16

Water

Life would not have been possible on earth without water. In fact, life originated in water. Water covers three-fourths of the earth's surface. It makes up 70 per cent of our body and 80 to more than 95 per cent of fruits and vegetables.

In ancient times, water was considered an element. But now it is established that it is a compound of hydrogen and oxygen. Among all the compounds found on earth, water is the most abundant.

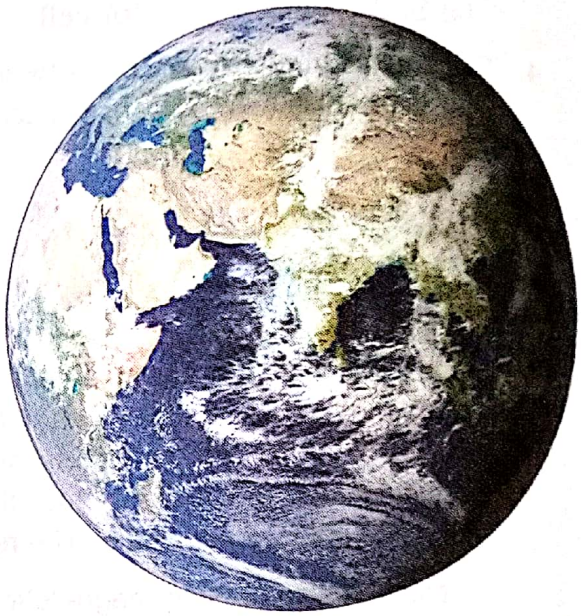

Fig. 16.1 Three-fourths of the earth's surface is covered by water.

WATER IS ESSENTIAL FOR LIFE

Water is essential for every living being—plant or animal. It acts in life processes in three ways.

1. By taking part in biochemical reactions The chemical reactions that take place in a living being are called ***biochemical reactions.*** Photosynthesis is a biochemical reaction in which water reacts with carbon dioxide in the presence of sunlight and chlorophyll to form glucose.

2. By acting as a medium Water acts as a medium for the processes inside the body of a living being. The reactions involved in digestion, for example, cannot take place in the absence of water. Water also helps in the transport of substances inside the body. For example, nutrients move in solution from one part to another inside a plant. Blood, which contains a lot of water, carries nutrients, gases, wastes, and so on, from one part of the body to another. The waste products expelled by the body as urine are also dissolved in water.

3. By acting as a coolant Water helps to regulate th temperature of the body. In summer, you sweat a lot. The evaporation of the sweat helps to cool down your body.

THE USES OF WATER

We need water for various purposes. The main uses of water can be classified into ***household, agricultural*** and ***industrial.***

Household use

We use water for drinking, cooking, bathing, washing, cooling and gardening. We also use water for flushing toilets and cleaning floors. We realise how important it is not to waste water when the water supply fails for a couple of days. There are some things you could do at home to avoid wasting water. For instance, you should not leave the tap on while brushing your teeth—you should use a mug of water instead. Also, you could easily bathe using a bucket of water. If you leave the tap on, you could end up using three buckets of water.

Make a rough estimate of the amount of water your family uses for cooking and drinking in a day. The task will become simpler if everyone keeps track of the number of (say 2 L) bottles of water they are using. To estimate how much water is used for washing, cleaning and bathing, ask everyone to use buckets of water rather than running water. Find out the capacity of the cistern to calculate the amount of water flushed down the toilet every day.

Answer these questions after you have made your calculations and compare them with those of your classmates.

1. Is it true that we use five (or six) times as much water for bathing, cleaning, and so on, as we do for cooking and drinking?
2. Is this fair, considering that a majority of the people in our country do not get clean water for drinking?

Agricultural use

Like all plants, crops need water for (i) photosynthesis, (ii) drawing minerals from the soil, and (iii) transporting substances from one part to another. They also lose a lot of water by evaporation, mainly from the leaves. This loss of water is known as ***transpiration.*** The amount of water thus lost is several hundred times greater than that used by plants for other purposes. So, a large amount of water is required for producing a crop. You may be surprised to learn that for producing 1 kg of corn, the plants use 350 kg, i.e., 350 L, of water. We say that the water requirement of corn is 350. The ***water requirement*** of wheat is 500 and that of potatoes is 636.

Fig. 16.2 Huge amounts of water are needed for irrigation.

The soil must contain sufficient moisture to meet to the needs of the crop growing on it. It may not rain enough for the soil to be sufficiently moist. That is why farmers need to irrigate the land. Huge amounts of water are required for this purpose.

Industrial use

Industries are often set up on the banks of rivers because they need huge quantities of water for the following purposes.

1. As a reactant (a substance taking part in a chemical reaction is called a ***reactant***)
2. As a solvent
3. Steam is used for the production of electricity and for other purposes
4. For the disposal of wastes
5. As a coolant

Fig. 16.3 Steam is used in cooling towers.

INTERCHANGEABILITY OF THE STATES OF WATER

Water exists in all three states in nature. It also changes from one state to another. How do these changes occur, and what favours these changes?

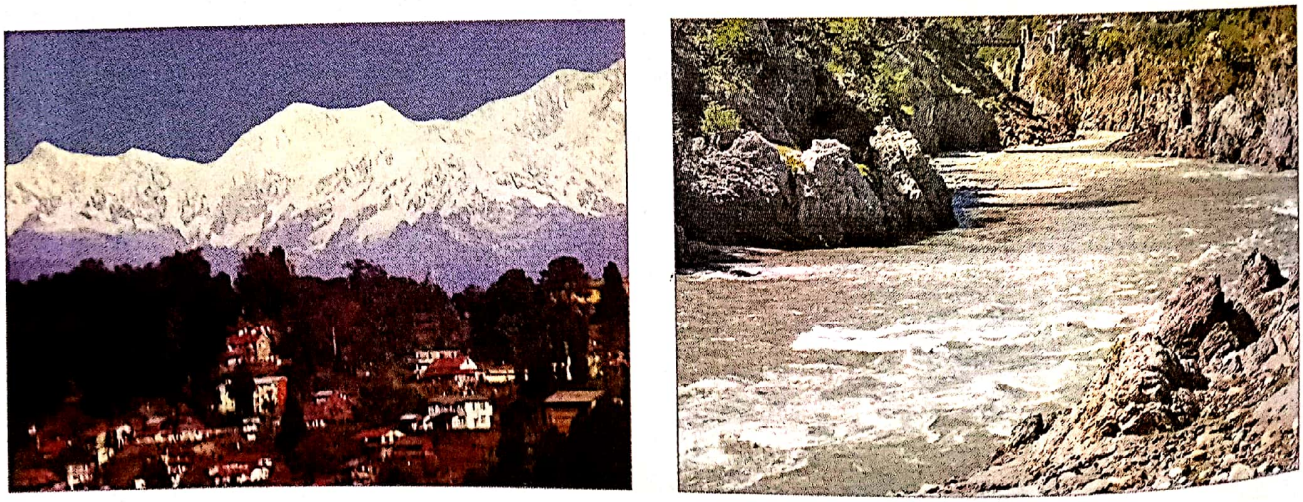

Fig. 16.4 The visible states of water in nature

Evaporation and condensation

Evaporation and condensation of water take place frequently in nature. Let us take a look at these phenomena in some detail.

Evaporation You know that when a liquid changes into the vapour (gaseous) state, we say that the liquid has vaporised. Vaporisation is fast at the boiling point of the liquid. But the change in state from liquid to vapour also takes place below the boiling point. This is called ***evaporation.*** You must have observed that a small amount of water spilt on the floor disappears on its own. And wet clothes dry when hung on a clothes line. All this happens because water evaporates into the atmosphere. Some questions may come to your mind in this context. Why do wet clothes dry faster in the sun than in the shade? Why do they take a comparatively long time to dry in the rainy season? Why do we spread them out on a clothes line? Why do clothes dry faster when there is a breeze? You can seek the answers to these questions by doing the following activities.

Take two similar *shallow* dishes. Pour small but equal amounts of water into them. Place one of the dishes in the sun and the other in the shade. Leave them till all the water disappears. Water from the dish kept in the sun disappears first. This is because the water kept in the sun receives more heat than that kept in the shade. In fact, *the hotter the liquid, the faster is the evaporation.*

Take a glass, a bowl and a shallow dish made of the same material, say steel. Pour small but equal amounts of water into them. Let the water evaporate in the sun. Do the water evaporate from the glass the slowest, from the bowl faster and from the shallow dish the fastest?

This is because a liquid evaporates from the surface. So, *the larger the surface (i.e., the surface area), the faster is the evaporation of the liquid.*

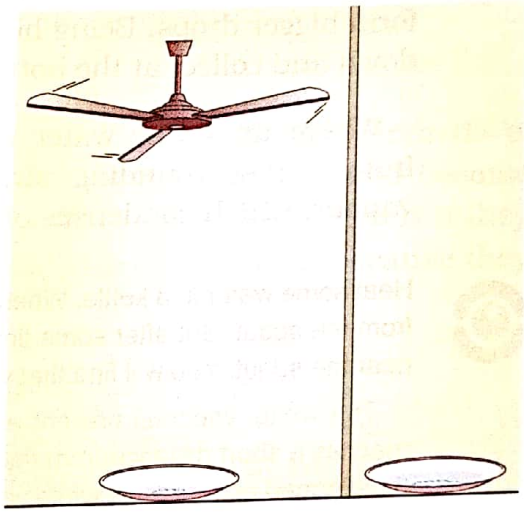

Fig. 16.5 A draught helps a liquid evaporate faster.

Take small but equal amounts of water in two similar shallow dishes. Place one of the dishes under a moving fan and the other away from the fan. Do you find that the water under the fan evaporates faster than that placed away from the fan? This is because the draught (i.e., a current of air) continuously blows away whatever vapours are formed. This helps fresh vapours to be formed and the water evaporates faster.

Conditions that help evaporation In short, the following conditions help evaporation

1. **A high temperature** The higher the temperature, the faster is the evaporation of a liquid.
2. **Low humidity** Air always contains water vapour. But there is a limit up to which it can take up water vapour. When air contains much less water vapour than its capacity, its humidity is said to be low, or the air is said to be dry. When it contains a lot of vapour—close to its capacity—the air is said to be humid. Naturally, humid air can take up less water vapour than dry air. In other words, evaporation takes place

faster in dry air. This is why wet clothes dry faster in summer than in the rainy season.

3. **A large surface area** The larger the surface area, the faster is the evaporation of a liquid. This is because molecules evaporate only from the surface of a liquid. By spreading out wet clothes on a clothes line, we increase the surface area of the clothes.

4. **Draught** A draught helps a liquid to evaporate.

Condensation ***A change in state from gaseous to liquid is called condensation.***

If you place some ice in a glass or take out a bottle of water from a fridge, the walls of the glass or bottle will look hazy. This is because droplets of water collect on the outside of the glass or bottle, making it look hazy. If you leave the bottle or glass for a few minutes, the droplets combine to form bigger drops. Being heavy, the drops trickle down and collect at the bottom.

Where does this water come from? It comes from the surrounding air. Air contains water vapour, which condenses on being cooled.

Fig. 16.6 Droplets of water collect on the outer walls of a glass containing ice.

Heat some water in a kettle. When the water starts boiling, some white 'vapours' will appear at a small distance from the spout. But after some time, you will see no such 'vapours'. Now place a vessel containing cold water near the spout. You will find that water droplets collect on the outer walls of the vessel.

The white 'vapours' are not actually water vapour. Water vapour is colourless and so, invisible. When it reaches a short distance from the spout, however, it gets condensed by the cold air it meets. The tiny droplets thus formed appear to be white vapours. When the surrounding air becomes hot after some time, these droplets vaporise again and become invisible. But when the vapours come in contact with a cold surface (the vessel containing cold water), they condense.

Fig. 16.7 Steam condenses on the walls of a vessel containing cold water.

THE WATER CYCLE

Water from the land and sea continuously evaporates into the atmosphere. Also, we use up a lot of water for different purposes. Yet the amount of water on the earth is almost constant. This is because the water is not lost—it only circulates among the land, sea and air. This circulation of water is called the ***water cycle.*** We will study it in three parts.

Evaporation and condensation

Water evaporates from the oceans, lakes, rivers and ponds, as well as from plants and animals. If the air is too cold, as on winter nights, the water vapour condenses at a very low height and forms a ***fog.*** A fog may extend from the ground up to a height of about three-fourths of a kilometre. In the day, if it is warm, the vapour rises with hot air. With increasing height, it becomes colder. Nearly a kilometre above the surface of the earth, it is cold enough for the water vapour to condense into droplets around dust particles to form ***clouds.***

Precipitation

The droplets in the clouds are extremely small. They are so small that hundreds of thousands of them may have to combine to form a drop. When the droplets become large, they fall. While falling, if they meet hot air, they again get vaporised. But if they meet cold air or cold mountains, they fall as ***rain.*** Forests also attract rain because they are cool.

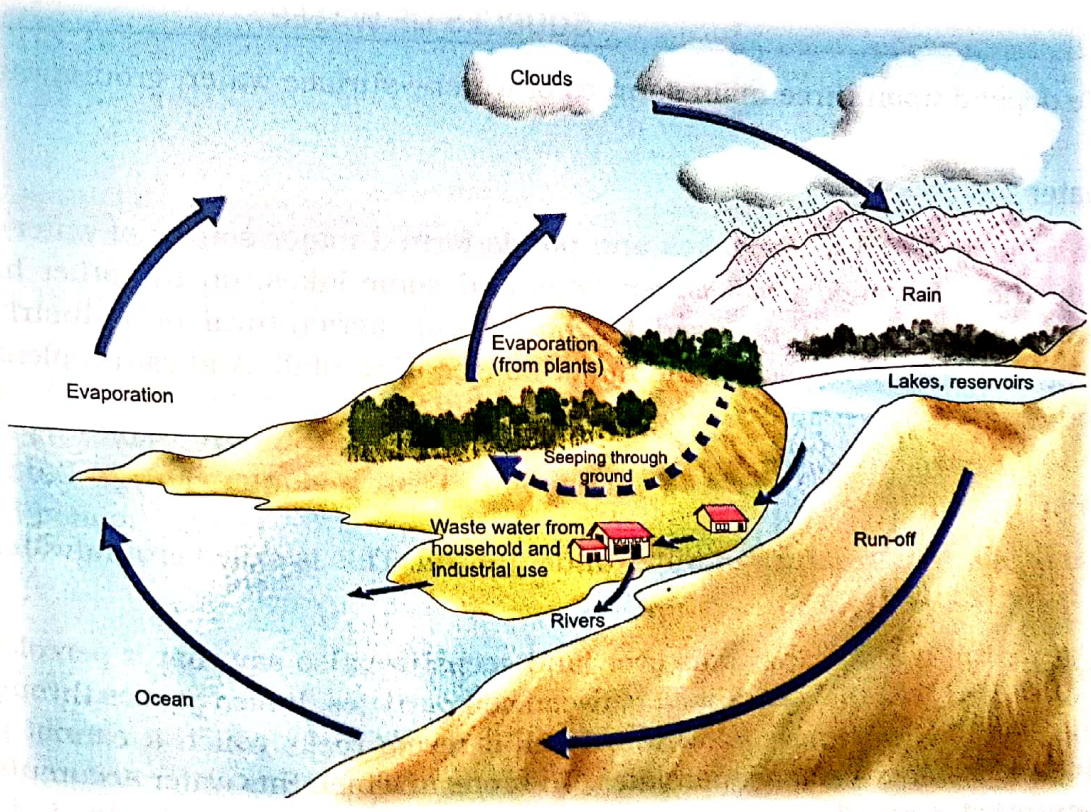

Fig. 16.8 The water cycle

In very high clouds, the water freezes into crystals of ice because it is very cold. These crystals fall as ***snowflakes*** when they become heavy. Sometimes rain passes through a very cold layer of air and freezes into ***hailstones***.

During a cold night, the water vapour of the air condenses into droplets over any surface exposed to it. This is called ***dew***. If you have played outdoor games like cricket or football early in the morning in winter, you may have noticed that the ground is wet with dew. The dew evaporates in the sun as the day progresses.

The deposition of water from the atmosphere onto the earth in any form—liquid or solid—is called precipitation. Rain, snow, hail and dew are forms of precipitation.

Return to the ocean

The water that falls as rain or snow returns to the oceans. Land is at a higher level than the ocean. Therefore, most of the rainwater runs off to oceans, either directly or through rivers and streams. Snow from the mountains melts and runs off to rivers, which merge with the oceans. The water we use for various purposes is discharged into lakes, rivers or oceans after being treated. So, this water too returns to the oceans. The oceans also get plenty of water directly through rainfall.

We have already defined the water cycle. It can also be defined as the continual exchange of water between the air, the land and the ocean. Life on land would not have been possible without the water cycle.

SOURCES OF WATER

We depend upon three main sources of water—surface water, groundwater and rain.

Surface water

Water bodies like rivers, lakes and ponds form a major source of water for us. The water from these is called ***fresh water.*** Seas and some lakes, on the other hand, contain salt water, which cannot be used for household, agricultural or industrial purposes. But evaporation from the sea is the major source of rainfall. And rain replenishes our surface and groundwater resources.

Groundwater

There is a great reservoir of water underground. This is called groundwater. Let us see how it is formed.

A part of the rain that falls over land seeps (we also say that it percolates) through the soil. It displaces the air trapped between soil particles. It also passes through some kinds of rocks, and slowly moves downwards till it meets rocks which it cannot permeate. Above such rocks, this water accumulates. The zone in which this water accumulates is called the ***saturated zone.*** Thus a reservoir of groundwater is formed. The level of groundwater is known as the ***water table.***

Groundwater is pumped out through manually operated or power-operated tubewells. It is good for household, agricultural and industrial purposes.

Is groundwater everlasting? Groundwater is not everlasting. With the growing population, the need for water is also increasing. When too much groundwater is pumped out, the water table falls. And quite often it falls below the lower end of the pipe in the borewell. Then no water can be pumped out. Groundwater is partially replenished by the direct seepage of rainwater. It is also replenished by seepage from a nearby river, if any. Then the water table rises again.

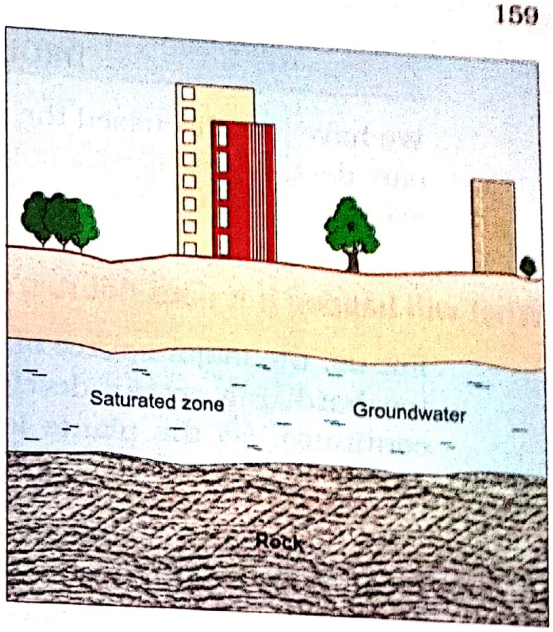

Fig. 16.9 Groundwater

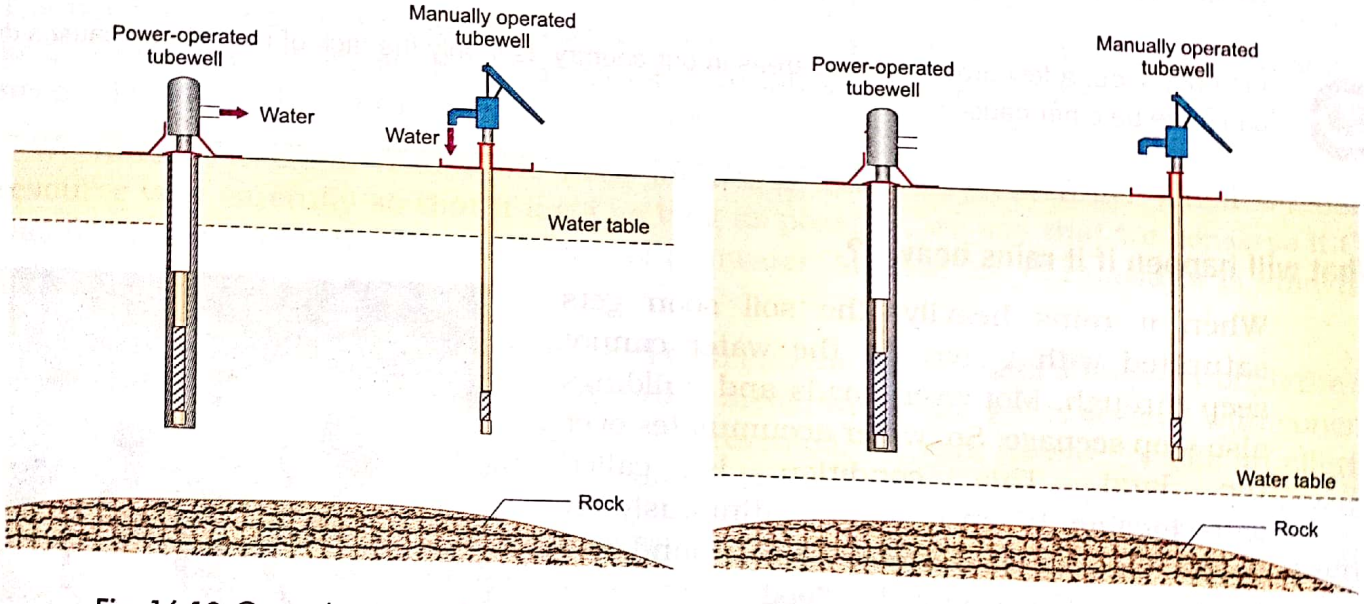

Fig. 16.10 Groundwater can be pumped out only when the water table is high, not when it is low.

You may have seen water gushing out from under the ground from a spring. This water is groundwater. Springs supply water to many lakes and ponds.

Fig. 16.11 A spring

DROUGHT AND FLOOD—THE TWO EXTREMES

We have just discussed the role rain plays in renewing our water resources. Lack of rainfall can destroy crops and create an acute water shortage. Too much rain can also cause widespread destruction and loss of life.

What will happen if it does not rain?

For us, the major source of water is rain. If it does not rain, the soil dries up and becomes too hard. Big cracks develop in the soil. Plants do not get moisture, but transpiration continues. So the plants lose water very fast and finally die. Grass does not grow and animals have nothing to graze on.

Without rainfall, there is no water to irrigate the crop land. So crops get destroyed and there is a shortage of food. Farmers who depend on crops for their survival suffer immensely. Rivers, lakes, ponds and wells dry up. The water table falls and borewells fail. This leads to a shortage of drinking water. When a place faces such conditions due to poor or no rainfall for a year or two, we say that there is a ***drought.***

Find out about a few drought-prone areas in our country. Is it only the lack of rainfall that causes drought? Or can there be other causes too?

What will happen if it rains heavily?

When it rains heavily, the soil soon gets saturated with water. All the water cannot seep through. Moreover, roads and buildings also stop seepage. So, water accumulates over the land. This condition is called ***waterlogging.*** When it rains continuously for several days, rivers overflow, and the land gets submerged. This is called a ***flood.***

Fig. 16.12 Floods disrupt normal life.

Too much water in the soil displaces most of the air. Therefore, animals living underground, like earthworms and snakes, come out in search of air. As the roots of plants cannot move, the plants die.

When ponds, lakes and rivers overflow, the aquatic animals living in them also get forced out. There is great loss of aquatic life. Floods also ruin crops. They can also cause massive loss of life and damage to property.

Floods wash away the upper layer of the soil. We call this the ***erosion of soil.*** Plants and trees prevent erosion because their roots hold the soil particles strongly.

Trees also break the force of flood water. To prevent soil erosion, we must discourage the cutting of trees and the uprooting of other plants.

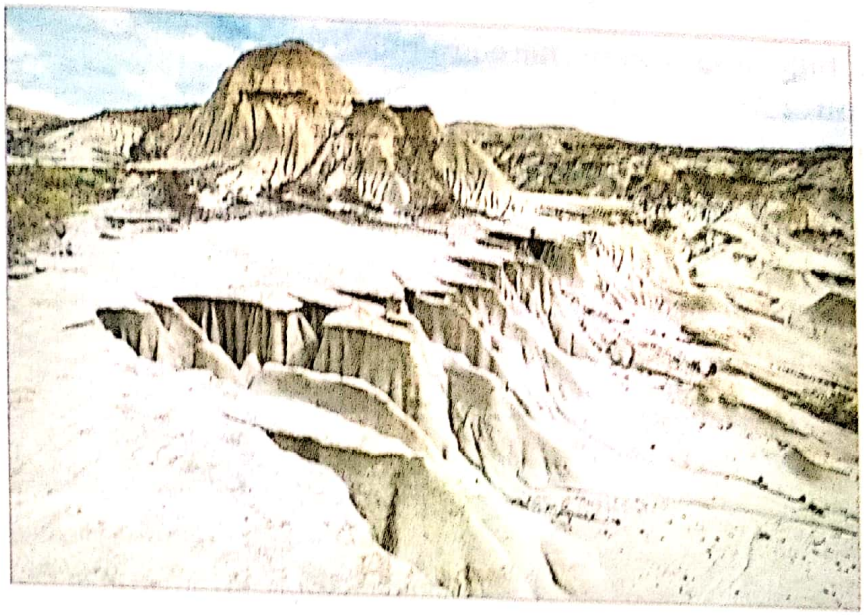

Fig. 16.13 Erosion of soil

LET US CONSERVE WATER

The need for water is increasing every day with rise in population. We have to grow more food, so we need more water for irrigation. Industries also must expand to cater for our needs. This too adds to the demand for water.

We must, therefore, realise the need for using water very carefully. When we use a resource very carefully so that it lasts as long as possible, we say that we ***conserve*** it.One way of conserving water is to make use of rainwater. Making use of rainwater is known as ***rainwater harvesting.***

Rainwater usually runs off into rivers and then into the sea. Some of it seeps through the soil to renew groundwater resources. But in urban areas, where the soil is covered with concrete structures and metalled roads, even this is prevented. We can, however, make an effort to utilise rainwater instead of allowing it to run off. Here are some ways of harvesting rainwater.

1. Pits or tanks are dug in low-lying areas to collect rainwater. This water can be filtered, disinfected and supplied for consumption. Sometimes, the collected water (after being filtered) is fed into the dried-up borewells to replenish the groundwater reservoir.

2. Rooftop rainwater harvesting is also useful. The rainwater from the roof of a house is collected through pipes in tanks on the ground. How much water do we get this way?

   Let us suppose the roof area of a house is 100 m^2, the annual rainfall is 100 cm (1 m), and that we are able to collect only 70% of the rainwater. Then the volume of water collected in a year is 100 m^2 × 1 m × (70/100) = 70 m^3 = 70,000 L. For a family of four, requiring 400 L of water a day, the harvested water will run for 175 days, i.e., about 6 months.

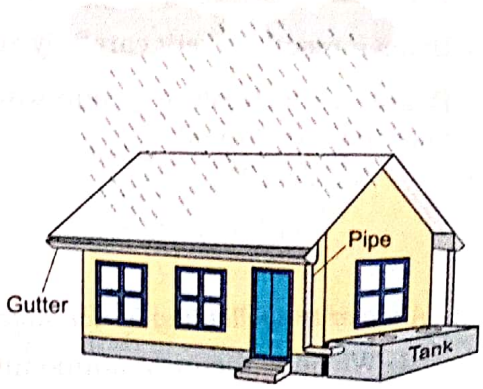

Fig. 16.14 Rooftop rainwater harvesting

3. In a hilly area, where there are hills on three sides, a reservoir is made by raising a dam on the fourth side. The harvested rainwater is supplied to the nearby city.

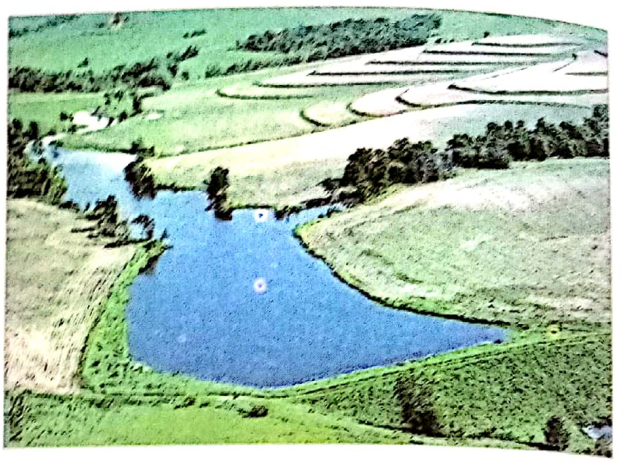

Fig. 16.15 Rainwater harvesting in hilly areas

Points to Remember

- Water is essential for life. It takes part in biochemical reactions and also acts as a medium for living processes and a coolant in the living system.
- We need water for household, agricultural and industrial purposes.
- Water exists in three states. It is present in all the three states in nature. The three states of water are interchangeable.
- A change in state from liquid to vapour below the boiling point of a liquid is called evaporation. A high temperature, low humidity, a large surface area and a draught help a liquid evaporate faster.
- A change in state from gaseous to liquid is called condensation.
- Surface water, groundwater and rain are our sources of water.
- The level of groundwater is known as the water table.
- The amount of water on the earth is almost constant. This is because water is not lost—it only circulates among the land, sea and air. This circulation of water is called the water cycle.
- The deposition of water from the atmosphere on to the earth in any form is called precipitation. Rain, snow, hail and dew are forms of precipitation.
- When it does not rain for a year or two, we have a drought.
- Heavy rains cause waterlogging and floods.
- The removal of the upper layer of soil is called erosion of soil. Plants and trees prevent erosion of soil.
- Using a resource very carefully so that it lasts as long as possible is called conservation of the resource.
- Rainwater harvesting is one way of conserving water. It involves making use of rainwater instead of allowing it to run off.

Exercises

A. *Answer the following in not more than 20 words.*

1. Which is the most abundant compound on the earth? Name three of its main uses.
2. Name one biochemical reaction in which water takes part.