Chapter 1

INTRODUCTION TO ENVIRONMENT, ECOLOGY AND NATURAL RESOURCES

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Environment may be defined in the simple terms as the sum total of all external conditions and influences that affect the living organisms. It includes lower part of the atmosphere, entire hydrosphere and soil and lithosphere to a depth where evidence of existence of living organism has been found. These together constitute **Biosphere or life zone of the earth.** Modern biosphere where man's activities dominate is sometimes referred to as **Anthroposphere or Noosphere.** It includes besides natural environment, complex of social, cultural and technological world that influence individual, community and ecosystem.

DIMENSIONS OF ENVIRONMENT

The environment is viewed as three dimensional in nature surrounding all living organisms. It is continuous in time and space and often difficult to delimit. In ecological investigations the environment is delimited by the age of the individual, population and communities. Nonetheless, past environment

has a bearing on the present environment as well as on the growth, abundance and distribution of living organisms at a given point of time.

COMPONENTS OF ENVIRONMENT

The environment is arbitrarily divided in to **Living or Biotic** (plants, animals, microbes and man) and **Physical or Abiotic** (includes all forms of energy, materials and conditions) components. Each of the two major components may be further divided into smaller units. For instance, biotic component may be viewed at different levels of organization starting from individual, population to community. Similarly the physical environment may be divided into climate, soil, physiography, fire etc. The components or the factors of the environment generally show a gradual change in time and space and the living organisms tend to continuously adjust with the changing environmental conditions by continuous variation in form, function, behaviour, and associated genotype. This phenomenon is explained by the term **ecocline**. On the other hand, transition between two or more diverse habitats or communities is sometimes abrupt, for example, between forest and grassland. Such a junction or tension belt between the two is called **ecotone**, which may have linear extent but is narrower than the adjoining community areas themselves.

Trigger factor and compensating factors

An environmental factor that initiates a set of chain reaction, and whose influence is often difficult to assess in a short period of time is called **trigger factor**, for example, irrigation of deserts, use of pesticides, increased level of CO_2 in atmosphere etc. **Compensating factors** are those where one factor substitutes the other e.g., substitution of altitude by latitude.

Nature of environment

All components, both biotic and abiotic, of the environment act as one whole. There is no barrier either between different

factors of physical environments or between organisms and the physical environment. Any one factors either living or non-living freely interacts with any other living or non-living componsnt. This property of one-ness of the environment is termed as **Holocoenotic** nature. Any alteration in one factor brings about change in the other factor of the environment. All factors of environment influence the organism simultaneously, but at a given time or place one or more components of the environment may have dominant influence over the other.

Dynamic nature of environment

The environment varies in time and space due to continuous change in its components. In space, the change can be observed at the micro level or at the macro level. At macro level, the Earth may be divided into four distinct horizontal zones depending on climate (tropical, temperate, alpine and tundra) each having its own distinct environment and biota. The environment changes in vertical scale, from sea surface to deep ocean, from outer space and to the ground surface, from low to high altitude, from forest floor to treetop etc. In time, the change can be measured in term of geological time scale (change in climate, oxygen and carbon dioxide levels in air, salt content in sea etc.), year-to-year variations, seasonal and diurnal changes etc.

Natural vegetation and associated fauna change with the change in the environmental condition. This explains the distribution of different types of plants and animals at different places on the Earth. Vegetation of a given place also changes with time. Such a change is associated with change in species composition, structure and function of the system.

Interaction between organism and environment

The influence of environmental factors on the organisms starts from sub-cellular level to the individual, population and community levels starting from their birth to death (**action**).

The living organisms react to the environmental factors in various ways and tend to modify it through various ways (**reaction**). The different components of environment interact among themselves. As a result of reaction and co-action the environment in vicinity of the organisms in a population and community is different from the general environmental conditions of the area. These two are distinguished as **micro- and macro- environment** respectively. All the living organisms including man and their physical environment in an area constitute an ecological system or **ecosystem**, which is a self-sustained and self-regulated unit of the landscape.

Flow of energy and cycling of nutrients

As a result of interaction between organism and environment, solar energy is converted into organic food energy by green plants in the process of **photosynthesis**. The food energy is transferred from green plants to several other groups of organisms such as herbivore, carnivore and detrivore by the process of eating and being eaten up and ultimately is dissipated into space in the form of heat energy. The process is known as **Energy flow.** This process of transfer of food energy makes a chain, called as food chain. At each step of the transfer of energy in the food chain there occurs huge energy loss (*ca.* 90%). As a result there are fewer steps in the food chain. Energy flow supports all life on the Earth. Besides energy, the inorganic elements present in soil, water and air enter into the biotic or living component of the ecosystem mainly through green plants and again return to the physical environment after the death and decay of living organisms for reuse by the plants. This process is known as **Biogeochemical cycle.**

Ecological niche

The term is used to describe the role a species plays in an ecosystem. For instance, what space it occupies in the ecosystem? How it obtains food? What relationships it has

with other species? What services it provides in the ecosystem etc. Some species are specialists and occupy a very specific niche, while others have a broad range of habitats. The first group of species tends to be rare and less resilient to disturbance or change than the second group of species, which are generalists and may survive under broad range of conditions.

PRINCIPLES PERTAINING TO LIMITING FACTORS

Every living organism has limits to the environmental conditions within which it successfully grows and reproduces. Justus von Liebig (1840) based on his studies on the mineral nutrition of plants concluded that a single factor that is in the **shortest supply** or **minimum level** relative to its demand, is the critical determinant of the growth and reproduction of the species. This principle is strictly applicable under steady-state condition.

Later this principle of limiting factors was extended by stating that each environmental factor has both minimum as well as **maximum** levels, thus organisms have ecological minimum and maximum with a range in between, often called as **tolerance limits or limits of tolerance.** The species do not survive beyond these limits. Thus absence or failure of an organism is controlled by the qualitative and quantitative deficiency or excess with respect to any one of the several factors. Some species have narrow tolerance limits (steno-species) while others may have wide tolerance limits (eury-species) for the environmental factors.

The science of Ecology examines the reciprocal relationship between organisms and environment i.e. how their environment influences growth, abundance and distribution of organisms? An understanding of ecological interactions helps us to understand human impacts on the environment and to manage ecosystems in better way. For instance,

1. An understanding of the laws of energy and the loss of biomass in food chains suggests that we could more easily

feed the world's growing population if people ate more fruits, grains and vegetables.

2. An understanding of the nutrient cycling and of how they can be adversely altered through industrial and agricultural developments could help us devise alternative strategies, in particular ones that do not disrupt important cycles of life.
3. Knowledge of succession and productivity of different successional communities has proved useful in managing natural resources like forest, grassland etc., for maximum yield.
4. The law of tolerance reminds us of the need to act in a ways that preserve conditions essential to other life forms. By exceeding the limits, we become the agents of destruction.
5. The niche concept helps us manage ecosystems in more sustainable manner.
6. The understanding that an organism's interactions are complex, we are compelled to examine big picture before we embark on any course of action.

METHODS OF ECOLOGICAL ENQUIRY

Measurements are rarely exact representations of ecological concepts, and different measurements can inform about a concept in different ways. The measurements do not always represent concepts accurately but instead are usually limited in some aspects of their effectiveness, accuracy, or precision and must be weighed and considered as partial representations.

No single technique of investigation — whether experiment, survey, field description, or analysis of patterns in existing data is always superior. Certain techniques of investigation are more appropriate at certain times. The task of the scientist is to recognize when each is most appropriate according to the current needs of the investigation, not to adhere to one procedure through habit.

The method of progressive synthesis: It is a methodology for scientific investigation in ecology that acknowledges the requirement to make upward inference about integrative ecology. It defines how different techniques available for investigating ecological problems, e.g., surveys, experiments, modeling, can be used in constructing objective knowledge. Progressive Synthesis has a philosophy, three principles, and five components. The philosophy is pragmatic realism. Science aims to provide the best explanatory account of natural phenomena, and acceptance of a scientific theory involves the belief that it belongs to such and account. To produce best explanatory account, three principles must guide investigations. (1) Criticism of increasing breadth must be applied to objectives, methods and results. (2) Precision in definition is required to develop the coherence in breadth a detail of an explanation. (3) Postulates must be assessed with explicit standards so that their merit and the degree of objectivity of the theory of which they are part can be criticized.

NATURAL RESOURCES

The environment is the source of all the resources that fuel the economy and make our lives possible, and acts a sink for all of our wastes.

Renewable resources

The resources that can be renewed by natural processes such as soils, forests, grassland, Agriculture, fish, wildlife, air, and water are called renewable resources. Although these resources can be regenerated, humans can deplete them as a result of overuse to an extent that their renewal becomes exceedingly difficult and time consuming. By the same token, humans can also facilitate renewable resources. Some resources may be renewed much more rapidly (animals, crops, grassland) than others (soil and forest). Important renewable resources grown on land are as under:

a) Agricultural products, vegetables, grains, fruits, fibers and medicines etc.
b) Natural vegetation such as forests, grassland, deserts etc. source of varied kinds of materials used by humans such as food, timber, fuel wood, fodder, pulp etc., act as a source of scenic beauty and provide recreational area. They are key to several vital ecosystem level processes such as control of soil erosion, water conservation, biodiversity conservation, water and nutrient cycling, energy transfer etc. that are crucial for the survival of humans.
c) Water Resources: fresh water (lakes and streams) and seawater.

Nonrewnable resources

Those resources, which cannot renew by natural processes at all or not rapidly enough to be usable by current human society. They include fossil fuels (oil, coal, natural gas) and nonmetallic minerals (phosphates, magnesium), and metallic minerals (copper, aluminum). Continued harvest or use of resources depends on proper human planning and management. Improper use and/or management result in impairment or exhaustion, with harmful social and economic effects.

Global resource use pattern

All people need resources, but we live in a world of haves and have-nots. The world's resources are shared in highly disproportionate manner. The most noticeable demand comes from the developed nations. The US ranks first in per capita consumption. With less than 5 percent of total population, it consumes about one-quarter to half of most commercially traded communities and produces a quarter to half of most industrial wastes.

The resource demands are extraordinary in the heavily populated developing nations, too. The natural environments and resources bases of India, China, and Bangladesh are

suffering enormously under the strain of large and rapidly growing populations.

According to the world bank estimates more than 1.3 billion people — one-fifth of the world — live in acute poverty in which they lack access to an adequate diet, decent housing, basic sanitation, clean water, education, medical care, and other essentials for a humane existence. These people have become both the victims and agents of environmental degradation.

The world's affluent nations are major consumers of the world's resources and are the worst polluters of the environment.

APPROACHES TO RESOURCE MANAGEMENT

Management of resources requires an understanding of economics and environmental ethics and ability to think critically. Several economic myths pervade our society that prevents progress toward a sustainable use of natural resources.

- Environmental protection is bad for the economy.
- Environmental protection is a luxury of lesser value than economic growth.
- Environmental quality is non economic.
- Economic growth is good, indeed essential.

Many believe that a breakthrough in technology can solve our resource and environmental problems as have happened in the past. Availability of cheap energy may accomplish many things — pollution will be controlled, food will be available for all, and clothing and shelter for the needy millions will be provided. Food production may be increased dramatically.

Some believe that technology will not be able to solve all our problems since global population; resource consumption and many forms of pollution are all growing exponentially. The world's best scientists, technologists, ecologists, sociologists, and economists are struggling to find solutions; the annual increase is becoming overwhelming.

It is difficult to say which of the two viewpoints are close to the truth. It seems moderate view is more appropriate. A shift from today's **spendthrift society** to a **sustainable society is probably the answer**, if we start now.

A sustainable society is one that meets its needs without preventing future generations and other species from meeting their needs. It appears to be a simple goal but it is enormously complicated and difficult to achieve.

PRINCIPLES OF SUSTAINABLE NATURAL RESOURCE USE

- Harvest rates for renewable resources should not exceed their regeneration rates.
- Waste emissions should not exceed the ability of nature to assimilate or recycle those wastes.
- Non-renewable resources may be exploited only at rates equal to the creation of renewable substitutes.

GOALS OF SUSTAINABLE DEVELOPMENT

1. Every person should get the benefits of a healthy environment.
2. Healthy sustainable economy that affords the opportunity for a high quality of life.
3. Equity and opportunity for economic, social and environmental well being.
4. Protection and restoration of natural resources for current and future generations.
5. Full opportunity for all citizens to participate in and influence the natural resource, environmental and economic decisions that affect them.
6. Stabilization of population.
7. Access to formal education will prepare citizens for meaningful work and a high quality of life, and give them an understanding of concepts involved in sustainable development.

Ecological approach

Ecological approach is a systems approach. It requires thinking in terms of whole ecosystem, not just isolated part of it. It calls for protecting and managing the entire ecosystems. This requires maintaining ecological integrity of the system therefore efforts must be made to protect the diversity of species, populations, and ecosystems in a given management area. This approach pleads for the use of resources in such a way that ensure their long-term health and vitality. It emphasizes multiple uses of resources and restricted or limited human activity. This is now commonly referred to as **ecosystem approach or ecosystem management.**

- Many ecologists believe "sustainable" growth of any sort is impossible in the long run because of the limits imposed by nonrenewable resources and the capacity of the biosphere to absorb our wastes. The economic growth makes possible a more comfortable lifestyle; it does not automatically result in a cleaner environment.
- Supporters of sustainable development believe that both technology and social organization can be managed in ways that meet essential needs and provide long-term — but not infinite — growth within natural limits, if we use ecological knowledge in our planning. It will require dedicated, highly coordinated, and long sustained efforts of large number of people from all walks of life e.g., from factory workers to business executives, from college students to farmers, from scientists to politicians, from food specialists to geographers. It requires imaginative and inspirational leadership from government leaders at all levels.

REFERENCE

Justus von Liebig 1980. Chemistry in its application to agriculture and physiology. Taylor and Walton, London.