation of employment and income.

15.4 Methods of Forest Management

Afforestation, Social Forestry & Farm Forestry

- A massive need-based and time bound programme of afforestation and tree planting, with particular emphasis on fuelwood and fodder development, on all degraded and denuded lands in the country, whether forest or non-forest land.
- To encourage the planting of trees along the sides of roads, railway lines, rivers and streams and canals, and on other unutilised lands under State/corporate, institutional or private ownership.
- Village and community lands, not required for other productive uses, should be taken up for the development of tree crops and fodder resources. Technical

assistance and other inputs necessary for initiating such programmes should be provided by the Government. The revenues generated through such programmes should belong to the panchayats where the lands are vested in them; in all other cases, such revenues should be shared with the local communities. The vesting, in individuals, particularly from the weaker sections (such as landless labour, small and marginal farmers, scheduled castes, tribals, women) of certain ownership rights over trees, could be considered, subject to appropriate regulations. Beneficiaries would be entitled to usufruct and would in turn be responsible for their security and maintenance.

- Land laws should be so modified wherever necessary so as to facilitate and motivate individuals and institutions to undertake tree-farming and grow fodder plants, grasses and legumes on their own land. Appropriate regulations should govern the felling of trees on private holding.

West Bengal is in many ways the pioneer of forest management in India. It was part of the region that saw the introduction of forest management during the Mauryan Dynasty (circa 321 B.C. to 184 B.C.). Later, under the British Colonial administration the northern forests were amongst the first areas to be declared as Reserved Forests,(forests which are accorded with certain degree of protection. This term was first introduced in the India Forest Act,1927) a process that was later extended to the entire country. The recently introduced Joint Forest Management (JFM) also had its origin in West Bengal; in the Arabari forest experiment of 1972 (in Midnapore District), and was also later adopted across India from 1990 onwards. The number of Forest Protection Committees (FPCs) in West Bengal has grown rapidly in recent years under the Joint Forest Management scheme. It grewfrom 600 in 1989, to 1,738 by 1991, and has swelled to 3,614 by the end of 2001, with a total of 415,200 members. Large parts of the forest area in a degraded condition (including plantations) have been put under the protection of FPCs.

The West Bengal Forest Department estimated that 60% of the FPCs in South West Bengal is ‘good’ to ‘very good’ (i.e. active) while the figure is only 30% in North Bengal. For West Bengal the percentage of active groups averages about 50% of the total. The total area formally transferred to the protection of the people is 529,945 ha., about 44% of the total forest area of the state.

Some of these factors emanated from the political and social action of the people, others were from the state. Perhaps the most important contributing cause was the continued dependence of the people on the forests for their subsistence needs. Their continued use of the forest, in spite of forest protection staff harassing them, led to violent clashes between the two, which obviously had to be resolved. The second important factor was specific to North Bengal, where the taungya villagers began demanding cash for forest work that they had historically performed for free as part of a long term arrangement with the Forest Department(FD). The third factor was the outbreak of Naxalism in the early seventies, a radical movement for people's empowerment. There were also state-related factors involved not specific to forestry although their fall-out has influenced participatory forestry. These include the electoral success of the Left Front Government in 1977 and their distribution of surplus land to landless people, providing tenancy rights to bargadarsand the promotion of the elected panchayat system throughout the state. Through JFM, the FPC members receive conditional entitlements to collect dry firewood and other subsistence forest products unharassed, plus 25% net revenue from timber marketed from the forest; on the condition that they protect the forest from theft and damage. In case there is a breach of conditions, the FD have the power to revoke the JFM agreement. But no such case has happened so far, and the FD is not likely to take such action, as a single such action could jeopardize the whole JFM operation.

Considering the provisions of JFM in West Bengal, there are three stakeholders: the FPC members, the Forest Department and to a lesser extent the Panchayat Samity/ Gram Sabha. The FD has not encouraged Non-Governmental Organisations to be involved in the execution of JFM, other than in a few cases where the department has specifically permitted an NGO to be associated with FPCs as a consultant for an operation.

The perspectives, objectives and strategies of the FD are found to be quite different from those of the FPCs. The FD's commitment to JFM clearly comes from their interest in protection and up-gradation of degraded forests, without wishing to make any change in the forest management system that they had conventionally pursued.

The implementation strategy of the FD, in translating these twin objectives into action, is to promote participation of the FPC, by making them fully responsible in forest protection. It does not give them any decision-making powers in respect of forest

management methods, marketing, micro-plan status of JFM.It is a 'two-way street', one which can lead both to gr eat heights of ecological resurrection, social empowerment and livelihood improvements, and the other to ecological, livelihood and empowerment downturns.

15.5 Drivers of the policy changes in West Bengal

In the post-colonial period, there has been forest management in West Bengal. There has been a major change in policy and forest Management in West Bengal away from 'Classical Forest Management' pattern towards Joint Forest Management.

Participation of the people in state forest management, in the very restricted form, made its appearance for the first time in about 150 years. (Although on the other hand in the significant areas of West Bengal's forests that were nationalised after independence the people initially enjoyed extensive use and management rights, until the state extinguished rights by 1971) The Forest Department realized during the 1970s and 1980s that it is beyond them to manage the forests with the forest staff or according to the forest management system that it had adopted in the postcolonial period. For a long while they thought that protection could be improved by increasing the number of staff. In 1980, the staff number went on swelling even in the immediate past decade. The State Report of West Bengal Forests for the year 1990-91 mentions the number of senior posts as 120 and 6,345 posts of all other categories. In 2001, it reports 239 and 11,778 showing that the Department has increased its staff by about 100% in 10 years without any significant gain either in the forest area, the quality of forest and its ecosystem. The FD failed to close the gap between demand and supply of the major forest produces. It indicates that JFM has been part of the continuing strategy of expanding and extending the FD 'empire'. But how and why such massive staff increases took place is certainly intriguing, as in most other states recruitments have been strictly limited since the late 80s, leading to another type of crisis.

Social Forestry did not 'wean' local people away from the use of state appropriated forest as a common property resource. The people disposed the additional wood produced by them in their own land to cater to industrial and urban needs. Their dependence on the local forest for firewood and grazing was not reduced.

The people at large, but particularly those near the forest, had shown their disapproval for the Department's way of functioning through a number of local but violent protests which resulted in the death and injury of a number of people including both activists and Forest Department staff. The 1980s saw the forest staff more or less staying away from their duty of forest protection partly due to the violent nature of protests as well as mafia operation in timber smuggling. A small number of forest staff realised the value of participation as the way out of the impasse and they worked proactively to bring about the change, and indeed, with people taking over a large part of protection this impasse was effectively resolved.

It became clear from two success stories (namely of the Arabari experiment in the 1970s, and farm and social forestry in the 1980s) that local people would constructively assist in the growth and development of forest provided they had benefits from its management. The Arabari experiment also indicated that the people were not thieves as they were being labelled, but long-standing users who had to satisfy some legitimate demands namely their home needs of and subsistence support for their livelihood from the forest resources.

The change in the central policy of 1988 was another driving force that expedited the implementation of participatory forestry. In addition, some enabling features helped in driving management towards participatory management

Positive Aspects

1. The women and the poor in many FPC associated forests have got back a certain amount of dignity as they are generally out of the clutches of the 'law and order guardians' of the FD Women normally do the collection. In addition, the women specially the poor would go to the FPC areas to collect dry and fallen firewood for sale in the local market. This is done especially in the winter and summer.
2. A reasonably friendly relationship has developed between the FD and the FPC members.
3. Involved FPCs families are receiving a sustained income from JFM.
4. A number of different local activities have received institutional suppo rt from the FPCs. These include micro-saving, women group participation, involvement in

eco-tourism etc. The last, facilitated by West Bengal Forest Development Corporation, has been internalized by the FPCs. Such areas are few in numbers at present but are quite popular with the local people and also people from distant urban places. Few FPC members are trained in cooking and as caretakers. The visitors have to take their services during their stay in the forest cottages.

5. Some improvement in bio diversity and forest quality has taken place in forests, especially in SW Bengal.
6. Employment opportunities have gone up in certain areas. **Negative Aspects**
    1. The West Bengal JFM orders have not fully reflected the GoIs policies and orders relating to JFM in fundamental ways:
    2. The GoIs forest policy objectives of 1988 state thus: • First, to maintain country's environment stability through preservation; • Second, to conserve the natural forests; • Third, meeting the basic needs of people specially fodder, small timber and maintaining the relationship between tribal and the fringe people by protecting their customary rights on the forest. One of the strategies to do the last is to actively involve the people in the conservation of the forest
        2. JFM Micro plans failed to reflect local people's needs:
        3. FD failed to manage the forests to achieve JFM from technical and social point of view.
        4. FD failed to socially manage the forests to achieve JFM objectives;
        5. No consideration is given to compensate those deprived of them income as JFM is introduced in the village
        6. Lack of interest of many forest officials in promotion of JFM
        7. Lack of proper institutionalization in FPCs of decision-making, monitoring and other processes.

15.6 Summary and Conclusion

This mismatch between what is demanded and the attempts of officials to produce only those products which they had routinely learnt to produce borders on intellectual blindness. And yet the foresters are adamant not to make any significant change in their perspective, nor to empower the people to take over as a dominant partner in management, as they claim local people are ignorant of forestry.

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