

ENVIRONMENTAL SCIENCE

Unit I: Ecology and Environment

From this unit, you will learn the following concepts:

- a. Biotic and abiotic factors of the environment
- b. Concept of biosphere
- c. Population parameters
- d. Concept of carrying capacity
- e. Biogeochemical cycle: carbon, nitrogen, phosphorus, water, energy flow

Introduction to the Concept of Environment

The term environment has been derived from a French word “Environs” which means ‘to be around’. 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 components of nature. Environment regulates the life of the organisms including human beings. Human beings interact with the environment more strongly than other living beings.

a. Factors of environment:

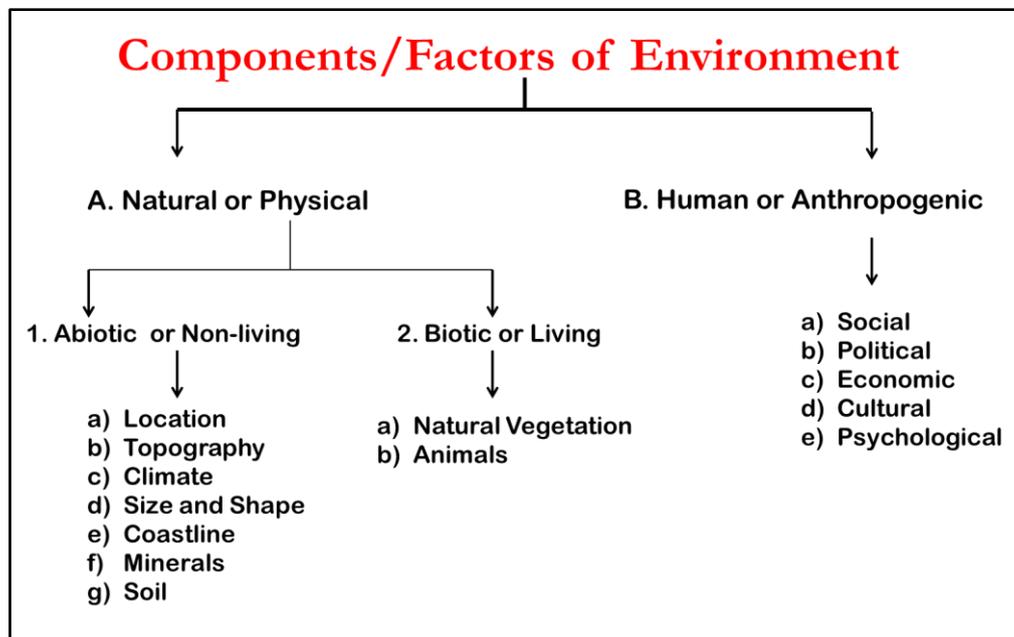


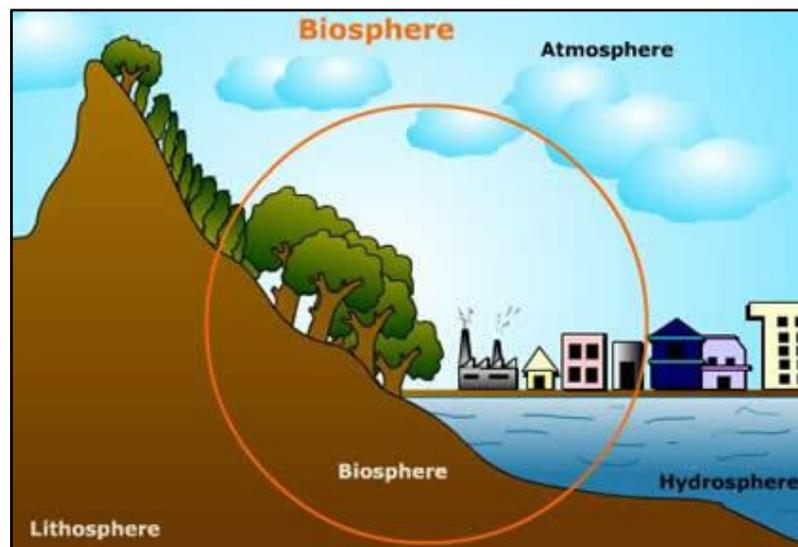
Fig.1: Components or Factors of environment

b. Concept of Biosphere:

The biosphere is the fourth sphere, and consists of the places where life can be found. It includes life in all forms and at all places. Since life exists in the air, on and in the

earth, and on and in water, the biosphere overlaps, connects, and influences all of the other spheres - and they all affect the biosphere.

Considering the total number of organisms on earth, however, the biosphere is actually fairly small in size. Most of the biosphere's life is found between 500 meters below the surface of the ocean and six kilometers above the surface of the earth, although there are organisms, especially microorganisms, able to live at much higher and lower depths. The biosphere is quite old; its creation overlaps with the appearance of the first bacteria, about 3.5 billion years ago. As life has changed and become more



complex, so has the biosphere.

Fig.2: Biosphere

c. Population parameters:

Population parameters are useful to ensure that populations, communities and ecosystems are managed in an ecologically sustainable manner on the basis of the following parameters or scales of measurement:

1. **Birth rate:** number of species produced per 1000 species.
2. **Death rate:** number of deaths per 1000 individuals
3. **Density:** species living per 1sq. km. area.
4. **Immigration:** migration into the region
5. **Emigration:** migration outside the region.

d. Concept of carrying capacity

The **carrying capacity** of a biological species in an environment is the maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water, and other necessities available in the environment. It refers to the

maximum number of species which an area or an ecosystem can hold while fulfilling its needs required to sustain life without harming other species.

e. Biogeochemical cycle:

The circulation of chemical nutrients like carbon, oxygen, nitrogen, phosphorus, calcium, water etc. through the biological and physical world are known as "biogeochemical cycles". The term "biogeochemical" tells us that biological, geological and chemical factors are all involved in the process.

1. **Water or Hydrological Cycle:** The **water cycle**, also known as the **hydrological cycle** or the **hydrologic cycle**, describes the continuous movement of water on, above and below the surface of the Earth. Natural forces circulate water from surface to water bodies like rivers and seas, to atmosphere and then back to the surface.

a. Human impacts on the water cycle:

- i. Removing forest and vegetation increase runoff and erosion, reduce transpiration and lower water table.
- ii. Irrigation agricultural fields depletes rivers, lakes and streams and increases evaporation.
- iii. Damming rivers increase evaporation and infiltration.
- iv. Emitting pollutant changes the nature of precipitation.
- v. The most threatening impact. Overdrawing of groundwater for

2. **Carbon Cycle:** Carbon enters the atmosphere as **carbon dioxide** from respiration and combustion.

a. Process of the carbon cycle: Carbon dioxide is absorbed by producers to make **carbohydrates** in photosynthesis. Animals feed on the plant passing the carbon compounds along the food chain. Most of the carbon they consume is exhaled as **carbon dioxide** formed during respiration. The animals and plants eventually **die**. The dead organisms are eaten by **decomposers** and the carbon in their bodies is returned to the atmosphere as carbon dioxide. In some conditions decomposition is **blocked**. The plant and animal material may then be available as **fossil fuel** in the future for combustion.

b. Human impacts on the carbon cycle:

- i. burning fossil fuels moves carbon the ground to the air.

- ii. Cutting forests and burning fields moves carbon from vegetation to the air.
- iii. Today's atmospheric carbon dioxide reservoir is the largest in the past 800,000 years. It is the driving force behind the climate change.

3. Nitrogen cycle: Nitrogen is essential for the formation of **amino acids** in proteins. The **nitrogen cycle** is a model that explains how nitrogen is **recycled**. There's a lot of nitrogen in **air** – about **78%** of the air is nitrogen. Because nitrogen is so **unreactive**, it cannot be used directly by plants to make protein. Only **nitrates** are useful to **plants**, so we are dependent on other processes to **convert** nitrogen to nitrates in the soil.

a. Process of the nitrogen cycle: Nitrogen gas is converted to nitrate compounds by **nitrogen-fixing bacteria** in soil or root nodules. **Lightning** also converts nitrogen gas to nitrate compounds. The Haber process converts nitrogen gas into ammonia used in fertilizers. Ammonia is converted to nitrates by **nitrifying bacteria** in the soil. Plants absorb nitrates from the soil and use these to build up **proteins**. The plant may be eaten by an **animal**, and its biomass used to produce **animal protein**. Urea and digested material is broken down by **decomposers**. This results in nitrogen being returned to the soil as **ammonia**. Decomposers also break down the **bodies** of dead organisms resulting in nitrogen being returned to the soil as ammonia. **Higher only:** In some conditions, **denitrifying bacteria** in the soil break down nitrates and return nitrogen to the air. This is usually in **waterlogged soil**. Improving drainage reduces this effect, making the soil more fertile.

b. Human impacts on the nitrogen cycle:

- i. **Haber -Bosch process:** production of fertilizers by combining nitrogen and hydrogen to synthesize ammonia. Due to this human being could overcome the limits on crop productivity by fixing atmospheric nitrogen with fertilizers. However, this has resulted in:
 - ii. Increased emission of greenhouse gases and smog.
 - iii. Washing out calcium and potassium out of the soil.

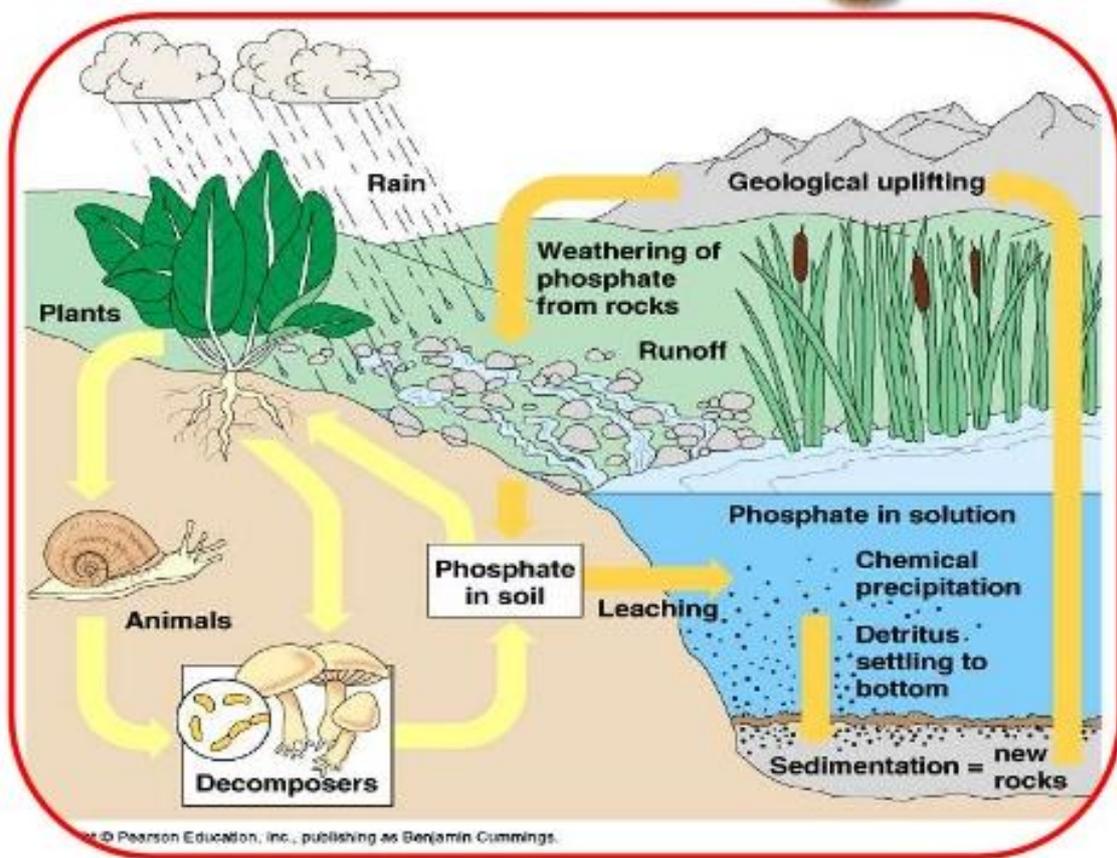
- iv. Moving of the atmospheric nitrogen into the terrestrial system and oceans.
- v. Reduced the diversity of plants adapted to low- nitrogen soils.
- vi. Changed estuaries and coastal ecosystems and fisheries.

4. **Phosphorus cycle:** Phosphorus is an essential element to all life. It is an important part of the ATP molecule that stores and gives every cell its energy. It is also found in DNA and RNA, which tell the cells how to look and act. Needless to say, phosphorus is needed for every living organism to grow and function. **The phosphorus cycle** is the process in which phosphorus travels from its main source of rocks through ecosystems to living organisms.

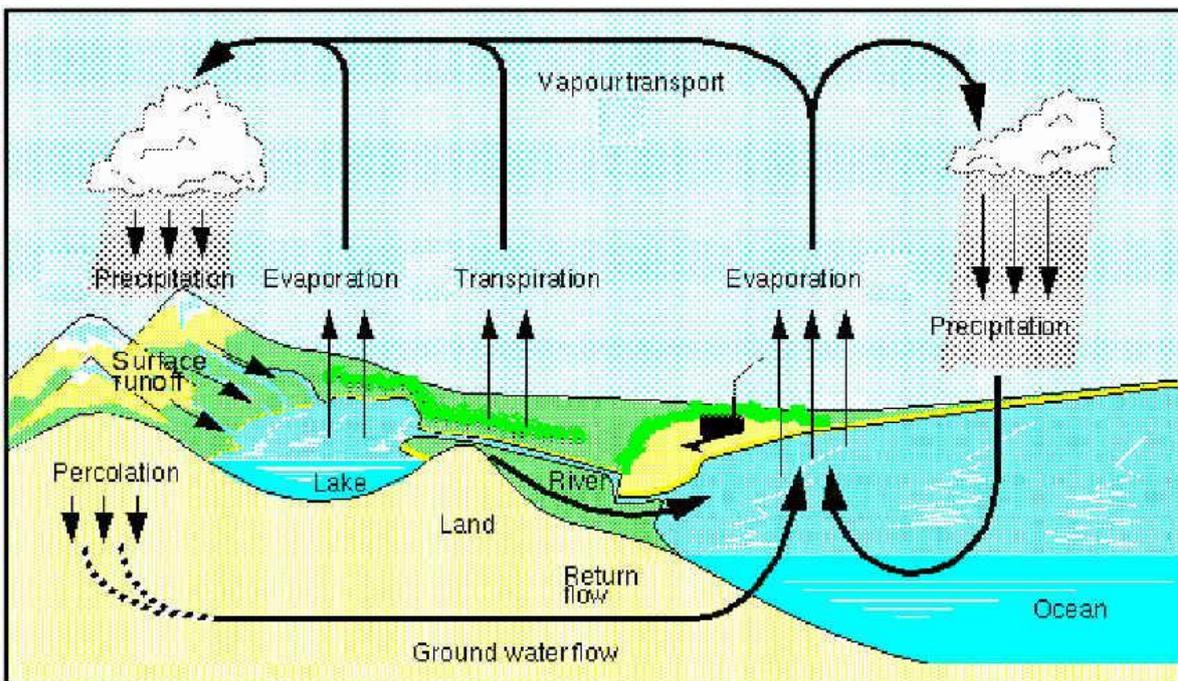
a. Process of the Phosphorus Cycle: The phosphorus cycle begins its journey in the crust of the Earth, as phosphorous is found in rocks. Weathering causes it to break free from the rocks and wash away into the ground. At this time, the phosphorus gets mixed in the soil. Land plants are now able to soak up the phosphorus from the ground. Animals obtain the phosphorus by eating the plants. Sometimes the phosphorus just gets washed up into the water supply. Aquatic plants and other producers are able to obtain phosphorus directly from the water. Animals, too, can get phosphorus from drinking the water. The phosphorus is returned to the Earth in different ways. Plants and producers that are not eaten will die, and their phosphorus will be broken down when they decay. This will return the phosphorus back to the earth to mix with the soil or water. Then new producers that use the soil or water will be able to use the phosphorus. Humans and other animals return phosphorus through our waste. When our waste gets broken down, the phosphorus goes into the water system.

b. Human impacts on the phosphorus cycle:

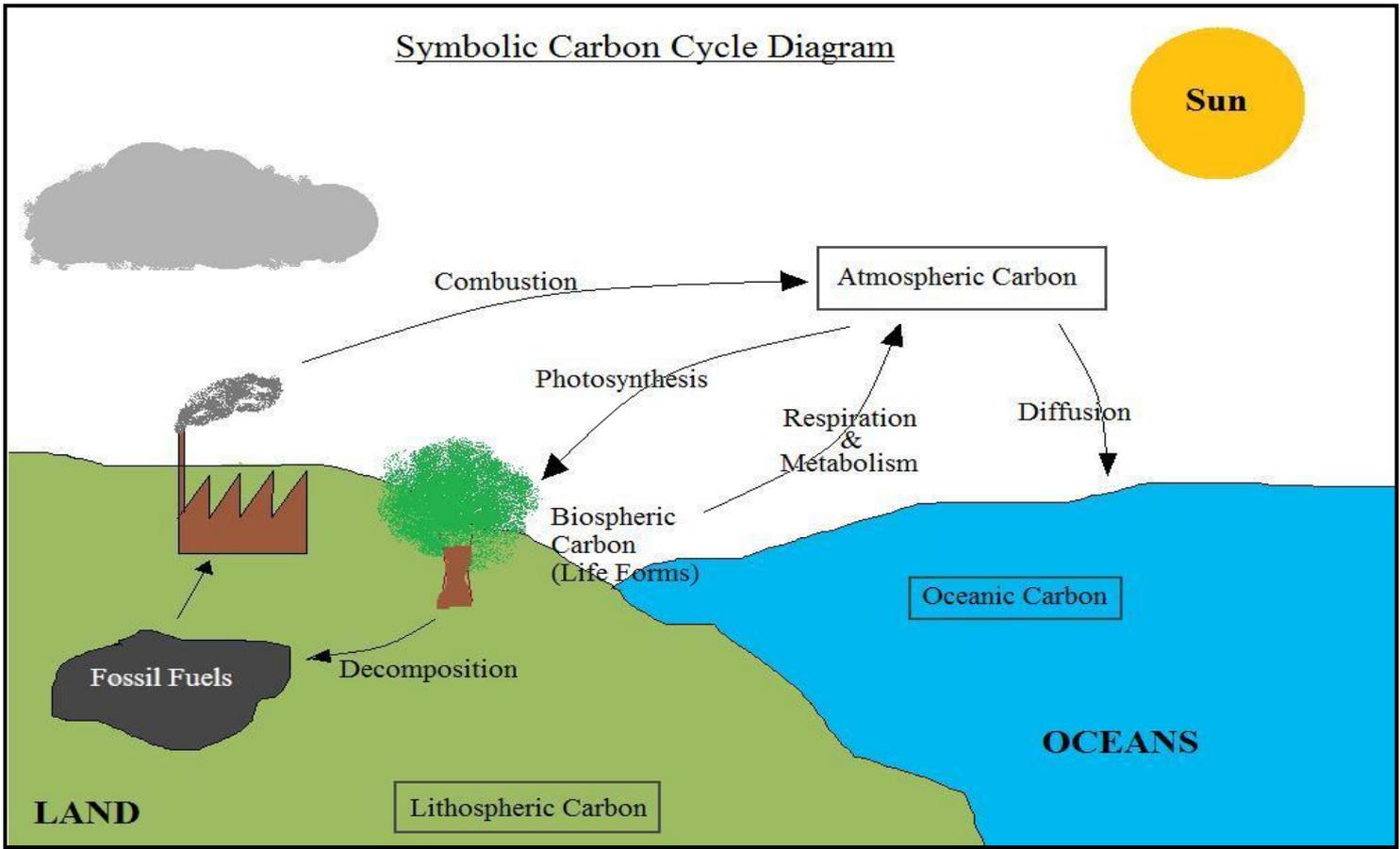
- i. Mining rocks for fertilizers moves phosphorus from the soil to the worlds water systems.
- ii. Waste water discharge also releases phosphorus.
- iii. Runoff containing phosphorus causes eutrophication of aquatic system. Alters the structure and functioning of the aquatic system.



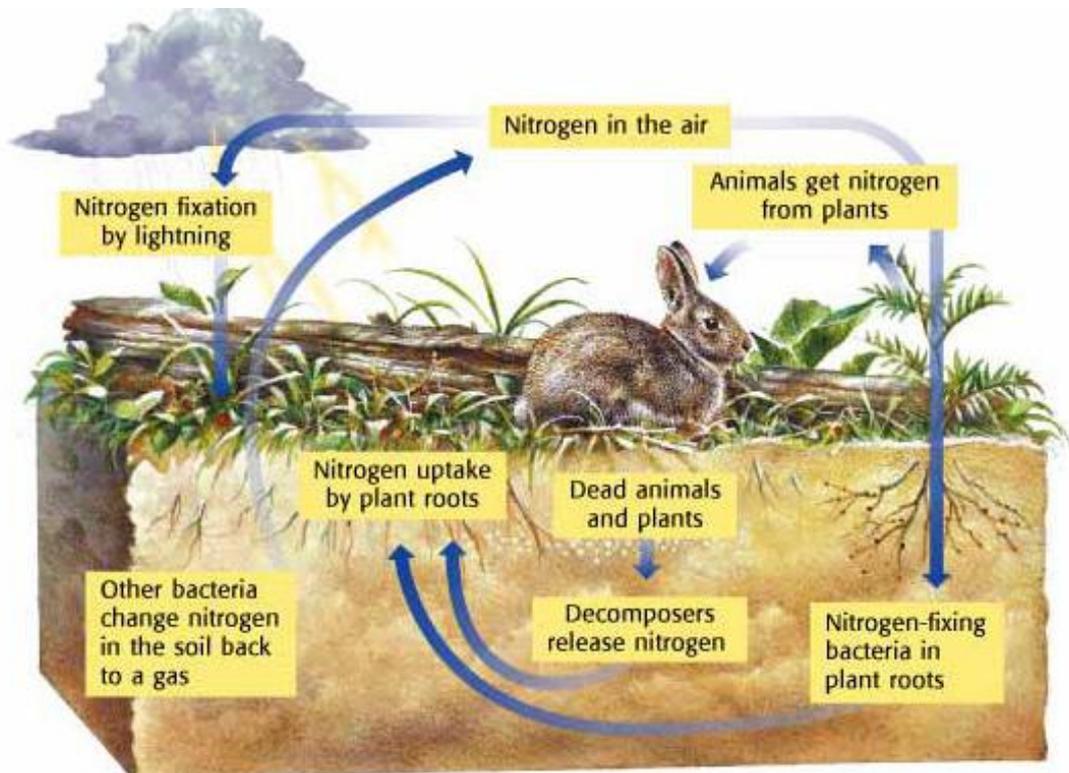
THE PHOSPHOROUS CYCLE



THE WATER CYCLE



THE CARBON CYCLE



THE NITROGEN CYCLE