UNIT 6

Environmental Science

GC82AK

Learning Objectives

After completing this lesson, students will be able to

- relate different aspects of environmental science.
- describe biogeochemical cycles.
- explain water cycle, nitrogen cycle and carbon cycle.
- analyse the impacts of human activities on water cycle, nitrogen cycle and carbon cycle.
- correlate the adaptations of plants with the habitat.
- explain the adaptations of bat and earthworm.
- explain recycling of water.
- discuss the importance of water conservation and water recycling method.

Introduction

"Nature has the power to refresh and renew"
- Helen Keller

Several environmental issues such as pollution, global warming, ozone layer depletion, acid rain, deforestation, land slide, drought and desertification have gained major focus across the world. Environmental science provides holistic knowledge about natural processes, effects of human intervention and solutions to overcome such environmental issues. Thus, it is defined as the study of patterns, processes in the natural world and their modifications by human activities. Elements of nature continuously undergo changes and transformations. They are recycled over and over again on earth and make themselves always available on earth. In the same way, all living organisms react with their environment and develop certain morphological, anatomical, physiological and reproductive features to withstand particular conditions. This lesson deals with biogeochemical cycles, adaptations by the plants and animals, water conservation and recycling of water.

6.1 Biogeochemical cycles (bio – life; geo – earth)

Biosphere is the part of the earth where life exists. All resources of biosphere can be grouped into two major categories namely:

(i) Biotic or living factors which include plants, animals and all other living organisms.

(ii) Abiotic or non-living factors which include all factors like temperature, pressure,

water, soil, air and sunlight which affect the ability of organisms to survive and reproduce.

There is a constant interaction between biotic and abiotic components in the biosphere and that make the biosphere a dynamic and stable system. Cyclic flow of nutrients between non-living and living factors of the environment are termed as biogeochemical cycles. Some of the important biogeochemical cycles are:

1. Water cycle 2. Nitrogen cycle 3. Carbon cycle

6.1.1 Water cycle

- Can you imagine life without water?
- Have you tried to find out how do we get rain?
- Why do lakes and ponds dry out during summer?
- What is the need for conserving and recycling water?

Water cycle has the answers for all these questions. Water cycle or hydrological cycle is the continuous movement of water on earth. In this process, water moves from one reservoir to another, from river to ocean or from ocean to the atmosphere by processes such as evaporation, sublimation, transpiration, condensation, precipitation, surface runoff and infiltration, during which water converts itself to various forms like liquid, solid and vapour (Fig. 6.1). Let's begin the process of water cycle with evaporation.

Evaporation

Evaporation is a type of vaporization, where liquid is converted to gas before reaching its boiling point. Water evaporates from the surface of the earth and water bodies such as the oceans, seas, lakes, ponds and rivers turn into water vapour.

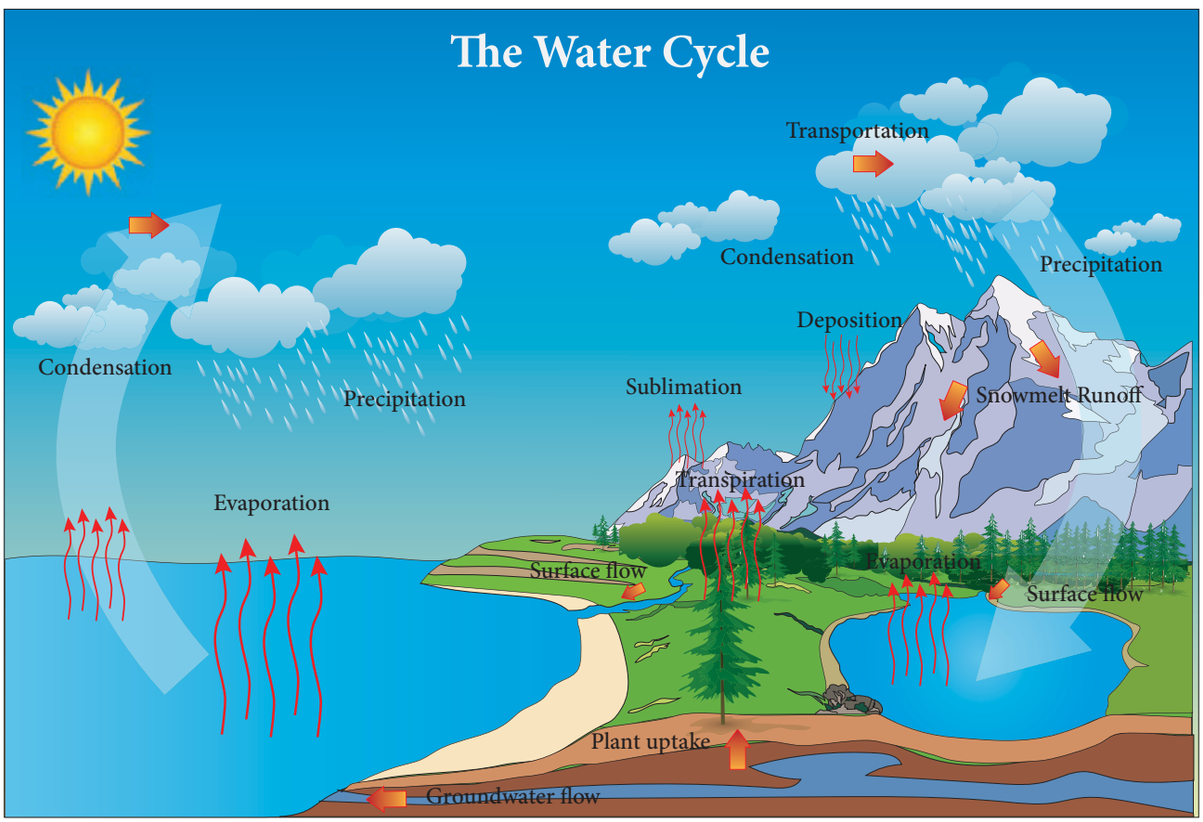

Figure 6.1 Water cycle

Sublimation

Sublimation is conversion of solid to gas, without passing through the intermediate liquid phase. Ice sheets and ice caps from north and south poles, and icecaps on mountains, get converted into water vapour directly, without converting into liquid.

Transpiration

Transpiration is the process by which plants release water vapour to atmosphere through small pores in leaves and stems.

Condensation

Condensation is the changing of gas phase into liquid phase and is the reverse of vaporisation. At higher altitudes, the temperature is low. The water vapour present there condenses to form very tiny particles of water droplets. These particles come close together to form clouds and fog.

Precipitation

Due to change in wind or temperature, clouds combine to make bigger droplets, and pour down as precipitation(rain). Precipitation includes drizzle, rain, snow and hail.

Run off

As the water pours down, it runs over the surface of earth. Runoff water combines to form channels, rivers, lakes and ends up into seas and oceans.

Infiltration

Some of the precipitated water moves deep into the soil. Then it moves down and increases the ground water level.

Percolation

Some of the precipitated water flows through soil and porous or fractured rock:

Infiltration and percolation are two related but different processes describing the movement of water through soil.

Human impacts on water cycle

Major human activities affecting the water cycle on land are urbanisation, dumping of plastic waste on land and into water, polluting water bodies and deforestation.

Activity 1

Create your own water cycle

Aim

To understand utilisation and recycling of water.

Materials

A large transparent bowl, plastic wrap, a stone, a smaller container and a rubber band.

Procedure

The small container is placed in the middle of the large bowl. Water is filled in the large container and it is covered with plastic wrap. The plastic wrap is fastened around the rim of the large container with the rubber band. The stone is placed on the top of the plastic wrap. This is placed under sun for few hours.

Observation

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Inference

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6.1.2 Nitrogen cycle

Nitrogen is primary nutrient important for survival of all living organisms. It is an essential component of proteins, DNA and chlorophyll. Atmosphere is a rich source of nitrogen and contains about 78% nitrogen. Plants and animals cannot utilize atmospheric nitrogen. They can use it only if it is in the form of ammonia, amino acids or nitrates.

Processes involved in nitrogen cycle are explained below.

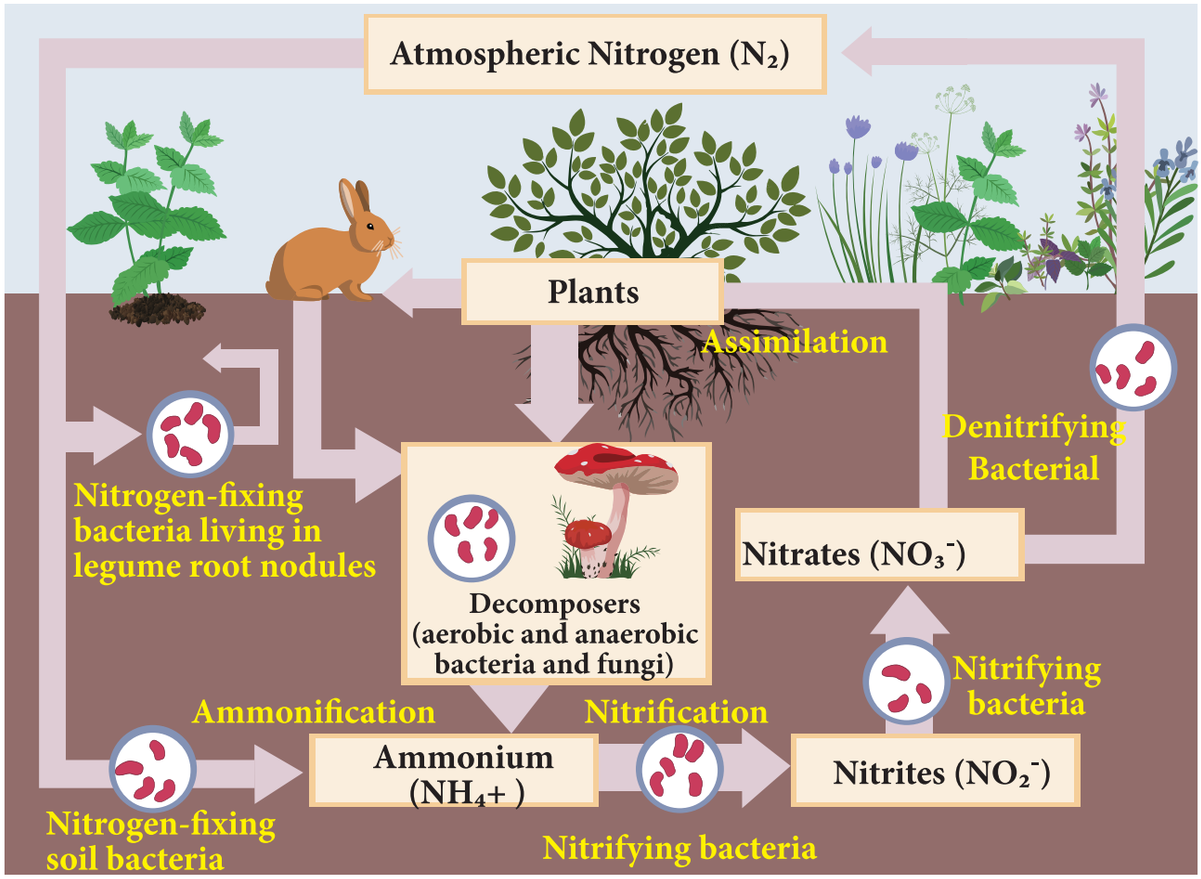

Figure 6.2 Nitrogen cycle

Nitrogen fixation

Nitrogen fixation is the conversion of atmospheric nitrogen, which is in inert form into reactive compounds available to living organisms. This conversion is done by a number of bacteria and blue green algae (Cyanobacteria). Leguminous plants like pea and beans have a symbiotic relationship with nitrogen fixing bacteria *Rhizobium*. Rhizobia occur in the root nodules of leguminous plants and fixes nitrogenous compounds.

Nitrogen assimilation

Plants absorb nitrate ions and use them for making organic matter like proteins and nucleic acids. Herbivorous animals convert plant proteins into animal proteins. Carnivorous animals synthesize proteins from their food.

Ammonification

The process of decomposition of nitrogenous waste by putrefying bacteria and fungi into ammonium compounds is called ammonification. Animal proteins are excreted in the form of urea, uric acid or ammonia. The putrefying bacteria and fungi decompose these animal proteins, dead animals and plants into ammonium compounds.

Nitrification

The ammonium compounds formed by ammonification process are oxidised to soluble nitrates. This process of nitrate formation is known as nitrification. The bacteria responsible for nitrification are called as nitrifying bacteria.

Denitrification

Free living soil bacteria such as *Pseudomonas sp.* reduce nitrate ions of soil into gaseous nitrogen which enters the atmosphere.

Human impacts on nitrogen cycle

Burning fossil fuels, application of nitrogen-based fertilizers and other activities can increase the amount of biologically available nitrogen in an

ecosystem. Nitrogen applied to agricultural fields enters rivers and marine systems. It alters the biodiversity, changes the food web structure and destroys the general habitat.

Table 6.1 Microorganisms involved in nitrogen cycle

Role played in nitrogen cycle	Name of the microorganisms
Nitrogen fixation	*Azotobacter* (in soil) *Rhizobium* (in root nodules) Blue green algae- *Nostoc*
Ammonification	Putrefying bacteria Fungi
Nitrification	Nitrifying bacteria *i. Nitrosomonas* *ii. Nitrobacter*
Denitrification	Denitrifying bacteria *Pseudomonas*

6.1.3 Carbon cycle

Carbon occurs in various forms on earth. Charcoal, diamond and graphite are elemental forms of carbon. Combined forms of carbon include carbon monoxide, carbon dioxide and carbonate salts. All living organisms are made up of carbon containing molecules like proteins and nucleic acids. The atmospheric carbon dioxide enters into the plants through the process of photosynthesis to form carbohydrates. From plants, it is passed on to herbivores and carnivores. During respiration, plants and animals release carbon into atmosphere in the form of carbon dioxide. Carbon dioxide is also returned to the atmosphere through decomposition of dead organic matter, burning fossil fuels and volcanic activities.

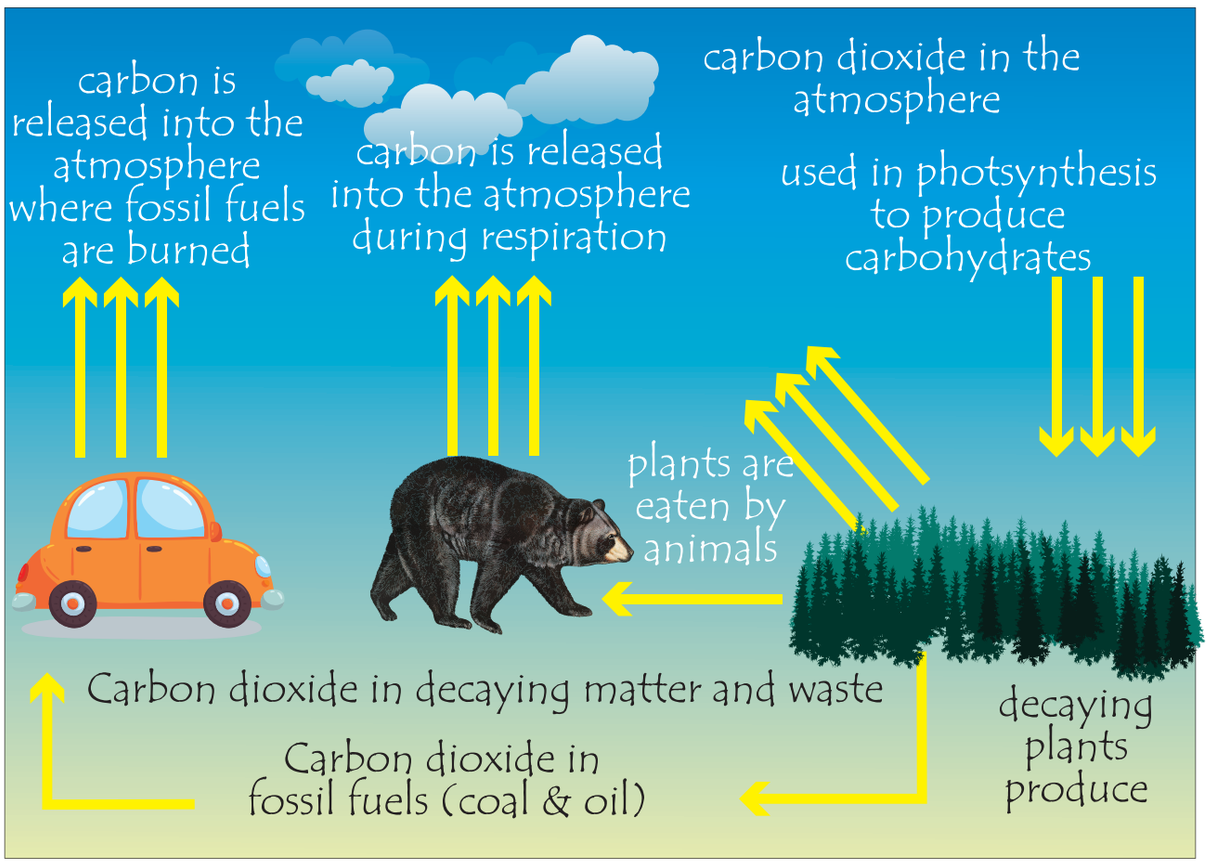

Figure 6.3 Carbon cycle

Human impacts on carbon cycle

More carbon moves into the atmosphere due to burning of fossil fuels and deforestation. Most of the carbon in atmosphere is in the form of carbon dioxide. Carbon dioxide is a greenhouse gas. By increasing the amount of carbon dioxide, earth becomes warmer. This leads to greenhouse effect and global warming.

It is really interesting to know how nature renews itself. At the same time, it also reminds us of our responsibility to reduce and restrain our activities that will affect the natural processes. Living organisms also try to adjust themselves according to their habitat and changes in the ecosystems. The adaptations help them to survive better.

6.2 Adaptations of plants

Any feature of an organism or its part that enables it to exist under conditions of its habitat is called adaptation. On the basis of water availability, plants have been classified as:

(i) Hydrophytes

(ii) Xerophytes

(iii) Mesophytes

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6.2.1 Hydrophytes

Plants growing in or near water are called hydrophytes. Hydrophytes may be free floating or submerged plants living in lakes, ponds, shallow water, marshy lands and marine habitat. Hydrophytes face certain challenges in their habitat. They are:

(i) Availability of more water than needed.

(ii) Water current may damage the plant body.

(iii) Water levels may change regularly.

(iv) Maintain buoyancy in water.

Adaptations of hydrophytes

1. Roots are poorly developed as in *Hydrilla* or absent as in *Wolffia*.
2. Plant body is greatly reduced as in *Lemna*.
3. Submerged leaves are narrow or finely divided. e.g. *Hydrilla*.
4. Floating leaves have long leaf stalks to enable the leaves move up and down in response to changes in water level. e.g. Lotus.
5. Air chambers provide buoyancy and mechanical support to plants as in *Eichhornia* (swollen and spongy petiole).

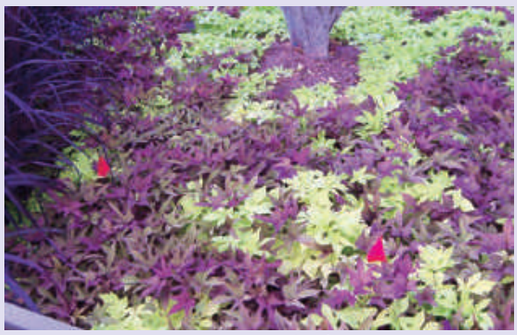
Hydrilla *Wolffia* *Lemna*

Eichhornia Lily Lotus

Figure 6.4 Hydrophytes

DO YOU KNOW?

Water hyacinth (*Eichhornia crassipes*) is a very charming plant. It is called as '***Cindrella of the plant kingdom***'. It covers entire surface of the water resources like ponds and lakes. It will not allow the light to penetrate into the water and increases the ***Biological Oxygen Demand*** leading to the death of aquatic plants and animals. It also alters the water clarity and decreases phytoplankton production, dissolved oxygen, nitrogen, phosphorus and heavy metals. During monsoon, it blocks the flow of water. During summer, the lake with water hyacinth evaporates nine times faster than the lake with no water hyacinth. Apart from its adverse effects, it is used as a green manure or converted as compost. It is also used as animal fodder. It can be processed to make paper, rope, handbags and even furniture.



Water Hyacinth

6.2.2 Xerophytes

Plants that grow in dry habitat are called xerophytes. These plants develop special structural and physiological characteristics to meet the following conditions:

(i) To absorb as much water as they can get from the surroundings.

(ii) To retain water in their organs for very long time.

(iii) To reduce the transpiration rate.

(iv) To reduce consumption of water.

Acacia

Calotropis

Opuntia

Figure 6.5 Xerophytes

Adaptations of xerophytes

1. They have well developed roots. Roots grow very deep and reach the layers where water is available as in *Calotropis*.
2. They store water in succulent water storing parenchymatous tissues. e.g. *Opuntia*, *Aloe vera*.
3. They have small sized leaves with waxy coating. e.g. *Acacia*. In some plants, leaves are modified into spines. e.g. *Opuntia*.
4. Some of the xerophytes complete their life cycle within a very short period when sufficient moisture is available

6.2.3 Mesophytes

Mesophytes are common land plants which grow in situations that are neither too wet nor too dry. They do not need any extreme adaptations.

Adaptations of mesophytes

1. The roots of mesophytes are well developed and are provided with root caps.

2. The stem is generally straight and branched.
3. The leaves are generally broad and thin.
4. The presence of waxy cuticle in leaves traps the moisture and lessens water loss.
5. Leaves have stomata which close in extreme heat and wind to prevent transpiration.

6.3 Adaptations of animals to Habitat, Temperature and Light

Animals can adapt themselves according to their habitat. Temperature and light are forms of energy which influence various stages of life activities such as growth, metabolism, reproduction, movement, distribution and behaviour. Animals develop special features or behaviour patterns to escape from extreme conditions of temperature and light. In this context, let us study the adaptive features of bat and earthworm.

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6.3.1 Adaptations of Bat

Bats are the only mammals that can fly. Mostly, bats live in caves. Caves provide them protection during the day from most predators and the temperature here is very stable. Apart from caves, bats also live in trees, hollowed logs and rock crevices. They are extremely important to humans as they reduce insect population and help to pollinate plants. Here, we will see the adaptations of bat in relation to their habitat.

Nocturnality

Bats are active at night. This is a useful adaptation for them, as flight requires a lot of energy during day. Their thin, black wing membrane (Patagium) may cause excessive heat absorption during the day. This may lead to dehydration.

Flight adaptation

Bat wings are entirely different from those of birds or insects. Modified forelimbs serve as wings. The bones in the wings of bats are elongated fingers and are connected by the flaps of skin on either side of the body known as Patagia. Tail supports and controls movements during flight. Muscles are well developed and highly powerful and achieve in beating of wings. Tendons of hind limbs provide a tight grasp when the animals are suspended upside down at rest.

Hibernation

Hibernation is a state of inactivity in which the body temperature drops with a lowered metabolic rate during winter. Bats are warm blooded animals but unlike other mammals, they let their internal temperature reduce when they are resting. They go to a state of decreased activity to conserve energy.

Echolocation

Bats are not blind. But to fly around and hunt for insects in the dark, they use a remarkable high-frequency system called echolocation. Bats give out high-frequency sounds (ultrasonic sounds). These sounds are reflected back from its prey and perceived by the ear. Bats use these echoes to locate and identify the prey.

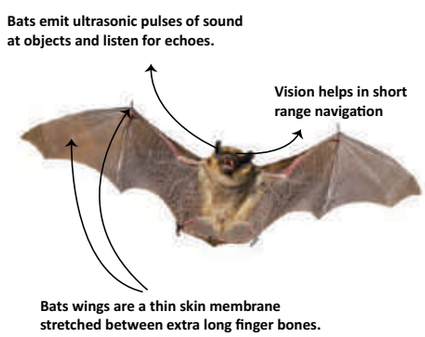

Figure 6.6 Bats

6.3.2 Adaptations of Earthworm

An earthworm is a segmented worm which belongs to Phylum Annelida. It is commonly found living in soil, feeding on live and dead organic matter. The faecal wastes are called worm castings (Vermicasts) which are rich in nitrogenous content adding fertility to the soil. Earthworm plays a large role in keeping soil health facilitating aeration, water infiltration and producing organic matter to increase crop growth. Some of the adaptations of earthworm are explained below.

Stream-lined body

The earthworm has a cylindrical, elongated and segmented body. This helps them to live in narrow burrows underground and for easy penetration into the soil.

Skin

Mucus covers the skin which does not allow soil particles to stick to it. The slippery skin is kept moist as it respires through the skin. Moist skin helps in oxygenation of blood.

Burrowing

Its body is flexible having circular and longitudinal muscles which help in movement and subsoil burrowing. Each segment on the lower surface of the body has number of bristles called setae. They help the earthworm to move through the soil and provide anchor in the burrows.

Aestivation

When the soil becomes too hot or dry, earthworms become inactive and undergo a process called aestivation. Earthworm moves deeper into the soil. It secretes mucus and lowers their metabolic rate in order to reduce water loss. They remain dormant until conditions become favourable. They come out of their burrow during rainy season. The ideal temperature range is 60-80°F. The ability to tolerate temperature depends on the surrounding moisture in the environment.

Nocturnality

Earthworms are sensitive to light. It has no eyes but can sense light through light sensitive cells (Photo-receptors) present in their skin. They give the skin the capacity to detect light and changes in light intensity. They react negatively to bright light (Photophobic). It remains in its burrow during the day to avoid light.

Figure 6.7 Earthworms

DO YOU KNOW?

Earthworms are referred as '***Farmer's friend'.*** After digesting organic matter, earthworms excrete a nutrient- rich waste product called castings.

Vermicompost is a manure prepared by using earthworms to speed up the process of decomposition of plant and animal waste. Vermicomposting is a fundamental practice of organic gardening. Vermicompost helps better plant growth and crop yield, improves physical structure of soil, increases the water holding capacity of soil and is helpful in elimination of biowastes.

6.4 Water conservation

Water is one of the precious natural resources. Clean and fresh water is essential for almost every human activity. Pollution has decreased our own water supply. We are polluting and decreasing the water for all creatures on earth.

Water conservation is the preservation, control and management of water resources. It also includes activities to protect the hydrosphere and to meet the current and future human demand.

6.4.1 Importance of water conservation

- It creates more efficient use of the water resources.
- It ensures that we have enough usable water.
- It helps in decreasing water pollution.
- It helps in increasing energy saving.

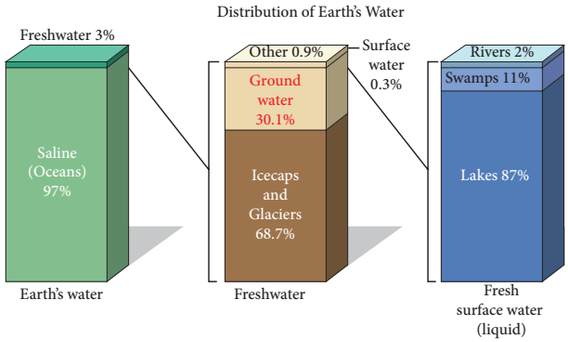

Figure 6.8 Distribution of Earth's water

Activity 2

Write slogans to support conservation of water.

1. ----------

2. ----------

3. ----------

6.4.2 Ways of water conservation

Industrial conservation

Water conservation measures that can be taken by industries are:

- using dry cooling systems.
- if water is used as cooling agent, reusing the water for irrigation or other purposes.

Agricultural conservation

Agricultural water is often lost due to leaks in canals, run off and evaporation. Some of the water conserving methods are:

- using lined or covered canals that reduce loss of water and evaporation.
- using improved techniques such as sprinklers and drip irrigation.
- encouraging the development of crops that require less water and are drought resistant.
- mulching of soil in vegetable cultivation and in horticulture.

DO YOU KNOW?

World Water Day on 22nd March every year, is about focusing attention on the importance of water.

The theme for World Water Day 2018 is 'Nature for Water'- exploring nature-based solutions to the water challenges we face in the 21st century.

Domestic conservation

All of us have the responsibility to conserve water. We can conserve water by the following activities:

- Using a bucket of water to take bath than taking a shower.
- Using low flow taps.
- Using recycled water for lawns.
- Repairing the leaks in the taps.
- Recycling or reusing water where ever it is possible.

6.4.3 Some of the strategies to support water conservation

(i) Rain water harvesting.
(ii) Improved irrigation techniques.
(iii) Active use of traditional water harvesting structures.
(iv) Minimising domestic water consumption.
(v) Awareness on water conservation.
(vi) Construction of farm ponds.
(vii) Recycling of water.

6.5 Farm ponds

Farm ponds are used as one of the strategies to support water conservation. Much of the rainfall runs off the ground. The run off not only causes loss of water but also washes away precious top soil. Farm ponds help the farmers to store water and to use it for irrigation.

6.5.1 Layout of a farm pond

Farm pond is a dugout structure with definite shape and size. They have proper inlet and outlet structures for collecting the surface runoff flowing from the farm area. The size and depth of the pond depend upon the amount of land available, the type of soil, water requirement of farmers and the cost of excavation. The stored water is used for irrigation.

Figure 6.9 Farm pond

6.5.2 Advantages of farm ponds

The advantages of farm ponds are:

- They provide water to growing crops, without waiting for rainfall.
- They provide water for irrigation, even when there is no rain.
- They reduce soil erosion.
- They recharge ground water.
- They improve drainage.
- The excavated soil can be used to enrich soil in fields and levelling lands.
- They promote fish rearing.
- They provide water for domestic purposes and livestock.

6.5.3 Limitations of farm ponds

- Farm ponds reduce water flow to other tanks and ponds situated in lower-lying areas.
- They occupy a large portion of farmer's lands.

6.6 Water recycling

Water recycling, apart from rain water harvesting, is also one of the key strategies to conserve water. Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, flushing in toilets and ground water recharge.

DO YOU KNOW?

Grey water is reusable waste water from residential, commercial and industrial bathroom sinks, bath tub, shower drains and washing of clothes. Use of non-toxic and low sodium soap and personal care products is required to protect vegetation when reusing grey water for irrigation.

6.6.1 Water recycling stages

Conventional waste water treatment consists of a combination of physical, chemical and biological processes which remove solids, organic matter and nutrients from waste water. The waste water treatment involves the following stages:

Primary treatment

Primary treatment involves temporary holding of the waste water in a tank. The heavy solids get settled at the bottom while oil, grease and lighter solids float over the surface. The settled and floating materials are removed. The remaining liquid may be sent for secondary treatment.

Activity 3

Make a poster depicting the ways and importance of conserving water and recycling of water.

Secondary treatment

Secondary treatment is used to remove the biodegradable dissolved organic matter. This is performed in the presence of oxygen by aerobic microorganisms (Biological oxidation). The microorganisms must be separated from treated waste water by sedimentation. After separating the sediments of biological solids, the remaining liquid is discharged for tertiary treatment.

Tertiary treatment

Tertiary or advanced treatment is the final step of sewage treatment. It involves removal of inorganic constituents such as nitrogen, phosphorus and microorganisms. The fine colloidal particles in the sewage water are precipitated by adding chemical coagulants like alum or ferric sulphate.

Inlet - sewage water

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Primary treatment(physical)

- Sedimentation (heavy solids)
- Floatation (oil, grease, lighter solids)
- Filtration

↓

Secondary treatment(biological)

- Biological oxidation (biodegradable dissolved organic matter)
- Sedimentation (biological solids)
- Filtration

↓

Tertiary treatment (physio-chemical)

- (nitrogen, phosphorus, suspended solids, heavy metals)
- Disinfection (chlorination 5-15mg/l)

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Outlet- recycled water

6.6.2 Uses for recycled water

- Agriculture
- Landscape
- Public parks
- Golf course irrigation
- Cooling water for power plants and oil refineries
- Toilet flushing
- Dust control
- Construction activities

6.7 IUCN (International Union for Conservation of Nature and Natural Resources)

IUCN is an international organization working in the field of nature conservation and sustainable use of natural resources. It provides public, private and non- governmental organizations with the knowledge to enable human progress, economic development and nature conservation to take place together. IUCN is the global authority on the status of the natural world and the measures needed to safeguard it.

Vision of IUCN

The vision of IUCN is 'A just world that values and conserves nature'.

Mission of IUCN

The mission of IUCN is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable. IUCN has widened its focus beyond conservation of ecology and now incorporates issues related to sustainable development in its projects. It tries to influence the actions of governments, business and other stakeholders by providing information and advice.

The organization is best known to the wider public for compiling and publishing the IUCN red list of threatened species, which assesses the conservation status of species worldwide.

India, a mega diverse country with only 2.4 % of world's land area, accounts for 7-8% of all

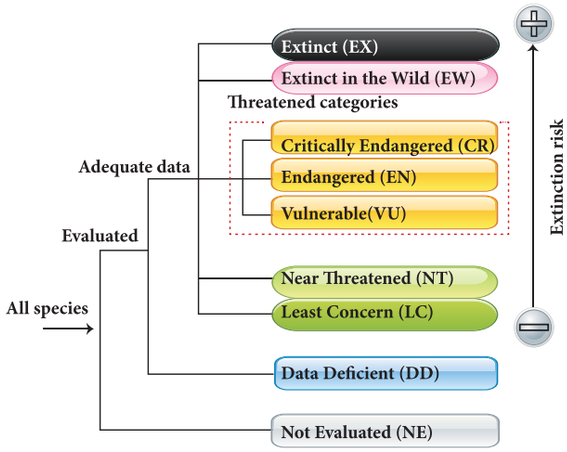


Figure 6.10 Red list categories of IUCN

recorded species. It includes over 45,000 species of plants and 91,000 species of animals. The country's diverse physical features and climatic conditions have resulted in a variety of ecosystems such as forests, wetlands, grasslands, desert, coastal and marine ecosystems. Four of 34 globally identified biodiversity hotspots are found in India. They are:

- The Himalayas
- The Western ghats
- The North-East
- The Nicobar islands

India became state member of IUCN in 1969, through the Ministry of Environment, Forest and Climate change(MoEFCC). The following data for plants and animals in India is given in Table 6.2 available on the IUCN Red List Version 2017-3 (Table 6 A & B). It has been last updated on 5th December 2017.

IUCN was founded on 5th October 1948 at Gland, Switzerland.

Table 6.2 IUCN Red List Categories

Category	EX	EW	CR	EN	VU	NT	LR/cd	DD	LC
Plants	6	2	72	175	143	45	1	77	932
Animals	0	0	77	207	391	330	2	784	3774

CR: Himalayan brown/red bear

EN: Red Panda

Figure 6.11 Animals in Red List

Points to Remember

- Environmental science is the study of patterns, processes in the natural world and their modification by human activities.
- Biotic or living factors include plants, animals and all other living organisms.
- Abiotic or non-living factors include all factors which affect ability of organisms to survive and reproduce like water, soil, air and sunlight.
- Cyclic flow of nutrients between non-living environment and living organisms are termed as biogeochemical cycles.
- *Nitrogen fixation* is the conversion of atmospheric nitrogen into reactive compounds available to living organisms.
- The process of decomposition of nitrogenous waste by putrefying bacteria and fungi into ammonium compounds is called *ammonification.*
- The ammonium compounds formed by ammonification process is oxidised to soluble nitrates. The process of nitrate formation is known as *nitrificatio*n.
- Hydrophytes may be free floating or submerged plants living in lakes, ponds, shallow water, marshy lands and marine habitat.
- Plants that grow in dry habitat are called xerophytes.
- Mesophytes are common land plants which grow in situations that are neither too wet nor too dry.
- Animals develop special features or behaviour patterns to escape from the extreme conditions of temperature and light.
- When the soil becomes too hot or dry, earthworms become inactive and undergo a process called Aestivation.
- Hibernation is a state of inactivity in which the body temperature of earthworms drops with a lowered metabolic rate during winter.
- Water conservation is the preservation, control and management of water resources.
- Farm pond is a dugout structure with definite shape and size. They have proper inlet and outlet structures for collecting the surface runoff flowing from the farm area.
- Water recycling is reusing treated wastewater for beneficial purposes such as agricultural and landscape irrigation, industrial processes, toilet flushing and ground water recharge.
- IUCN is the global authority on the status of the natural world and the measures needed to safeguard it.

GLOSSARY

Aestivation	A state of inactivity and a lowered metabolic rate in animals, during summer.
Assimilation	The conversion of nutrients into usable form that is incorporated into the tissues and organs.
Biogeochemical cycle	The cyclic flow of nutrients between non-living environment and living organisms.
Buoyancy	The capacity to remain afloat in liquid or gas.
Echo location	The use of sound waves and their echoes to determine the location of objects.
Hibernation	A state of inactivity and a lowered metabolic rate in animals, during winter.
Infiltration	The process by which water on the ground surface enters the soil.
Precipitation	Any product of condensation of atmospheric water vapour that falls on earth.
Setae	The hair-like locomotory structure, present in each segment of an earthworm.
Stomata	Minute pores in the epidermis of leaves which facilitate gaseous exchange and transpiration.
Sublimation	The conversion of solid state into vapour state without going through a liquid state.

TEXTBOOK EVALUATION

GCZPFI

I. Choose the correct answer.

1. All the factors of biosphere which affect the ability of organisms to survive and reproduce are called as _____.
   a. biological factors
   b. abiotic factors
   c. biotic factors
   d. physical factors

2. The ice sheets from the north and south poles and the icecaps on the mountains, get converted into water vapour through the process of_____.
   a. evaporation b. condensation
   c. sublimation d. infiltration

3. Free living soil bacteria such as Pseudomonas sp. are responsible for the _____ process in the nitrogen cycle.
   a. ammonification
   b. nitrogen fixation
   c. nitrification
   d. denitrification

4. The atmospheric carbon dioxide enters into the plants through the process of _____.
   a. photosynthesis
   b. assimilation
   c. respiration
   d. decomposition

5. Increased amount of _____ in the atmosphere, results in greenhouse effect and global warming
   a. carbon monoxide
   b. sulphur dioxide
   c. nitrogen dioxide
   d. carbon dioxide

6. Which of the following is not an adaptation of hydrophytes?
   a. poorly developed root system
   b. reduced plant body
   c. water storing parenchymatous tissues
   d. finely divided submerged leaves

7. In some xerophytes, leaves are modified into spines as an adaptation _____.
   a. to reduce transpiration rate
   b. to store water
   c. to reduce consumption of water
   d. all of the above

8. Identify the incorrect statement with respect to adaptations of earthworm.
   a. Earthworm has a stream lined body with no antennae or fins.
   b. Each segment of earthworm has setae.
   c. Many earthworms become inactive in a process called hibernation, during winter season.
   d. Earthworms remain in its burrow during day time, to avoid sunlight.

9. Which of the following is one of the strategies to conserve water?
   a. Water recycling
   c. Increasing the number of bore wells
   b. Using large overhead water tanks
   d. Watering the plants using hose

10. Specific constituents such as nitrogen, phosphorus, suspended solids and heavy metals found in the wastewater are removed during _____ treatment of water recycling process.
   a. primary
   c. tertiary
   b. secondary
   d. none of the above

II. Match the following.

Microorganism	Role Played
Nitrogen fixation	Nitrosomonas
Ammonification	Azotobacter
Nitrification	Pseudomonas species
Denitrification	Putrefying bacteria

III. State whether the statements are true or false. Correct the false statements.

1. Nitrogen is a greenhouse gas.
2. Poorly developed root is an adaptation of mesophytes.
3. Bats are the only mammals that can fly.
4. Earthworms use the remarkable high frequency system called echoes.
5. Aestivation is an adaptation to overcome cold condition.

IV. Answer in brief.

1. What are the two factors of biosphere?
2. According to you, which process of water cycle is adversely affected by human activities?
3. How do human activities affect nitrogen cycle?
4. What is adaptation?
5. What are the challenges faced by hydrophytes in their habitat?

6. Identify the given plant. How does it adapt itself to its habitat?

7. Why is it important to conserve water?
8. List some of the ways in which you could save water in your home and school?
9. What is grey water?
10. What are the uses of recycled water?
11. What is IUCN? What is the vision of IUCN?

V. Answer in detail.

1. Describe the processes involved in the cyclic flow of water between biotic and abiotic factors of biosphere?
2. Explain carbon cycle with the help of a flow chart? How can you reduce your contribution of carbon dioxide to the atmosphere?
3. What are the conditions in a dry habitat to which plants develop adaptations? List out the adaptations of xerophytes?
4. How does a bat adapt itself to its habitat and also in response to temperature and light?
5. What is water recycling? Explain the conventional wastewater recycling treatment?

VI. Give reason.

1. Roots grow very deep and reach the layers where water is available. Which type of plants develops the above adaptation? Why?
2. Why streamlined bodies and presence of setae is considered as adaptations of earthworm?
3. Echo location serves as an adaptation in bats. Justify the given statement.
4. Farm ponds serve as an excellent water conservation strategy. Why is it impossible for all farmers to construct it in their fields?

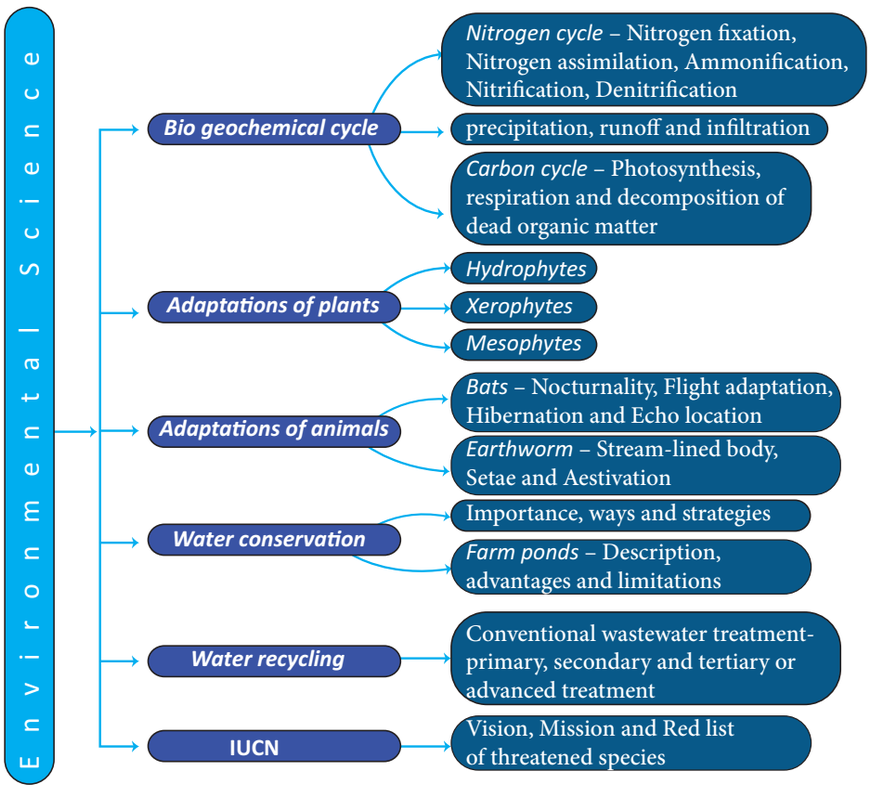
REFERENCE BOOKS

1. Shukla R.S and Chandel. P.S. A textbook of Plant Ecology including Ethnobotany and Soil Science.
2. Sharma P.D. Environment Biology and Toxicology . 13th edition , Rastogi Publications, Meerut.
3. Verma, P.S and Agarwal. V.K. Environmental Biology, S.Chand and Company, New Delhi.
4. Kotpal R.L Zoology- Phylum - Annelida –Rastogi Publications, Meerut.

INTERNET RESOURCES

1. www.freedringkingwater.com
2. www.freesciencefairproject.com
3. www.gissnasa.gov
4. www.nature.com
5. www.sciencefocus.com
6. www.sciencelearn.org
7. www.batsorg.com
8. www.fao.org
9. www.worldwaterday.org
10. www.IUCN.org

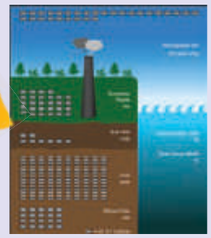
Concept Map



ICT CORNER

Environmental Science

Experiment with *Carbon cycle* using virtual simulator.



Steps

- Type the given URL to reach "The Carbon Cycle" simulation page.
- Press "Run Decade" button to observe the carbon cycle accumulating every 10 years.
- Select "Curb Emission" from "lesson" tab and adjust the simulation parameters to watch the effect of cycle.
- Select "Feedback Effects" from "lesson" tab and run the cycle and analyze the carbon accumulation result.


Step1


Step2


Step3


Step4

Carbon cycle

URL: https://www.learner.org/courses/envsci/interactives/carbon/carbon.html
or Scan the QR Code.

*Pictures are indicative only

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