

7

Weather, Climate and Adaptations of Animals to Climate

Do you remember the things that you were asked to pack when you were heading for a hill station? When the sky is cloudy, your parents insist that you carry an umbrella. Have you heard elders in your family discuss the weather before planning a family function? You must have also heard the experts discussing the weather before the start of a game. Have you ever wondered why? The weather may have a profound effect on the game. It has a profound effect on our lives. Many of our daily activities are planned based on the weather predicted for that day. There are daily reports of the weather on the television and radio and in the newspapers. But do you know what this weather really is?

In this chapter, we will study about the weather and climate. We will also see how different forms of life are adapted to the climate of their habitat.

7.1 WEATHER

In Fig. 7.1 a sample of weather report from a newspaper is given.

We find that the daily weather report carries information about the temperature, humidity and rainfall during the past 24 hours. It also predicts the weather for the day. Humidity, as you might know, is a measure of the moisture in air.

WEATHER

Max 16.1°C (-5)/Min 2.6°C (-4)
Sunset: Tuesday - 5:41 pm
Sunrise: Wednesday - 7:15 am
Moonset: Wednesday - 11:13 am
Moonrise: Tuesday - 11:05 pm
Mist/fog in the morning. Partly cloudy sky. Min temp will be around 4°C. Max humidity on Monday 83% and min 37%.

Fig. 7.1 A sample of a weather report from a newspaper



The weather reports are prepared by the Meteorological Department of the Government. This department collects data on temperature, wind, etc., and makes the weather prediction.

Activity 7.1

Cut out the weather reports of the last week from any newspaper. If you do not get a newspaper at home borrow from your neighbours or friends and copy these reports in your notebook. You can also collect weather reports from a library. Paste all the cut-outs on a white sheet or on a chart paper.

Now record the information from the weather reports collected by you in Table 7.1. The first row is just a sample. Fill all the columns according to the data in the chart that you have prepared.

Table 7.1
Weather data of a week

Date	Max. temp. (°C)	Min. temp. (°C)	Min. humidity (%)	Max. humidity(%)	Rainfall* (mm)
23-08-06	36.2	27.8	54	82	

*(Rainfall may not be recorded for all the days since it may not rain everyday. Leave the space for rainfall blank if the data is not available.)

Rainfall is measured by an instrument called the rain gauge. It is basically a measuring cylinder with a funnel on top to collect rainwater.

Do all the seven days have the same maximum and minimum temperatures, humidity and rainfall? The maximum and minimum temperatures recorded may be the same for some of the days. However, all the parameters are not the same on any two days. Over a week there may be considerable variation. **The day-to-day condition of the atmosphere at a place with respect to the temperature, humidity, rainfall, wind-speed, etc., is called the weather at that place.** The temperature, humidity, and other factors are called the **elements** of the weather. The weather of a place changes day after day and week after week. That is why we often say, “today’s

weather is too humid”, or “the weather was warm last week”.

The weather is such a complex phenomenon that it can vary over very short periods of time. It can happen sometimes that it is sunny in the morning, but suddenly clouds appear from nowhere and it starts raining heavily. Or, a heavy rain may vanish in a matter of minutes and give way to bright sunshine. You must have had several such experiences. Try to recall any such experience and share it with your friends. Since weather is such a complex phenomenon, it is not easy to predict.

Look at the graph given below which shows the maximum temperature recorded during 03 August 2006 to 09 August 2006 at Shillong, Meghalaya (Fig. 7.2).

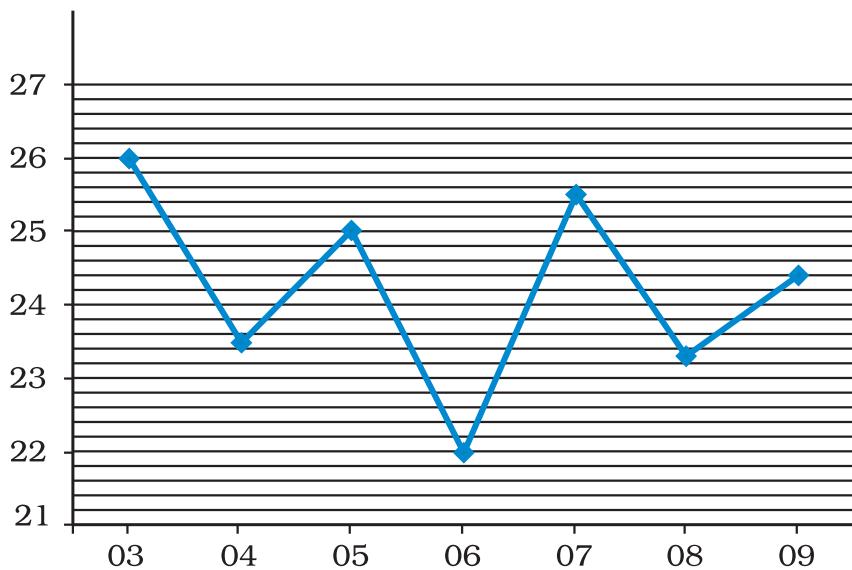
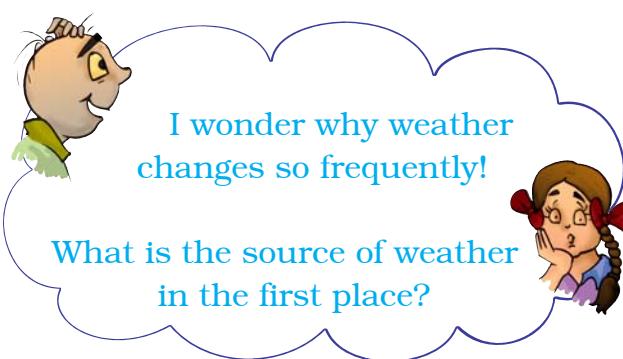


Fig. 7.2 Graph showing the variation of maximum temperature during 03 to 09 August 2006

As it is clear from any weather report, the maximum and minimum temperatures are recorded every day. Do you know how these temperatures are recorded. In Chapter 4 you have learnt



that there are special thermometers for this purpose, called **maximum and minimum thermometers**. Can you guess when during the day we have the maximum temperature and when the minimum?

The maximum temperature of the day occurs generally in the afternoon while the minimum temperature occurs generally in the early morning. Can you now understand why in summers we feel so miserable in the afternoon and comparatively comfortable early in the morning?

All changes in the weather are caused by the **sun**. The sun is a huge sphere of hot gases at a very high temperature. The distance of the sun from us is very large. Even then the energy sent out by the sun is so huge that it is the source of all heat and light on the earth. So, the sun is the primary source of energy that causes changes in the weather. Energy absorbed and reflected by the earth's surface, oceans and the atmosphere play important roles in determining the weather at any place. If you live near the sea, you would have realised that the weather at your place is different from that of a place in a desert, or near a mountain.

What about the times of sunrise and sunset? You know that in winters it becomes dark early and you do not get much time to play. Are the days shorter in winter than in summer? Try to find it out yourself by completing the project given at the end of the chapter.

7.2 CLIMATE

Meteorologists record the weather every day. The records of the weather have been preserved for the past several decades. These help us to determine the weather pattern at a place. **The average weather pattern taken over a long time, say 25 years, is called the climate of the place.** If we find that the temperature at a place is high most

of the time, then we say that the climate of that place is hot. If there is also heavy rainfall on most of the days in the same place, then we can say that the climate of that place is hot and wet.

In Table 7.2 and 7.3, we have given the climatic condition at two places in India. The mean temperature for a given month is found in two steps. First we find the average of the temperatures recorded during the month. Second, we calculate the average of such average temperatures over many years. That gives the mean temperature. The two places are: Srinagar in Jammu and Kashmir, and Thiruvananthapuram in Kerala.

Table 7.2 Srinagar (Jammu & Kashmir)

Month	Mean temperature °C		Mean total rainfall (mm)
	Daily minimum	Daily maximum	
Jan	-2.3	4.7	57
Feb	-0.6	7.8	65
Mar	3.8	13.6	99
Apr	7.7	19.4	88
May	10.7	23.8	72
Jun	14.7	29.2	37
July	8.2	30.0	49
Aug	17.5	29.7	70
Sep	12.9	27.8	33
Oct	6.1	21.9	36
Nov	0.9	14.7	27
Dec	-1.6	8.2	43

Table 7.3 Thiruvananthapuram (Kerala)

Month	Mean temperature °C		Mean total rainfall (mm)
	Daily minimum	Daily maximum	
Jan	22.2	31.5	23
Feb	22.8	31.9	24
Mar	24.1	32.6	40
Apr	24.9	32.6	117
May	24.7	31.6	230
Jun	23.5	29.7	321
July	23.1	29.2	227
Aug	23.2	29.4	138
Sep	23.3	30.0	175
Oct	23.3	29.9	282
Nov	23.1	30.3	185
Dec	22.6	31.0	66

(Note: The numbers for the mean total rainfall have been rounded off)

By looking at Tables 7.2 and 7.3 we can easily see the difference in the climate of Jammu & Kashmir and Kerala. We can see that Kerala is very hot and wet in comparison to Jammu & Kashmir, which has a moderately hot and wet climate for a part of the year.

Similar data for the western region of India, for example Rajasthan, will show that the temperature is high during most part of the year. But during winter, which lasts only for a few months, the temperature is quite low. This region receives very little rainfall. This is the typical desert climate. It is **hot and dry**. The north-eastern India receives rain for a major part of the year. Therefore, we can say that the climate of the north-east is **wet**.

7.3 CLIMATE AND ADAPTATION

Climate has a profound effect on all living organisms.

Animals are adapted to survive in the conditions in which they live. Animals living in very cold and hot climate must possess special features to protect themselves against the extreme cold or heat. Recall from Chapter 9 of your Class VI science book the definition of adaptation. Features and habits that help animals to adapt to their surroundings are a result of the process of evolution.

In Chapter 9 you will learn about the effect of weather and climate on soil. Here we study the effect of climate on animals only. In Class VI, you have read about adaptations of animals to certain

habitats. As examples of adaptation of animals to climatic conditions, we discuss only animals living in polar regions and tropical rainforests.

As the name suggests, the polar regions are situated near the poles, i.e., north pole and south pole.

Some well-known countries that belong to the polar regions are Canada, Greenland, Iceland, Norway, Sweden, Finland, Alaska in U.S.A. and Siberian region of Russia.

Examples of some countries where the tropical rainforests are found are India, Malaysia, Indonesia, Brazil, Republic of Congo, Kenya, Uganda, and Nigeria.

Activity 7.2

Take an outline map of the world. Mark the polar regions in blue. Similarly, mark the tropical regions in red.

(i) The polar regions

The polar regions present an extreme climate. These regions are covered with snow and it is very cold for most part of the year. For six months the sun does not set at the poles while for the other six months the sun does not rise. In winters, the temperature can be as low as -37°C . Animals living there have adapted to these severe conditions. Let us see how they are adapted by considering the examples of polar bears and penguins.

Polar bears have white fur so that they are not easily visible in the snowy white background. It protects them from

their predators. It also helps them in catching their prey. To protect them from extreme cold, they have two thick layers of fur. They also have a layer of fat under their skin. In fact, they are so well-insulated that they have to move slowly and rest often to avoid getting overheated.

Physical activities on warm days necessitate cooling. So, the polar bear goes for swimming. It is a good swimmer. Its paws are wide and large, which help it not only to swim well but also walk with ease in the snow. While swimming under water, it can close its nostrils and can remain under water for long durations. It has a strong sense of smell so that it can catch its prey for food. We can understand the adaptations of polar bears with the help of the flow chart shown in Fig. 7.3.

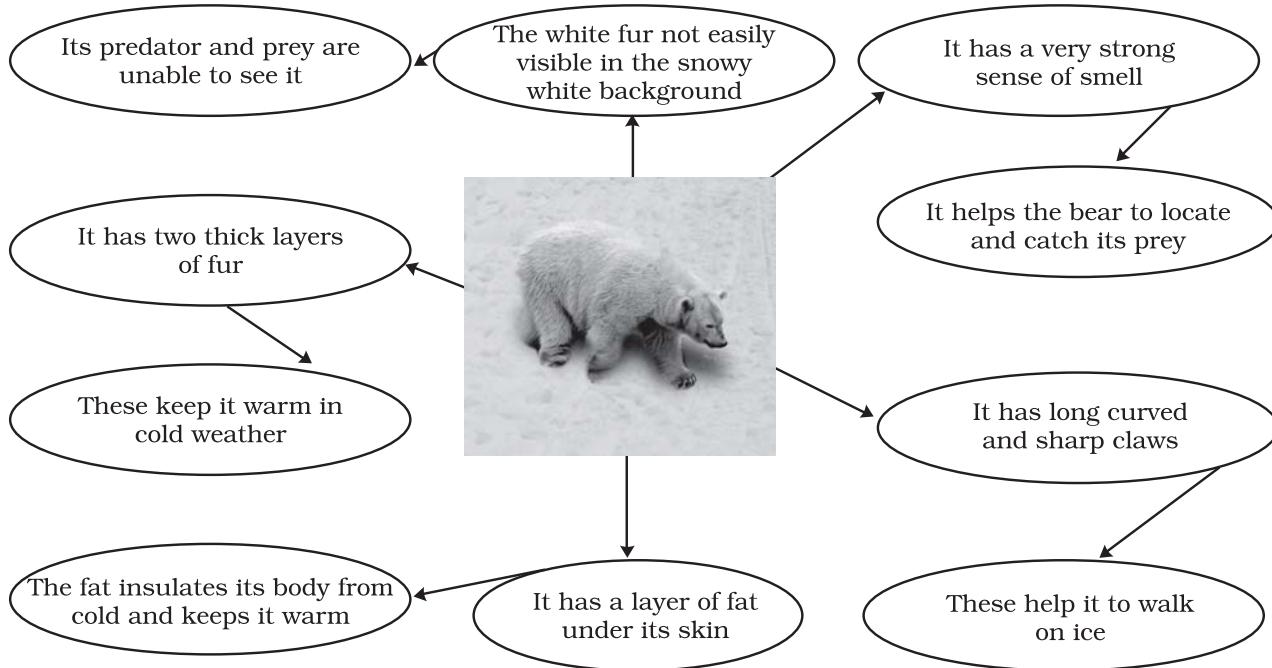


Fig. 7.3 Adaptations of polar bear

Another well-known animal living in the polar regions is the penguin (Fig. 7.4). It is also white and merges well with the white background. It also has a thick skin and a lot of fat to protect it from cold. You may have seen pictures of penguins huddled together. This they do to keep warm. Recall how warm you feel when you are in a hall full of people.



Fig. 7.4 Penguins huddled together



Fig. 7.5 Feet of penguin

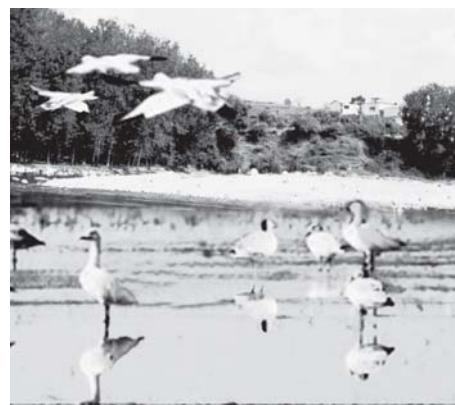
Like polar bears, penguins are also good swimmers. Their bodies are streamlined and their feet have webs, making them good swimmers (Fig. 7.5).

Other animals living in the polar regions are many types of fishes, musk oxen, reindeers, foxes, seals, whales, and birds. It is to be noted that while fish can remain under cold water for

long, birds must remain warm to survive. They migrate to warmer regions when winter sets in. They come back after the winter is over. You know probably that India is one of the destinations of many of these birds. You must have seen or heard about the Siberian crane that comes from Siberia to places like Bharatpur in Rajasthan and Sultanpur in Haryana, and some



Fig. 7.6 Migratory birds in their habitat/ Migratory birds in flight



Did you know?

Some migratory birds travel as much as 15000 km to escape the extreme climatic conditions at home. Generally they fly high where the wind flow is helpful and the cold conditions allow them to disperse the heat generated by their flight muscles. But how these birds travel to the same place year after year is still a mystery. It seems that these birds have a built-in sense of direction and know in which direction to travel. Some birds probably use landmarks to guide them. Many birds may be guided by the sun during the day and stars at night. There is some evidence that birds may use the magnetic field of the earth to find direction. And it is not only birds that migrate; mammals, many types of fish and insects are also known to migrate seasonally in search of more hospitable climates.

wetlands of north east and some other parts of India (Fig. 7.6).

(ii) The tropical rainforests

The tropical region has generally a hot climate because of its location around the equator. Even in the coldest month the temperature is generally higher than about 15°C. During hot summers, the temperature may cross 40°C. Days and nights are almost equal in length throughout the year. These regions get plenty of rainfall. An important feature of this region is the tropical rainforests. Tropical rainforests are found in Western Ghats and Assam in India, Southeast Asia, Central America and Central Africa. Because of continuous warmth and rain, this region supports wide variety of plants and animals. The major types of animals living in the rainforests are monkeys, apes, gorillas, lions, tigers, elephants, leopards, lizards, snakes, birds and insects.

Let us read about the adaptations of these animals to a hot, humid climate.

The climatic conditions in rainforests are highly suitable for supporting an enormous number and variety of animals.

Since the numbers are large, there is intense competition for food and shelter. Many animals are adapted to living on the trees. Red-eyed frog (Fig. 7.7) has developed sticky pads on its feet to help it climb trees on which it lives. To help them live on the trees, monkeys (Fig. 7.8) have long tails for grasping branches. Their hands and feet



Fig. 7.7 Red-eyed frog



Fig. 7.8 A new world monkey

are such that they can easily hold on to the branches.

As there is competition for food, some animals are adapted to get food not easily reachable. A striking example is that of the bird Toucan (Fig. 7.9), which possesses a long, large beak. This helps a toucan to reach the fruits on branches which are otherwise too weak to support its weight.

Many tropical animals have sensitive hearing, sharp eyesight, thick skin and a skin colour which helps them to camouflage by blending with the surroundings. This is to protect them from predators. For example, big cats



Fig. 7.9 Toucan



Fig. 7.10 Lion-tailed macaque

(lions and tigers) have thick skins and sensitive hearing.

The lion-tailed macaque (also called Beard ape) lives in the rainforests of Western Ghats (Fig. 7.10). Its most outstanding feature is the silver-white mane, which surrounds the head from the cheeks down to its chin. It is a good climber and spends a major part of its life on the tree. It feeds mainly on fruits. It also eats seeds, young leaves, stems, flowers and buds. This beard ape also searches for insects under the bark of the trees. Since it is able to get sufficient food on the trees, it rarely comes down on the ground.

Another well-known animal of Indian tropical rainforest is the elephant

(Fig. 7.11). It has adapted to the conditions of rainforests in many remarkable ways. Look at its trunk. It uses it as a nose because of which it has a strong sense of smell. The trunk is also used by it for picking up food. Moreover, its tusks are modified teeth. These can tear the bark of trees that elephant loves to eat. So, the elephant is able to handle the competition for food rather well. Large ears of the elephant help it to hear even very soft sounds. They also help the elephant to keep cool in the hot and humid climate of the rainforest.

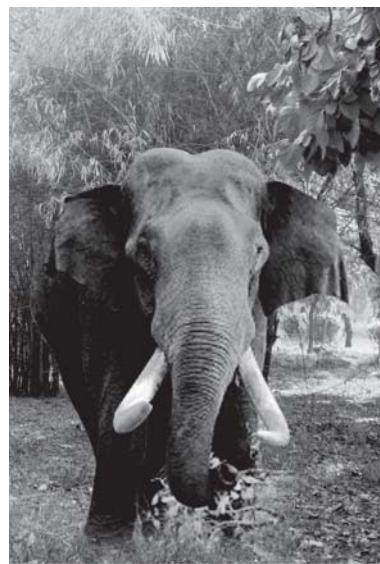


Fig. 7.11 An Indian elephant

Keywords

Adaptation	Maximum temperature	Tropical rainforest
Climate	Migration	Tropical region
Elements of weather	Minimum temperature	Weather
Humidity	Polar region	

What you have learnt

- The day-to-day condition of the atmosphere at a place with respect to the temperature, humidity, rainfall, wind-speed, etc., is called the weather at that place.
- The weather is generally not the same on any two days and week after week.
- The maximum temperature of the day occurs generally in the afternoon while the minimum temperature occurs in the early morning.
- The times of sunrise and sunset also change during the year.
- All the changes in the weather are driven by the sun.
- The average weather pattern taken over a long time, say 25 years, is called the climate of the place.
- The tropical and the polar regions are the two regions of the earth, which have severe climatic conditions.
- Animals are adapted to the conditions in which they live.
- The polar regions are very cold throughout the year. The sun does not set for six months in a year and in the other six months it does not rise.
- Animals in the polar region are adapted to the extremely cold climate by having some special characteristics such as white fur, strong sense of smell, a layer of fat under the skin, wide and large paws for swimming and walking, etc.
- Migration is another means to escape the harsh, cold conditions.
- Because of the hospitable climatic conditions huge populations of plants and animals are found in the tropical rainforests.
- Animals in the tropical rainforests are adapted such that they eat different kinds of food to overcome the competition for food and shelter.
- Some adaptations of animals living in the tropical rainforests include living on the trees, development of strong tails, long and large beaks, bright colours, sharp patterns, loud voice, diet of fruits, sensitive hearing, sharp eyesight, thick skin, ability to camouflage in order to protect themselves from predators, etc.

Exercises

1. Name the elements that determine the weather of a place.
2. When are the maximum and minimum temperature likely to occur during the day?
3. Fill in the blanks:
 - (i) The average weather taken over a long time is called _____.

- (ii) A place receives very little rainfall and the temperature is high throughout the year, the climate of that place will be _____ and _____ .
- (iii) The two regions of the earth with extreme climatic conditions are _____ and _____ .
4. Indicate the type of climate of the following areas:
- (a) Jammu and Kashmir: _____
- (b) Kerala: _____
- (c) Rajasthan: _____
- (d) North-east India: _____
5. Which of the two changes frequently, weather or climate?
6. Following are some of the characteristics of animals:
- | | |
|---------------------------|------------------------------|
| (i) Diets heavy on fruits | (ii) White fur |
| (iii) Need to migrate | (iv) Loud voice |
| (v) Sticky pads on feet | (vi) Layer of fat under skin |
| (vii) Wide and large paws | (viii) Bright colours |
| (ix) Strong tails | (x) Long and large beak |
- For each characteristic indicate whether it is adaptation for tropical rainforests or polar regions. Do you think that some of these characteristics can be adapted for both regions?
7. The tropical rainforest has a large population of animals. Explain why it is so.
8. Explain, with examples, why we find animals of certain kind living in particular climatic conditions.
9. How do elephant living in the tropical rainforest adapt itself.
- Choose the correct option which answers the following question:**
10. A carnivore with stripes on its body moves very fast while catching its prey. It is likely to be found in
- | | |
|-------------------|---------------------------|
| (i) polar regions | (ii) deserts |
| (iii) oceans | (iv) tropical rainforests |
11. Which features adapt polar bears to live in extremely cold climate?
- | |
|--|
| (i) A white fur, fat below skin, keen sense of smell. |
| (ii) Thin skin, large eyes, a white fur. |
| (iii) A long tail, strong claws, white large paws. |
| (iv) White body, paws for swimming, gills for respiration. |

12. Which option best describes a tropical region?
- hot and humid
 - moderate temperature, heavy rainfall
 - cold and humid
 - hot and dry

Extended Learning — Projects and Activities

1. Collect weather reports of seven successive days in the winter months (preferably December). Collect similar reports for the summer months (preferably June). Now prepare a table for sunrise and sunset times as shown:

Table

June			December		
Date	Sunrise	Sunset	Date	Sunrise	Sunset

Try to answer the following questions:

- Is there any difference in the time of sunrise during summer and winter?
- When do you find that the sun rises earlier?
- Do you also find any difference in the time of sunset during the month of June and December?
- When are the days longer?
- When are the nights longer?
- Why are the days sometimes longer and sometimes shorter?
- Plot the length of the day against the days chosen in June and December.

(Instructions for plotting graphs are given in Chapter 13.)

2. Collect information about the Indian Meteorological Department. If possible visit its website: <http://www.imd.gov.in>.

Write a brief report about the things this department does.

Did you know?

Rainforests cover about 6% of the earth's surface, but they have more than half of the animal life and about two-thirds of the flowering plants of the planet. However, much of this life is still unknown to us.

16

Water: A Precious Resource

“**Jal Hai, To Kal Hai**”

“If you have water, you can think of the future”

You are perhaps aware that 22 March is celebrated as the **world water day**! A school celebrated ‘water day’ and invited posters from the children of your age group. Some of the posters presented on that day are shown in Fig. 16.1.



Fig. 16.1 Collage of posters

What is the message you get from these posters? Write your observations in your notebook and discuss them in the class.

Have you ever felt a shortage of water at home or at school? Your parents or

teachers must very often be advising you not to waste water. No wonder we celebrate **water day** every year to attract the attention of everybody towards the importance of conserving water.

The amount of water recommended by the United Nations for drinking, washing, cooking and maintaining proper hygiene is a minimum of 50 litres per person per day. This amount is about two and a half buckets of water per person per day. Is your family getting at least this much of water? If yes, you should consider yourself fortunate because millions of people in our country do not get enough water. What about your friends and their families? Share your experience with them.

In some places there is an acute shortage of water. Taps running dry, long queues for water (Fig. 16.2), fights, marches and protests for demand of water have become a common sight, especially during summers. Some of the newspaper clippings shown in Fig. 16.3 clearly indicate this message. Is it not true that we face acute shortage of water?



Fig. 16.2 Long queue for water



Fig. 16.3 Newspaper clippings

Activity 16.1

Collect clippings from newspapers and magazines on the news items, articles and pictures related to water shortage. Paste them in your scrapbook and share it with your friends. List some problems faced by the people and discuss them in the class.

Water shortage has become a matter of concern throughout the world. It is estimated that in a few years from now

Year 2003 was observed as the International Year of Freshwater to make people aware of this dwindling natural resource.

more than one third of the people in the world could face water scarcity.

Before we discuss why water is getting scarce we must know how much water is available for use on our planet.

16.1 How MUCH WATER IS AVAILABLE

Look at the picture of the earth taken from space. Why does it appear blue? Surely, you can guess!

You are aware that about 71% of the earth's surface is covered with water. Almost all the water on the earth is contained in the seas and oceans, rivers, lakes, ice caps, as groundwater and in the atmosphere. However, most of this water is not fit for human consumption. The water that is fit for use is freshwater. Perform the



Fig. 16.4 Earth appears blue from space

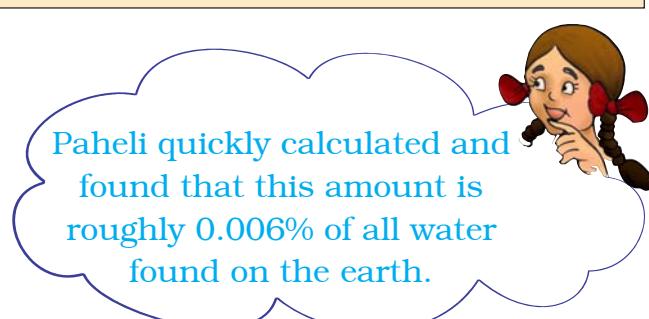
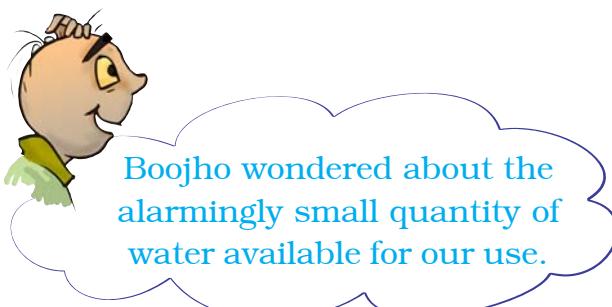
following activity to estimate roughly the relative amount of water available in some of these sources.

Activity 16.2

Most of us assume water to be a limitless resource. From this activity can you

Steps	Figure	Remark
Take a medium-sized bucket and fill it up with water. It contains about twenty litres of water.		Assume that this water represents all the water present on the earth.
Take a tea spoon of about 5 mL capacity and transfer 100 spoons of water from the bucket to a small container, like a bath mug.		This represents total freshwater on the earth.
From the bath mug transfer thirty spoons of water to a glass tumbler.		This gives a measure of usable water present as groundwater.
Finally take out a quarter ($1/4^{\text{th}}$) spoonfull of water from the mug.		It represents all the water present in all the lakes and rivers of the world.

- The water left in the bucket represents the saline water present in the seas, oceans and partly as groundwater. This water is not fit for human use.
- The water left in the bath mug represents the water, which is present in the frozen form in glaciers, ice caps and permanent snow; again not available readily.



appreciate the actual amount of water available for human use? Does the finding worry you? Discuss this in your class.

16.2 FORMS OF WATER

Are you afraid that continuous use will some day exhaust all the water available for use? You know that water on the earth has been maintained for millions of years by various processes which make the **water cycle**. You have studied the water cycle in Class VI. Write in your own words what you know about the water cycle.

You know that when water circulates through the water cycle it can be found in all the three forms, i.e., solid, liquid and gas—at any given time somewhere on the earth. The **solid** form, snow and ice, is present as ice caps at the poles of

the earth, snow-covered mountains and glaciers. **Liquid** water is present in oceans, lakes, rivers, and even underground. The **gaseous** form is the water vapour present in the air around us. The continuous cycling of water among its three forms keeps the total amount of water on the earth constant even when the whole world is using it. Does it give you any relief?

Can you recall the processes involved in water cycle? The following activity will help you.

Activity 16.3

Fig. 16.5 shows the processes involved in the water cycle. They are labelled by numbers. Match these numbers with the processes given in the jumbled form.

Most towns and cities have water supply system maintained by the civic

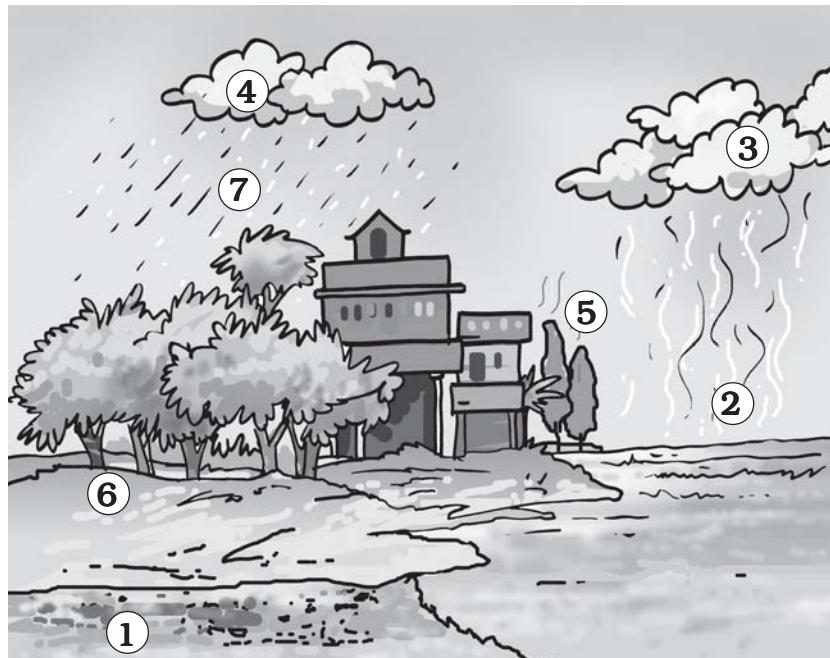
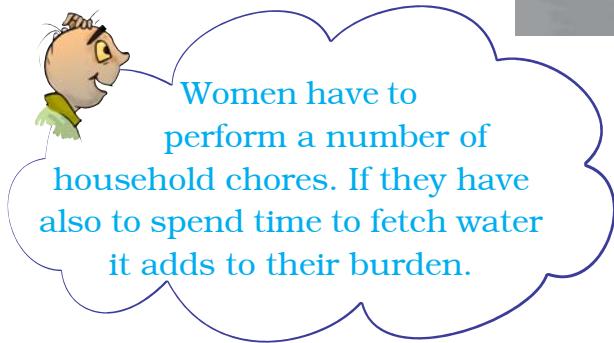


Fig. 16.5 Water cycle

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2. atooniaervp
3. acestoonnnid
4. duclos
5. tspratniaoinr
6. aitfinronit
7. ntciepirtaipo

bodies. The water is drawn from nearby lakes, rivers, ponds or wells. The water is supplied through a network of pipes. Many villages do not have such a water supply system. There people fetch water directly from the sources. Often women and children have to walk several kilometres to fetch water (Fig. 16.6). The children suffer a lot. They cannot attend school regularly since they spend hours in fetching water.



A large number of people draw water from wells, tube wells or hand pumps. From where do these sources get water?

16.3 GROUNDWATER AS AN IMPORTANT SOURCE OF WATER

If we dig a hole in the ground near a water body we may find that the soil is moist. The moisture in the soil indicates the presence of water underground. If we dig deeper and deeper, we would reach a level where all the space between particles of soil and gaps between rocks are filled with water (Fig. 16.7). The upper limit of this layer is called the **water table**. The water table varies from



Fig. 16.6 Women fetching water

place to place, and it may even change at a given place. The water table may be at a depth of less than a metre or may be several metres below the ground. The water found below the water table is called groundwater. What is the source of this groundwater?

The rainwater and water from other sources such as rivers and ponds seeps through the soil and fills the empty spaces and cracks deep below the ground. The process of seeping of water into the ground is called **infiltration**. The groundwater thus gets recharged by this process. At places the groundwater is stored between layers of hard rock below the water table. This is known as an **aquifer**. Water in the aquifers can be usually pumped out with the help of tube wells or handpumps.

Have you ever been to a site where construction work is going on? From

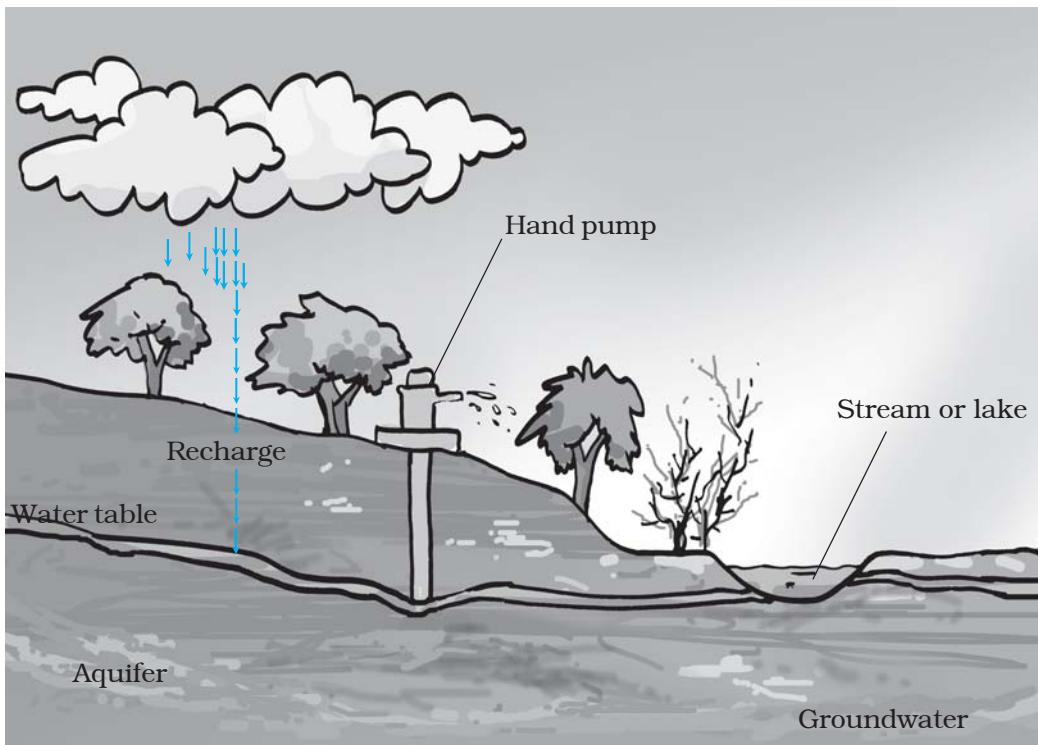


Fig. 16.7 Groundwater and water table

where do the workers get water for construction? May be you have seen boring being done at such sites to reach the water table. Enquire from the people working there how deep they have to dig.

Can we keep on drawing water from under the ground? How will it affect the water table?

16.4 DEPLETION OF WATER TABLE

Water drawn from under the ground gets replenished by seepage of rainwater. The water table does not get affected as long as we draw as much water as is replenished by natural processes. However, water table may go down if the water is not sufficiently replenished. This may happen due to many reasons. Increase in population, industrial and

agricultural activities are some common factors affecting water table. Scanty rainfall is another factor that may deplete the water table. Yet another factor affecting water table could be deforestation and decrease in the effective area for seepage of water.

Increasing population

Increasing population creates demand for construction of houses, shops, offices, roads and pavements. This decreases the open areas like parks, and playgrounds. This, in turn, decreases the seepage of rainwater into the ground. What could be the consequence? Recall that a *pukka* floor does not allow water to seep in easily, while in a grass lawn water seeps through in no time.

Moreover a huge amount of water is required for construction work. Often groundwater is used for this purpose.

So, on the one hand we are consuming more groundwater, and on the other we are allowing lesser water to seep into the ground. This results in depletion of water table. In fact, the water table in some parts of many cities has gone down to alarmingly low levels.

Increasing industries

Water is used by all the industries. Almost everything that we use needs water somewhere in its production process. The number of industries is increasing continuously. Water used by most of the industries is drawn from the ground.

Activity 16.4

Name some industries familiar to you. Make a list of the products obtained from these and used in our daily life. Discuss with your teacher and parents how the growing industrial activity is responsible for the depletion of water table.

Agricultural activities

A majority of farmers in India depend upon rains for irrigating their crops. Irrigation systems such as canals are there only in a few places. Even these systems may suffer from lack of water due to erratic rainfall. Therefore, farmers have to use groundwater for irrigation. Population pressure on agriculture forces increasing use of groundwater

day by day. This results in depletion of water table.

16.5 DISTRIBUTION OF WATER

The distribution of water over the globe is quite uneven due to a number of factors.

Some places have good amount of rain and are water-rich. On the other hand, there are deserts which have scanty rainfall.

India is a vast country and the rainfall is not the same everywhere. Some regions have excessive rains while some others have very little rainfall. Excessive rains cause floods, whereas the absence of rains results in droughts. Therefore, some regions in our country may have floods while others may suffer from droughts at the same time.

Activity 16.5

Given here is the rainfall map of India (Fig. 16.8). It gives the average annual rainfall in different regions of our country.

- Locate on the map the place you live in.
- Are you blessed with sufficient rainfall?
- Is there sufficient water available in your area throughout the year?

It may be possible that we are living in an area where there is sufficient rainfall yet there is shortage of water. Can we attribute this to mismanagement of water resources?

16.6 WATER MANAGEMENT

You have read in Class VI that in many places a regular supply of water is

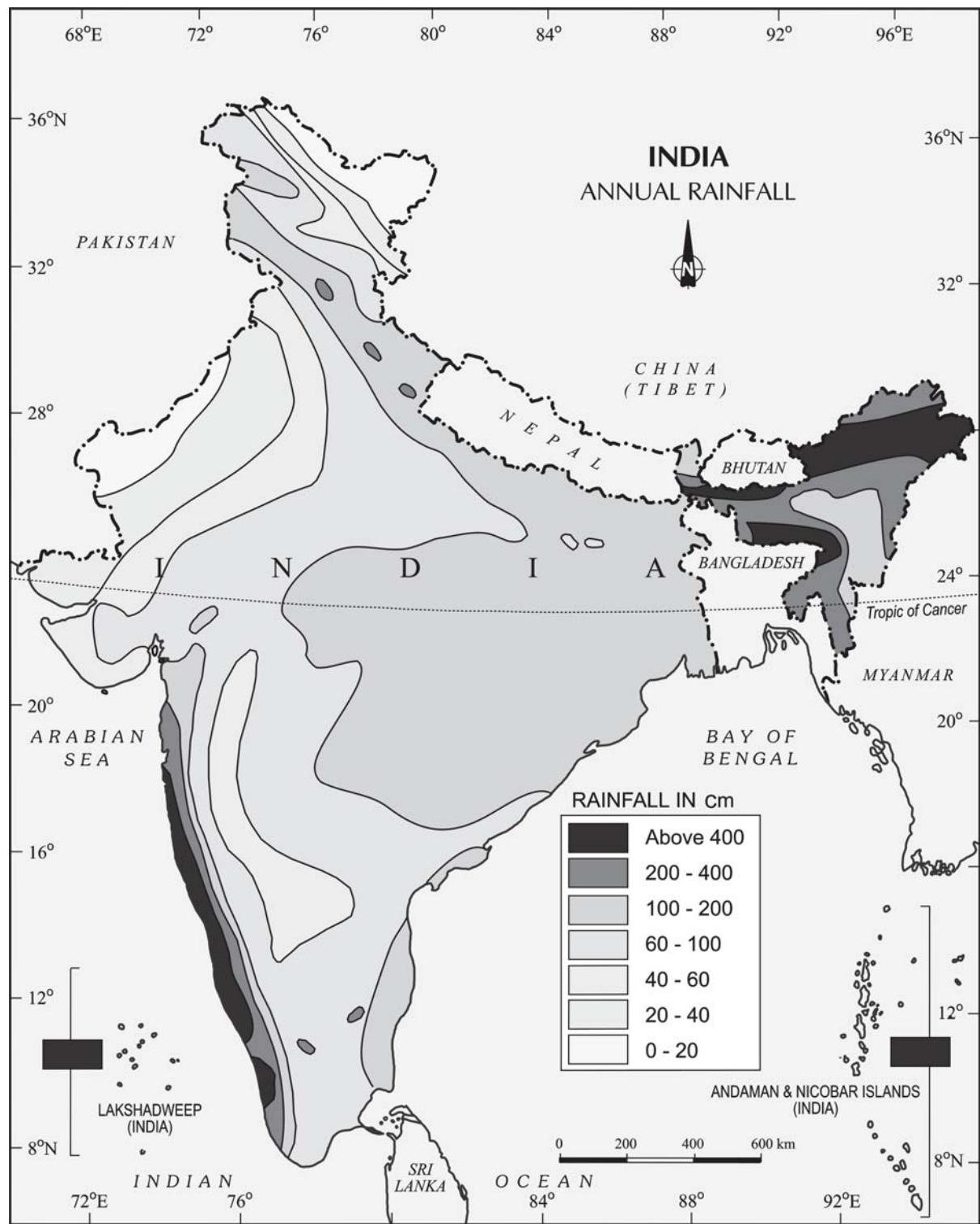


Fig. 16.8 Rain map of India

1. Government of India, Copyright 2007.
2. Based upon Survey of India map with the permission of the Surveyor General of India.
3. The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate baseline.
4. The external boundaries and coastlines of India agree with the Record/Master Copy certified by Survey of India.

provided by a well-planned pipe system. When the civic authorities supply water through pipes not all of it may reach the destination. You might have seen water supply pipes leaking and a lot of water gushing out of the pipes. It is the responsibility of the civic authorities to prevent such wastage of precious water.

Mismanagement or wastage may take place at the level of individuals also. All of us, knowingly or unknowingly, waste water while brushing teeth, shaving, bathing, washing and during many other activities. Leaking taps is another source of huge water wastage. We waste water as though we do not need water the next time!

We have seen that most of the water that we get as rainfall just flows away. This is a waste of precious natural resource. The rainwater can be used to recharge the groundwater. This is referred to as **water harvesting** or

rainwater harvesting, about which you have learnt in Class VI.

Find out if the buildings in your neighbourhood have water harvesting systems installed.

We have at many places in India an age old practice of water storage and water recharge like the **bawris**. *Bawri was the traditional way of collecting water.* With time the *bawris* fell into disuse and garbage started piling in these reservoirs. However, because of the acute water shortage, people in these areas have had to rethink. The *bawris* are being revived. Today the situation is that inspite of scanty rains these places are managing their water needs well.

A farmer using water in the field can also use water economically. Maybe you have heard of **drip irrigation** (Fig. 16.9). Drip irrigation is a technique of watering plants by making use of narrow tubings which deliver water directly at the base of the plant.

A case study

Bhujpur in the Kutch area of Gujarat has a very erratic rainfall. The only source of freshwater lies underground because rivers in this area do not have water throughout the year. Over the years, demand for water has grown. The withdrawal of groundwater has far exceeded recharge. As a result the water table has gone down alarmingly.

In 1989, the villagers along with a non-governmental organisation, decided to harvest rainwater. Eighteen check-dams were built on the Rukmavati river and its many tributaries. The water so collected increased percolation through the soil and recharged the aquifers.

According to farmers, the wells have water now and the water that flowed into the sea and was wasted has become available for irrigation.



Fig. 16.9 Drip irrigation in a field

16.7 WHAT ROLE YOU CAN PLAY

Have you ever shown concern if you saw a tap leaking in your house, school or any other place? Leaking taps waste a lot of water. You must make efforts to stop this leakage.

There are a number of ways you can adopt to minimise the wastage of water. Let us begin. We have given a few examples. Add on!

Water-wise habits

1. Turn off taps while brushing
2. Mop the floor instead of washing

16.8 EFFECT OF WATER SCARCITY ON PLANTS

You must have seen potted plants wilting and ultimately drying up if they did not get water even for a few days. You have already learnt in Chapter 1 that plants need water to get nutrients from the soil to prepare their food. Just imagine the consequences if water is not available to plants!

The green character of the planet shall be lost. This may mean the end of all life, for a world without plants shall mean no food, no oxygen, not enough rain, and innumerable other problems.

A successful initiative

Rajasthan is a hot and dry place. The challenge of natural scarcity of water was met by a successful experiment. A band of social workers has transformed a dry area in the Alwar district into a green place. They have revived five dried-up rivers — Arveri, Ruparel, Sarsa, Bhagani and Jahazwali by constructing water-harvesting structures.

Keywords

Aquifer

Depletion

Drip irrigation

Groundwater

Infiltration

Recharge

Water harvesting

Water table

What you have learnt

- Water is essential for all living beings. There can be no life without it.
- Water exists in three forms: solid, liquid and vapour.
- Though water is maintained by the water cycle, yet there is an acute scarcity of water in many parts of the globe.
- There is an uneven distribution of water. Much of it has resulted from human activities.
- Rapid growth of industries, increasing population, growing irrigation requirements and mismanagement are some of the causes for water shortage.
- We need to be worried about the wastage during the supply of water through pipes, the leaking taps in buildings and other places. Unnecessary use of water and overdrawing from groundwater should be avoided. Recharge of water to the ground should be increased.
- The need of the hour is that every individual uses water economically.
- Plants wilt and ultimately dry-up if they are not watered for a few days.

Exercises

1. Mark 'T' if the statement is true and 'F' if it is false:
 - (a) The freshwater stored in the ground is much more than that present in the rivers and lakes of the world. (T/F)
 - (b) Water shortage is a problem faced only by people living in rural areas. (T/F)
 - (c) Water from rivers is the only source for irrigation in the fields. (T/F)
 - (d) Rain is the ultimate source of water. (T/F)
2. Explain how groundwater is recharged?
3. There are ten tubewells in a lane of fifty houses. What could be the long term impact on the water table?
4. You have been asked to maintain a garden. How will you minimise the use of water?
5. Explain the factors responsible for the depletion of water table.
6. Fill in the blanks with the appropriate answers:
 - (a) People obtain groundwater through _____ and _____.

- (b) Three forms of water are _____, _____ and _____.
- (c) The water bearing layer of the earth is _____.
- (d) The process of water seepage into the ground is called _____.
7. Which one of the following is **not** responsible for water shortage?
- (i) Rapid growth of industries
 - (ii) Increasing population
 - (iii) Heavy rainfall
 - (iv) Mismanagement of water resources
8. Choose the correct option. The total water
- (i) in the lakes and rivers of the world remains constant.
 - (ii) under the ground remains constant.
 - (iii) in the seas and oceans of the world remains constant.
 - (iv) of the world remains constant.
9. Make a sketch showing groundwater and water table. Label it.

Extended Learning — Activities and Projects

1. Role play

You are a water detective in your school. You have a team of six members. Survey the campus and make a note of the following:

- (a) Total number of taps
- (b) Number of taps leaking
- (c) Amount of water wasted due to leakage
- (d) Reasons of leakage
- (e) Corrective measures taken

2. Groundwater pumped out

Try to find out if there are any hand pumps in your neighbourhood. Go to the owner or the users of a few of these and find out the depth at which they struck water? If there are any differences, think of the probable reason. Write a brief report and discuss it in your class. If possible, visit a place where boring is going on to install a hand pump. Watch the process carefully and find out the depth of the water table at that place.

3. Catching rainwater—Traditional methods

Form groups of 4 to 5 students in the class and prepare a report on the various traditional ways of water harvesting. If possible, use the following web link: www.rainwaterharvesting.org.

4. Conservation of water

Carry out a campaign to conserve water at home and in the school. Design posters to remind others of the importance of water resources.

5. Create a logo

Hold a competition to create a logo or a symbol depicting water scarcity.

Did you know?

The importance of water management has been highlighted by a watershed management project near the village of Kothapally. The project has yielded dramatic results. Groundwater levels have risen, green cover has increased, and productivity and incomes in this semi-arid region have dramatically improved.

17

Forests: Our Lifeline

One evening Boojho entered the park with an elderly person. He introduced him to his friends. Prof Ahmad was a scientist working in the university. The children started playing while Prof Ahmad sat on a bench in the corner. He was tired as he had participated in the golden jubilee celebrations of the town. After a while, the children also came and sat around him. They wanted to know about the celebrations. Prof Ahmad told them that after the cultural programme, the senior people discussed the town's unemployment problem. A plan was proposed to put up a factory by clearing an area of the forest just outside the town. This would give the increasing population of the town a chance to get jobs. The children were very surprised when Prof Ahmad told them that many people had objected to this idea.



Fig. 17.1 A view of a forest

"This is because the forests serve as green lungs and water purifying systems in nature", Prof Ahmad explained. The children were confused. Prof Ahmad realised that the children had not visited a forest. The children also wanted to know more about the forest, so they decided to visit it with Prof Ahmad.

17.1 VISIT TO A FOREST

One Sunday morning, the children packed a few things like a knife, a hand lens, a stick, a notebook and walked together through a forest trail near a village. On their way, they met Tibu, a young boy of their age group, of nearby village, who was taking cattle for grazing along with his aunt. He was very agile, running here and there to keep the herd together. When he saw the children, Tibu also started walking along with them, while his aunt went on a different path. As soon as they entered the forest Tibu raised his hand and signalled them to keep quiet because noise could disturb the animals living in the forest.

Tibu then took them to a place at a height to show them the broad view of the forest. Children were surprised because they could not see any land (Fig. 17.1). The different treetops had formed green cover over the land. However, the cover was not uniformly green. The

environment was peaceful and a cool breeze was blowing. This made children quite fresh and happy.

While coming down, they got excited on hearing a sudden sound of birds and some noise from the top branches of the trees. Tibu told them to relax since it was a normal phenomenon here. Because of the children's presence, some monkeys had climbed higher up on the trees where they disturbed the birds. Animals often give this type of warning call to alert other animals. Tibu also told that many other animals like boar, bison, jackals, porcupine, elephants live in the deeper areas of the forest (Fig. 17.2). Prof Ahmad cautioned children that they should not go deep into the forest.

Boojho and Paheli remembered that they have studied about forests as



Fig. 17.3 Forest as habitat

an example of a habitat in Class VI (Fig. 17.3). They could see now how the forest provides a home for many animals and plants.

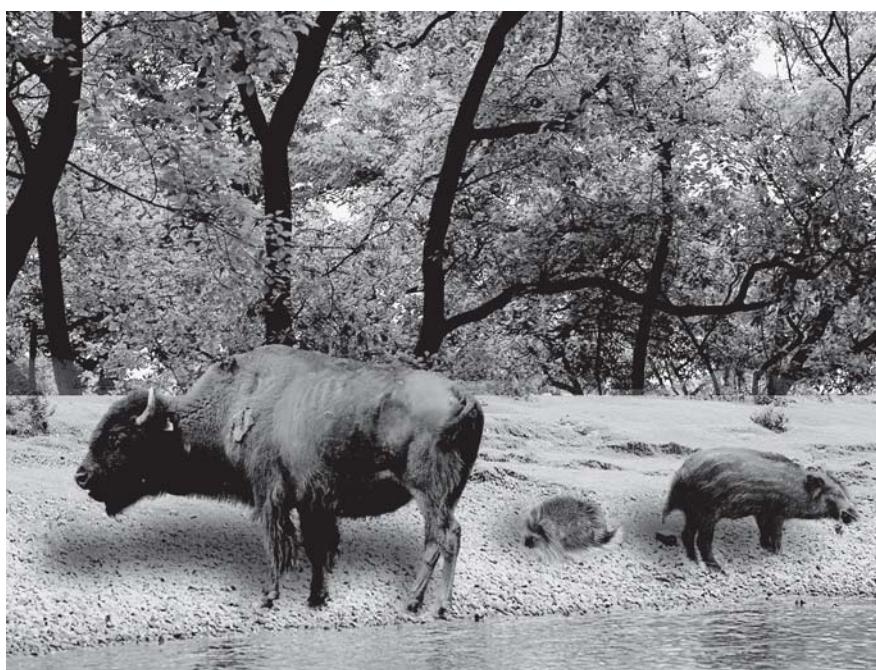


Fig. 17.2 Some forest animals

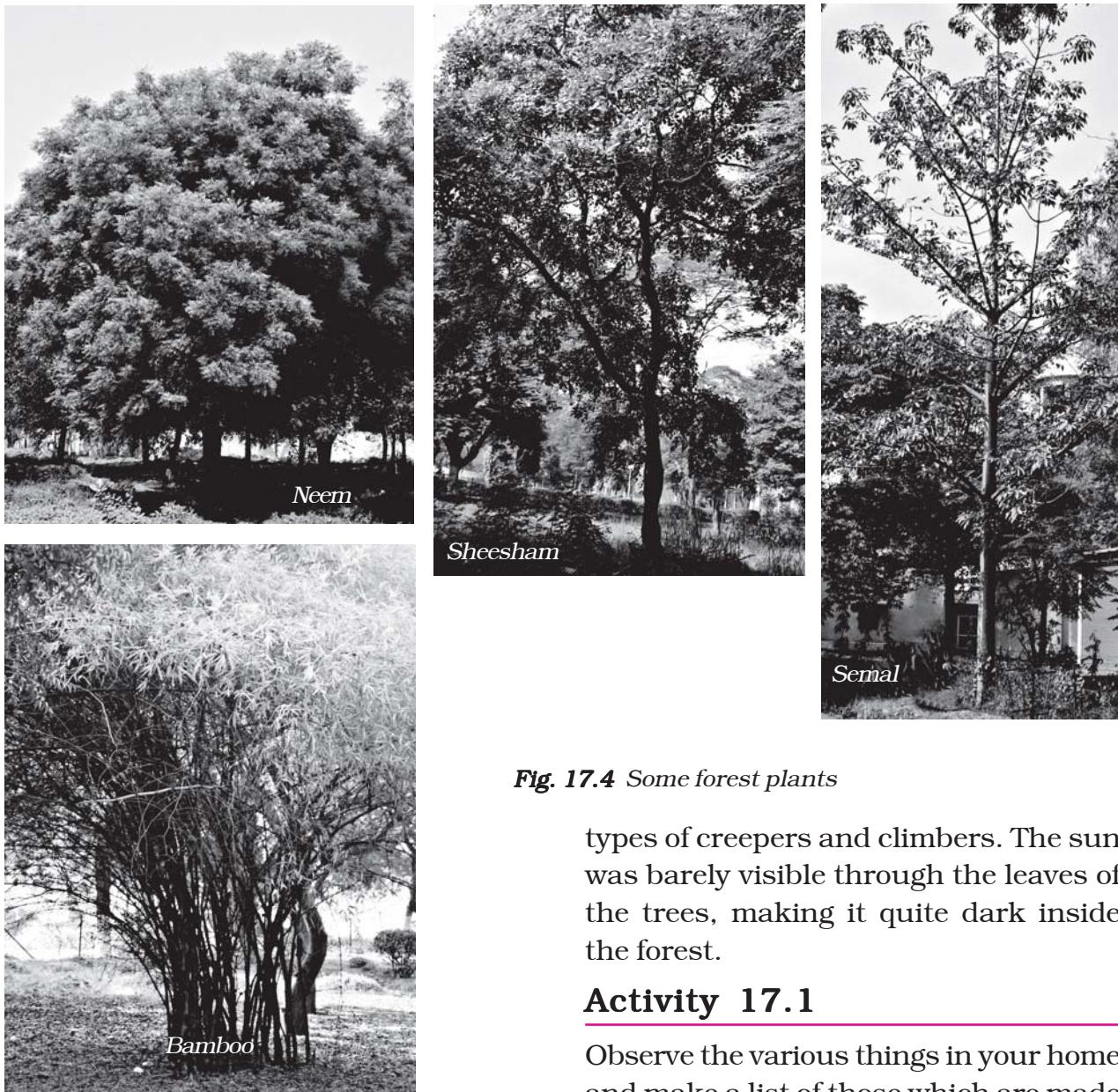


Fig. 17.4 Some forest plants

types of creepers and climbers. The sun was barely visible through the leaves of the trees, making it quite dark inside the forest.

Activity 17.1

Observe the various things in your home and make a list of those which are made from material which may have been obtained from the forest.

You might have many wooden items on your list like plywood, fuel wood, boxes, paper, matchsticks, and furniture. Do you know that gum, oils, spices, fodder for animals and medicinal plants are also some of the products which we get from the forest (Fig. 17.5).

The land where the children were walking was uneven and covered with many trees. Tibu helped them to identify *sal*, *teak*, *semal*, *sheesham*, *neem*, *palash*, *fig*, *khair*, *amla*, *bamboo*, *kachnar* (Fig. 17.4). Prof Ahmad pointed out that there are several other trees, shrubs, herbs and grasses in the forest. The trees were also covered with different

Sheila wondered who would have planted these trees. Prof Ahmad replied that in nature trees produce enough seeds. The forest floor provides favourable conditions for them to germinate and develop into seedlings



Fig. 17.5 Forest products

and saplings. Some grow up into trees. He added that branched part of a tree above the stem is known as the **crown** of the tree (Fig. 17.6).

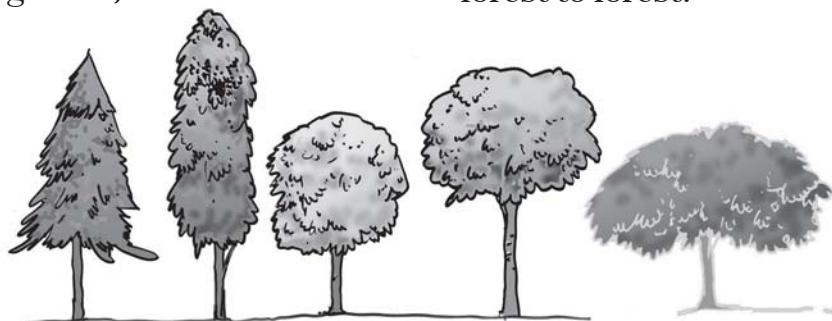


Fig. 17.6 Some crown shapes

Prof Ahmad asked children to look up and observe how the branches of the tall trees look like a roof over the other plants in the forest. He told them that this is called a **canopy** (Fig. 17.7).

Activity 17.2

Visit a forest or a park in your neighbourhood. Observe the trees and try to identify them. You can take the help of some elders or books on trees. List the characteristics of the trees that you observe, such as the height, shape of leaves, crown, flowers, and fruits. Also draw the crowns of some trees.

Prof Ahmad pointed out that trees had crowns of different types and sizes. These had created different horizontal layers in the forest. These are known as understoreys (Fig. 17.7). Giant and tall trees constituted the top layer followed by shrubs and tall grasses, and herbs formed the lowest layer.

“Would we see similar kind of trees in every forest?” — asked Boojho. Prof Ahmad said, “No, due to different climatic conditions there are variations in the types of trees and other plants. The types of animals also differ from forest to forest.”



Fig. 17.7 Canopy and under storeys in a forest

A few children were busy watching beautiful butterflies fluttering here and there on the flowers of shrubs and herbs. They had a close look at the bushes. While doing that their hair and clothes had seeds and shrubs clinging to them.

They came across numerous insects, spiders, squirrels, ants and various

other small animals on the bark of the trees, plant leaves and on decaying leaves on the forest floor (Fig. 17.8). They started making sketches of these creatures. The forest floor seemed dark coloured and was covered with a layer of dead and decaying leaves, fruits, seeds, twigs and small herbs. The decaying matter was moist and warm.

Children picked up various seeds and leaves for their collection. Walking over the dead leaf layer on the forest floor was like walking over a spongy carpet!

Is the decaying matter always warm? Prof Ahmad suggested that the children could perform an activity to get an answer to this question.

Activity 17.3

Dig a small pit. Put vegetable waste and leaves in it. Cover them with soil. Add some water. After three days, remove the



Fig. 17.8 Forest floor

upper layer of the soil. Does the pit feel warm inside?

Paheli asked, "There are so many trees here. Also, there are many forest like this. What difference will it make if we cut some trees for a factory?"

Prof Ahmad said, "You have read about autotrophs, heterotrophs and saprotrophs. You have learnt how green plants produce food. All animals, whether herbivores or carnivores, depend ultimately on plants for food. Organisms which feed on plants often get eaten by other organisms, and so on. For example, grass is eaten by

insects, which in turn, is taken by the frog. The frog is consumed by snakes. This is said to form a food chain: Grass → insects → frog → snake → eagle. Many food chains can be found in the forest. All food chains are linked. If any one food chain is disturbed, it affects other food chains. Every part of the forest is dependent on the other parts. If we remove one component, say trees, all other components would be affected."

Prof Ahmad asked children to pick up leaves from the forest floor and observe them under a hand lens. They found tiny mushrooms over the

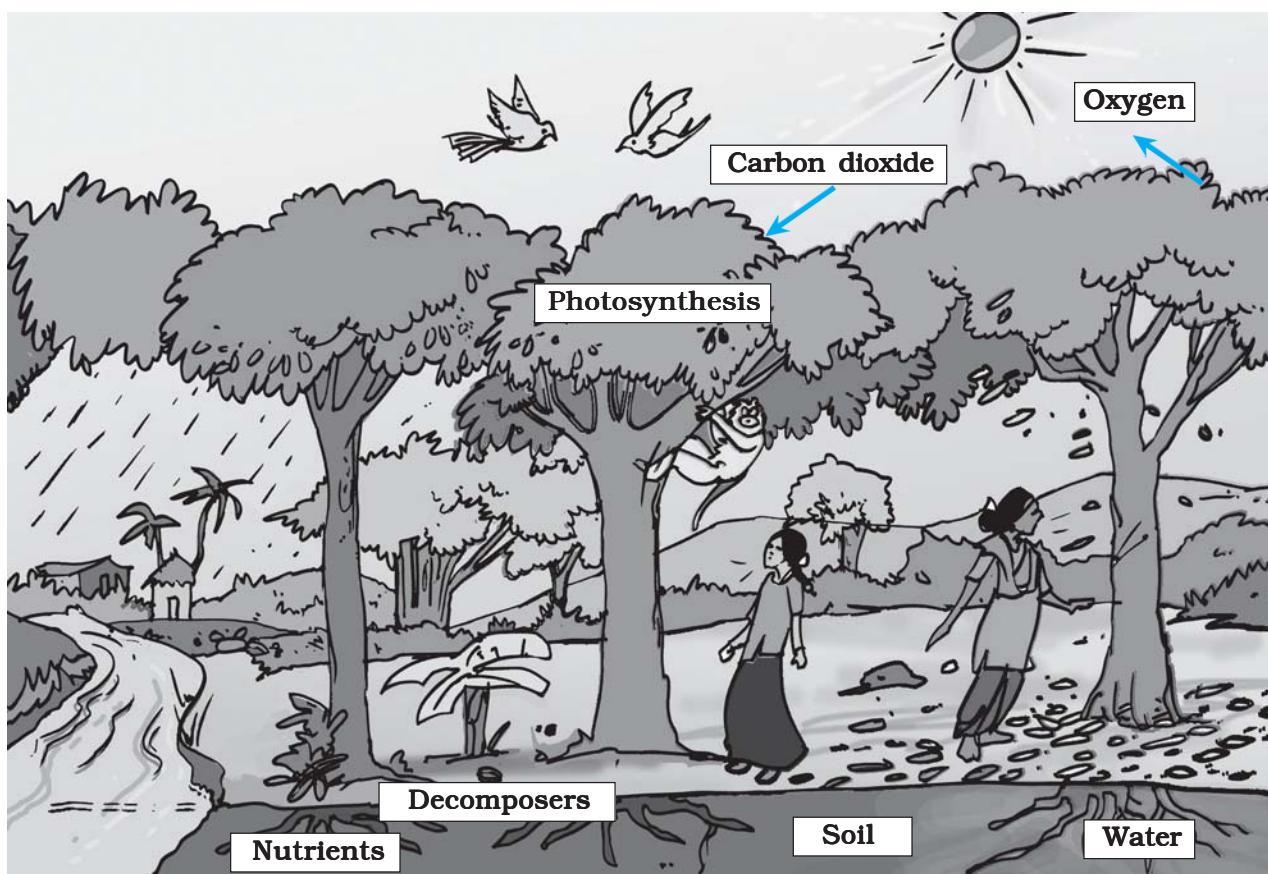


Fig. 17.9 Interrelationship of plant, soil and decomposers in a forest

decaying leaves. They also saw an army of tiny insects, millipedes, ants and beetle on them. They were wondering how these organisms live there. Prof Ahmad explained that apart from these animals which are easily seen, there are several organisms and micro-organisms that live in the soil. Paheli wondered what mushroom and other micro-organisms eat. Prof Ahmad replied that they feed upon the dead plant and animal tissues and convert them into a dark coloured substance called **humus**.

You have learnt about humus in Chapter 9. In which layer of the soil would you find humus? What is its importance to the soil?

The micro-organisms which convert the dead plants and animals to humus are known as **decomposers**. These micro-organisms play an important role in the forest. Soon, Paheli removed some dead leaves and discovered under them a layer of humus on forest floor. The presence of humus ensures that the nutrients of the dead plants and animals are released into the soil. From there, these nutrients are again absorbed by the roots of the living plants. “What happens if an animal dies in the forest?” Sheila asked. Tibu replied the dead animals become food for vultures, crows, jackals and insects.” In this way, the nutrients are cycled. So, nothing goes waste in a forest (Fig. 17.9).

Paheli reminded Prof Ahmad that he had not explained why forests are called green lungs. Prof Ahmad explained that

plants release oxygen through the process of photosynthesis. The plants help to provide oxygen for animal respiration. They also maintain the balance of oxygen and carbon dioxide in the atmosphere (Fig. 17.10). That is why forests are called lungs.

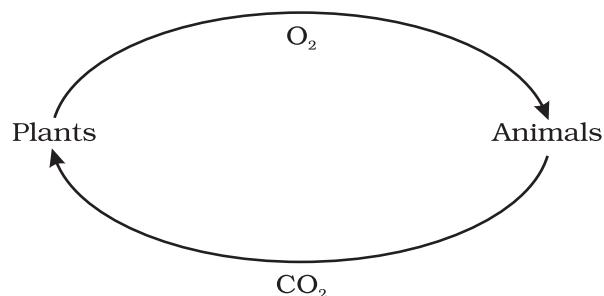
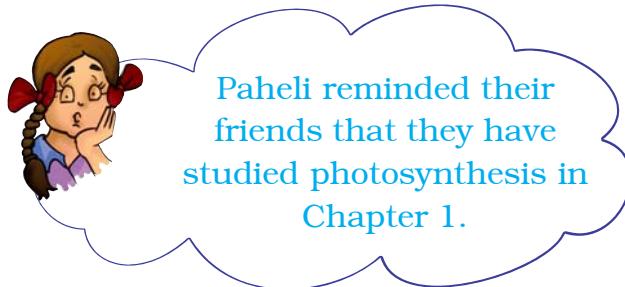


Fig. 17.10 Balance of oxygen and carbon dioxide

The children saw clouds forming in the sky. Boojho recalled what he had learnt about the water cycle in Class VI. Trees take in water from their roots and release water vapour into the air through evaporation.

If there were fewer trees, how will the water cycle be affected?

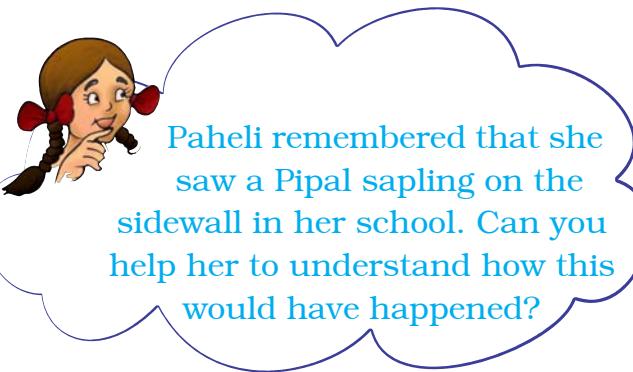
Tibu told them that the forest is not just home to plants and animals. Many people also live in the forest. Some of them may belong to different tribes. Tibu explained that these people depend mostly on the forests. The forest provides

them with food, shelter, water and medicines. They have traditional knowledge about many medicinal plants in the forest.

While Boojho was drinking water from a small stream, he saw some deer crossing the stream (Fig. 17.11). They disappeared into the bushes. The dense bushes and the tall grass provide animals with the food and shelter. They also protect them from carnivores that live in the forest.



Fig. 17.11 Deer in a forest



Paheli remembered that she saw a Pipal sapling on the sidewall in her school. Can you help her to understand how this would have happened?

Tibu then started looking closely at the forest floor. Soon he called and showed the children droppings of some animals, and explained the difference

between various types of droppings. Prof Ahmad informed them that the forest officers could recognise the presence of some animals in the forest by their droppings and footprints.

Boojho called every one and showed them a large, decaying heap of animal dropping. Several beetles and grubs were feeding on the heap and a bunch of seedlings was sprouting. "These seedlings are of the herbs and shrubs. The animals also disperse the seeds of certain plants and help the forest to grow



Fig. 17.12 A sapling on a wall

and regenerate. The decaying animal dung also provides nutrients to the seedlings to grow", said Prof Ahmad.

After listening to this, Boojho noted in his notebook, "By harbouring greater variety of plants, the forest provides greater opportunities for food and habitat for the herbivores. Larger number of herbivores means increased availability of food for a variety of carnivores. The wide variety of animals

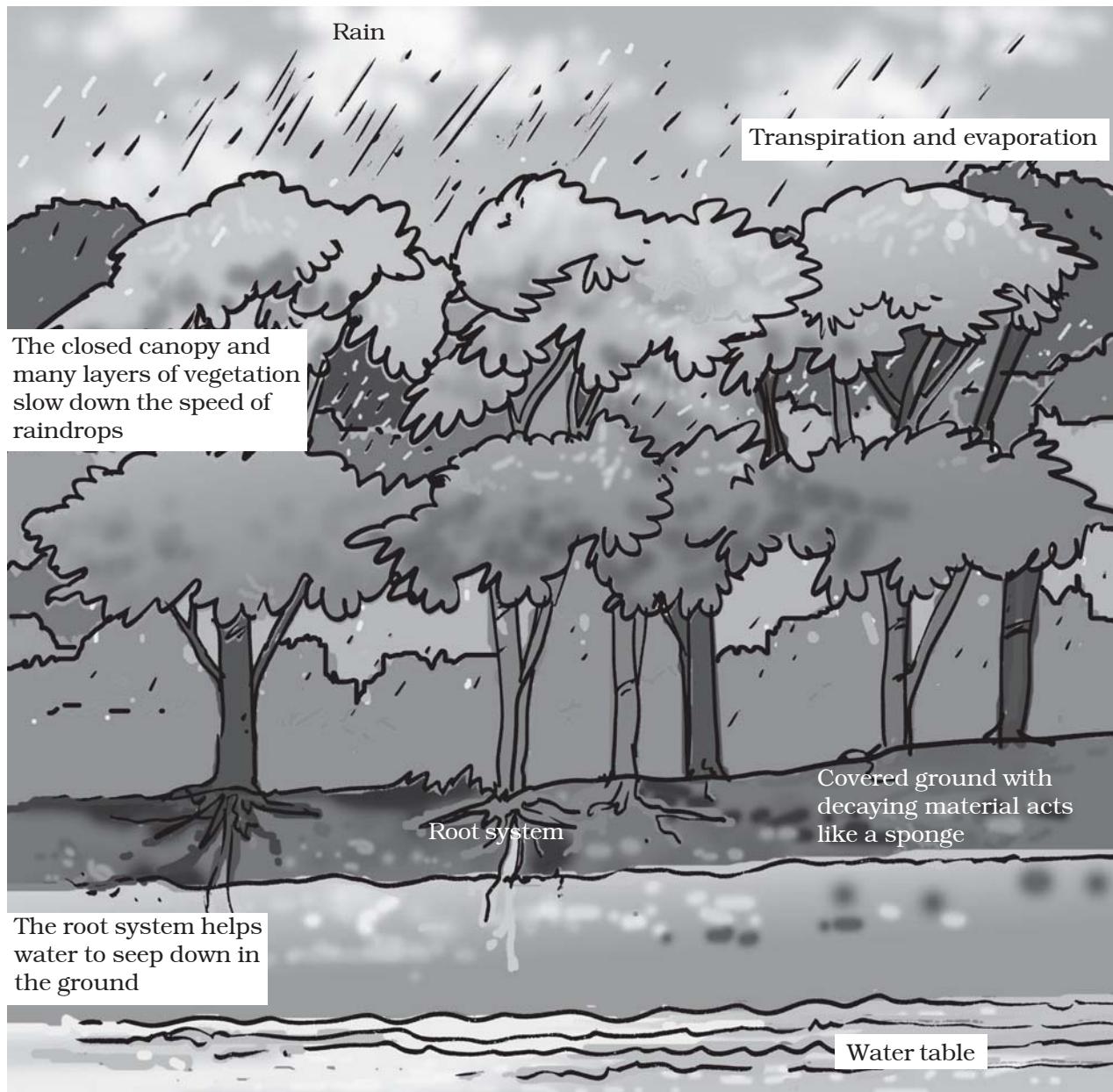


Fig. 17.13 Rainwater drips from the trees and seeps into the ground

helps the forest to regenerate and grow. Decomposers help in maintaining the supply of nutrients to the growing plants in the forest. Therefore, the forest is a '**dynamic living entity**' — full of life and vitality."

It was about afternoon and the children wanted to go back. Tibu

suggested another route for going back. While they were going back, it started raining. However, surprisingly, they saw that the raindrops were not hitting the forest floor directly. The uppermost layer of the forest canopy intercepted the flow of raindrops, and most of the water was coming down through the branches and

the stems of the trees. From the leaves it was dripping slowly over branches of the shrubs and herbs (Fig. 17.13). They found that the ground was still dry. After about half an hour, the rain stopped. They noticed that the layer of dead leaves over the forest floor appeared wet now. But water did not stagnate in the forest.

Boojho thought that if it had rained so heavily in his town, it would have flooded the drains and roads.

What would happen if it rains heavily in your town?

Prof Ahmad told them that the forest also acts as a natural absorber of rainwater and allows it to seep. It helps maintain the water table throughout the year. Forests not only help in controlling floods but also help maintain the flow of water in the streams so that we get a steady supply of water. On the other hand, if trees are not present, rain hits the ground directly and may flood the area around it. Heavy rain may also damage the soil. Roots of trees normally bind the soil together, but in their absence the soil is washed away or eroded.

The children spent an hour at Tibu's village on their way back. The weather of the village was quite pleasant. Villagers told them that due to the surrounding forest, they receive good rainfall. The air also remained cool. Noise pollution, too, is less because the forest absorbs the noise of the nearby highway.

The children learnt about the history of the village. It surprised them that the

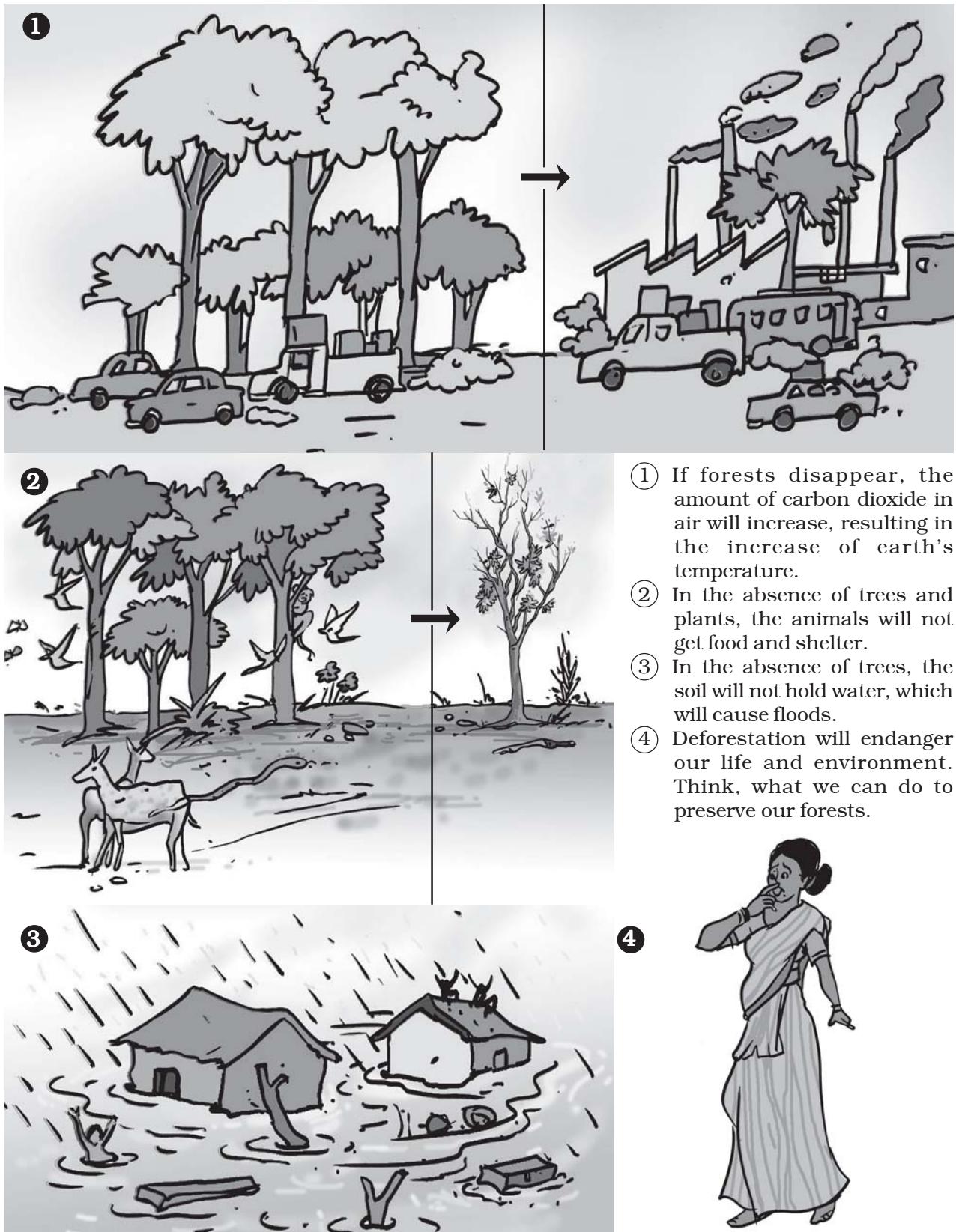
villages and the agricultural fields of that area were created after clearing the forest about sixty years ago. Tibu's grandfather told them that when he was young, the village was not as large as it was now. It was also surrounded by forests. Construction of roads, buildings, industrial development and increasing demand of wood created pressure on the forests and it started vanishing. He was not happy that the forest adjoining their village is not regenerating and is on the verge of disappearing due to overgrazing of animals and indiscriminate felling of trees. Prof Ahmad said that if we did things wisely we could preserve forests and environment as well as have development.

Children prepared a few pictures to show the consequences of such an event.

At the end of the visit, Prof Ahmad asked children to sum up the importance of forests. The children wrote: Forests provide us with oxygen. They protect soil and provide habitat to a large number of animals. Forests help in bringing good rainfall in neighbouring areas. They are a source of medicinal plants, timber and many other useful products. We must preserve our forests.



What would happen if forests
disappear?



Keywords

Canopy	Deforestation	Seed dispersal
Crown	Humus	Soil erosion
Decomposers	Regeneration	Understorey

What you have learnt

- We get various products from the forests surrounding us.
- Forest is a system comprising various plants, animals and micro-organisms.
- In a forest, trees form the uppermost layer, followed by shrubs. The herbs form the lowest layer of vegetation.
- Different layers of vegetation provide food and shelter for animals, birds and insects.
- The various components of the forest are interdependent on one another.
- The forest keeps on growing and changing, and can regenerate.
- In the forest, there is interaction between soil, water, air and living organisms.
- Forests protect the soil from erosion.
- Soil helps forests to grow and regenerate.
- Forests are the lifeline for the forest-dwelling communities.
- Forests influence climate, water cycle and air quality.

Exercises

1. Explain how animals dwelling in the forest help it grow and regenerate.
2. Explain how forests prevent floods.
3. What are decomposers? Name any two of them. What do they do in the forest?
4. Explain the role of forest in maintaining the balance between oxygen and carbon dioxide in the atmosphere.
5. Explain why there is no waste in a forest.
6. List five products we get from forests?

7. Fill in the blank:
- The insects, butterflies, honeybees and birds help flowering plants in _____.
 - A forest is a purifier of _____ and _____.
 - Herbs form the _____ layer in the forest.
 - The decaying leaves and animal droppings in a forest enrich the _____.
8. Why should we worry about the conditions and issues related to forests far from us?
9. Explain why there is a need of variety of animals and plants in a forest.
10. In Fig. 17.15, the artist has forgotten to put the labels and directions on the arrows. Mark the directions on the arrows and label the diagram using the following labels:
clouds, rain, atmosphere, carbon dioxide, oxygen, plants, animals, soil, roots, water table.
11. Which of the following is not a forest product?
- Gum
 - Plywood
 - Sealing wax
 - Kerosene
12. Which of the following statements is not correct?
- Forests protect the soil from erosion.
 - Plants and animals in a forest are not dependent on one another.
 - Forests influence the climate and water cycle.
 - Soil helps forests to grow and regenerate.

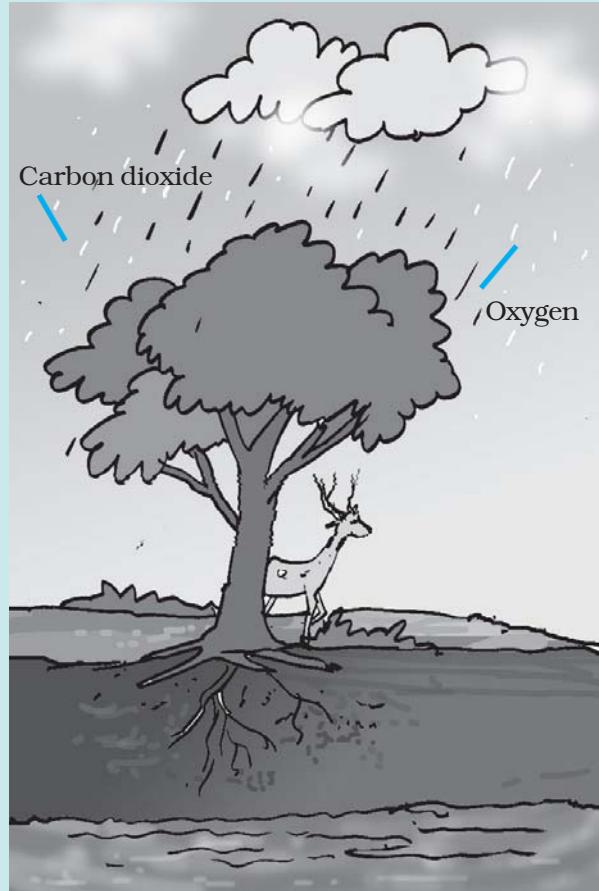


Fig. 17.15

13. Micro-organisms act upon the dead plants to produce
- (i) sand (ii) mushrooms (iii) humus (iv) wood

Extended Learning — Activities and Projects

1. The Department of Environment is to decide whether some portion of a forest in your area could be cleared for a housing complex. Write a letter to the department explaining your point of view as a concerned citizen.
2. Visit a forest. Here is a list of points that would make your visit more fruitful.
 - (a) Make sure that you have permission to go into the forest.
 - (b) Make sure that you can find your way around. Get a map and go along with some one who is familiar with the area.
 - (c) Keep a record of the things you see and do. Observations make the visit interesting. Sketches and photographs are useful.
 - (d) You may record bird calls.
 - (e) Collect different kinds of seeds or hard fruits like nuts.
 - (f) Try to recognise various types of trees, shrubs, herbs, etc. Make lists of plants from different places in the forest and of different layers. You may not be able to name all the plants, but it is worth recording and seeing where they grow. Make a record of approximate heights of plants, crown shape, bark texture, leaf size, and flower colour.
 - (g) Learn to recognise the animal's droppings.
 - (h) Interview the forest officials and the people of surrounding villages and other visitors.

You must never collect birds' eggs, and their nests should never be disturbed.

You can read more on the following website:

www.wild-india.com

Did you know?

In India the area under forest cover is about 21% of the total area. It had steadily been falling since independence. But people now seem to have realised the importance of the forest cover. Reports suggest that the area under forest cover has slightly increased in recent years.

18 Wastewater Story

All of us use water in our homes and make it dirty.

Dirty! Are you surprised?

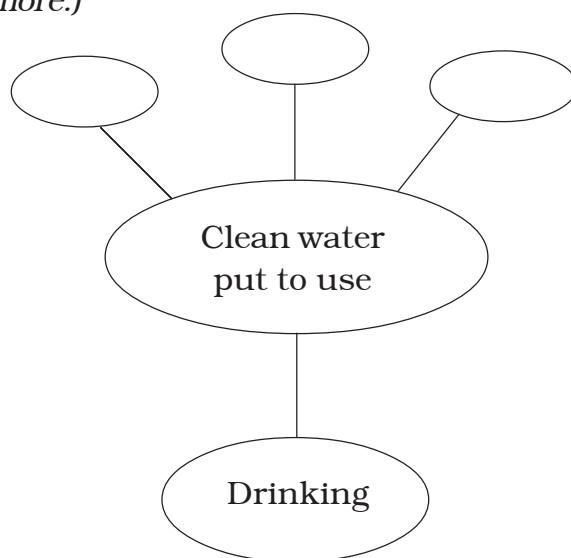
Rich in lather, mixed with oil, black-brown water that goes down the drains from sinks, showers, toilets, laundries is dirty. It is called **wastewater**. This used water should not be wasted. We must clean it up by removing pollutants. Have you ever thought where the wastewater goes and what happens to it?

18.1 WATER, OUR LIFELINE

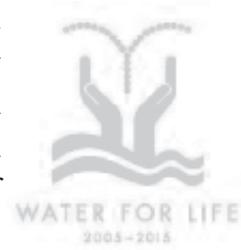
Clean water is a basic need of human being. Let us make a mindmap of the many uses of clean water.

Activity 18.1

(We have given one example of the use of clean water. You can add many more.)



Clean water that is fit for use is unfortunately not available to all. It has been reported that more than one billion of our fellow human beings have no access to safe drinking water. This accounts for a large number of water-related diseases and even deaths. Women and girls walk for several kilometres to collect clean water, as you read in Chapter 16. Is it not a serious matter for human dignity?



You have studied in Chapter 16 about the increasing scarcity of fresh-water due to population growth, pollution, industrial development, mismanagement and other factors. Realising the urgency of the situation on the World Water Day, on 22 March 2005, the General Assembly of the United Nations proclaimed the period 2005–2015 as the International Decade for action on “**Water for life**”. All efforts made during this decade aim to reduce by half the number of people who do not have access to safe drinking water.

Cleaning of water is a process of removing pollutants before it enters a water body or is reused. This process of wastewater treatment is commonly known as “Sewage Treatment”. It takes place in several stages.

18.2 WHAT IS SEWAGE?

Sewage is wastewater released by homes, industries, hospitals, offices and other users. It also includes rainwater that has run down the street during a storm or heavy rain. The water that washes off roads and rooftops carries harmful substances with it. Sewage is a liquid waste. Most of it is water, which has dissolved and suspended impurities. These impurities are called **contaminants**.

Activity 18.2

Locate an open drain near your home, school or on the roadside and inspect water flowing through it.

Record colour, odour and any other observation. Discuss with your friends and your teacher and fill up the following Table 18.1.

We know that sewage is a complex mixture containing suspended solids, organic and inorganic impurities, nutrients, saprotrophic and disease causing bacteria and other microbes.

Organic impurities –Human faeces, animal waste, oil, urea (urine),

pesticides, herbicides, fruit and vegetable waste, etc.

Inorganic impurities	– Nitrates, Phosphates, metals.
Nutrients	– Phosphorus and Nitrogen.
Bacteria	– Such as which cause cholera and typhoid.
Other microbes	– Such as which cause dysentery.

18.3 WATER FRESHENS UP — AN EVENTFUL JOURNEY

In a home or a public building generally one set of pipes brings clean water and another set of pipes takes away wastewater. Imagine that we could see through the ground. We would see a network of big and small pipes, called **sewers**, forming the **sewerage**. It is like a transport system that carries sewage from the point of being produced to the point of disposal, i.e. treatment plant.

Manholes are located at every 50 m to 60 m in the sewerage, at the junction

Table 18.1 Contaminant survey

S. No.	Type of sewage	Point of origin	Substances which contaminate	Any other remark
1.	Sullage water	Kitchen		
2.	Foul waste	Toilets		
3.	Trade waste	Industrial and commercial organisations		

of two or more sewers and at points where there is a change in direction.

Activity 18.3

Study the sewage route in your home/school/building. Do the following:

- Make a line diagram of the sewage route.
- Walk down the street or survey the campus to find the number of manholes.
- Follow an open drain and find out where it ends and which living organisms are found in and around it.

In case you do not have a sewerage system in your locality, find out how sewage is being disposed off.

Treatment of polluted water

Perform the following activity. It will help you understand the processes that take place at the wastewater treatment plant.

Activity 18.4

Divide yourself into groups to perform the activity. Record observations at each stage:

- Fill a large glass jar 3/4 full of water. Add some dirty organic matter such as grass pieces or orange peels, a small amount of detergent, and a few drops of an ink or any colour.
- Cap the jar, shake it well and let the mixture stand in the sun for two days.
- After two days, shake the mixture and pour a small sample into test tube. Label this test tube “**Before**

treatment; Sample 1”. How does it smell?

- Use an aerator from an aquarium to bubble air through the sample in the glass jar. Allow several hours for aeration; leave the aerator attached overnight. If you do not have an aerator, use a mechanical stirrer or a mixer. You may have to stir it several times.
- The next day when aeration is complete, pour another sample into a second test tube. Label it as “**After aeration; Sample 2”.**
- Fold a piece of filter paper to form a cone. Wet the paper with tap water and then insert the cone in a funnel. Mount the funnel on a support (as you have learnt in Class VI).
- Place layers of sand, fine gravel and finally medium gravel in the funnel (Fig. 18.2). (An actual filtration plant does not use filter paper, but the sand filter is several metres deep).
- Pour the remaining aerated liquid through the filter into the beakers. Do not allow the liquid to spill over the filter. If the filtered liquid is not clear, filter it a few times till you get clear water.
- Pour a sample of the filtered water into a third test tube labelled “**Filtered; Sample 3”.**
- Pour another sample of the filtered water into a fourth test tube. Add a small piece of a chlorine tablet. Mix well until the water is clear. Label the test tube “**Chlorinated; Sample 4”.**



Fig. 18.2 Filtration process

- Observe carefully the samples in all the test tubes. **Do not taste!** Just smell them!

- Now answer the following questions:**
- What changes did you observe in the appearance of the liquid after aeration?
 - Did aeration change the odour?
 - What was removed by the sand filter?
 - Did chlorine remove the colour?
 - Did chlorine have an odour? Was it worse than that of the wastewater?

18.4 WASTEWATER TREATMENT PLANT (WWTP)

Treatment of wastewater involves physical, chemical, and biological processes, which remove physical, chemical and biological matter that contaminates the wastewater.

1. Wastewater is passed through bar screens. Large objects like rags, sticks, cans, plastic packets, napkins are removed (Fig. 18.3).



Fig. 18.3 Bar screen

2. Water then goes to a grit and sand removal tank. The speed of the incoming wastewater is decreased to allow sand, grit and pebbles to settle down (Fig. 18.4).



Fig. 18.4 Grit and sand removal tank

3. The water is then allowed to settle in a large tank which is sloped towards the middle. Solids like faeces settle at the bottom and are removed with a scraper. This is the **sludge**. A skimmer removes the floatable solids like oil and grease. Water so cleared is called clarified water (Fig. 18.5).



Fig. 18.5 Water clarifier

The sludge is transferred to a separate tank where it is decomposed by the anaerobic bacteria. The biogas produced in the process can be used as fuel or can be used to produce electricity.

4. Air is pumped into the clarified water to help aerobic bacteria to grow. Bacteria consume human waste, food waste, soaps and other unwanted matter still remaining in clarified water (Fig. 18.6).

After several hours, the suspended microbes settle at the bottom of the tank as activated sludge. The water is then removed from the top.



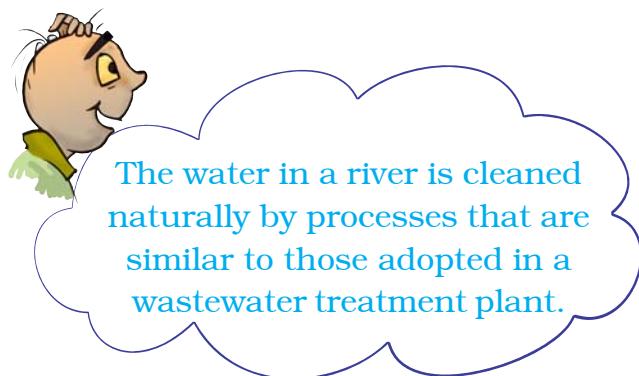
Fig. 18.6 Aerator

The activated sludge is about 97% water. The water is removed by sand drying beds or machines. Dried sludge is used as manure, returning organic matter and nutrients to the soil.

The treated water has a very low level of organic material and suspended matter. It is discharged into a sea, a river or into the ground. Nature cleans it up further. Sometimes it may be necessary to disinfect water with chemicals like chlorine and ozone before releasing it into the distribution system.

Become an active citizen

Waste generation is a natural part of human activity. But we can limit the type of waste and quantity of waste produced. Often we have been repelled by offensive smell. The sight of open drains is disgusting. The situation



Did you know ?

It has been suggested that we should plant eucalyptus trees all along sewage ponds. These trees absorb all surplus wastewater rapidly and release pure water vapour into the atmosphere.

worsens in the rainy season when the drains start overflowing. We have to wade through the mud pools on the roads. Most unhygienic and unsanitary conditions prevail. Flies, mosquitoes and other insects breed in it.

You can be an enlightened citizen and approach the municipality or the gram panchayat. Insist that the open drains be covered. If the sewage of any particular house makes the neighbourhood dirty, you should



request them to be more considerate about others' health.

18.6 BETTER HOUSE KEEPING PRACTICES

One of the ways to minimise or eliminate waste and pollutants at their source is to see what you are releasing down the drain.

- Cooking oil and fats should not be thrown down the drain. They can harden and block the pipes. In an open drain the fats clog the soil pores reducing its effectiveness in filtering water. Throw oil and fats in the dustbin.
- Chemicals like paints, solvents, insecticides, motor oil, medicines may kill microbes that help purify water. So do not throw them down the drain.

- Used tealeaves, solid food remains, soft toys, cotton, sanitary towels, etc. should also be thrown in the dustbin (Fig. 18.7). These wastes choke the



Fig. 18.7 Do not throw everything in the sink

drains. They do not allow free flow of oxygen. This hampers the degradation process.

18.7 SANITATION AND DISEASE

Poor sanitation and contaminated drinking water is the cause of a large number of diseases.

Let us look at our own country. A vast number of our people are still

Vermi-processing toilet

A design of a toilet in which humans excreta is treated by earthworms has been tested in India. It has been found to be a novel, low water-use toilet for safe processing of human waste. The operation of the toilet is very simple and hygienic. The human excreta is completely converted to vermi cakes — a resource much needed for soil.

without sewerage facilities. Where do they relieve themselves?

A very large fraction of our people defecates in the open, on dry riverbeds, on railway tracks, near fields and many a time directly in water. Untreated human excreta is a health hazard. It may cause water pollution and soil pollution. Both the surface water and groundwater get polluted. Groundwater is a source of water for wells, tubewells, springs and many rivers as you learnt in Chapter 16. Thus, it becomes the most common route for water borne diseases. They include cholera, typhoid, polio, meningitis, hepatitis and dysentery.

18.8 ALTERNATIVE ARRANGEMENT FOR SEWAGE DISPOSAL

To improve sanitation, low cost **onsite sewage** disposal systems are being encouraged. Examples are septic tanks, chemical toilets, composting pits. Septic tanks are suitable for places where there is no sewerage system, for hospitals,

isolated buildings or a cluster of 4 to 5 houses.

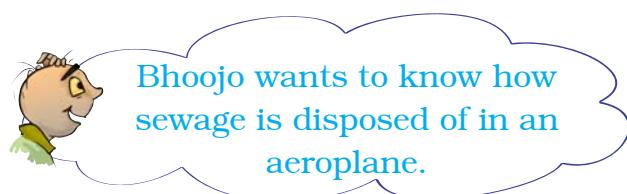
Some organisations offer hygienic on-site human waste disposal technology. These toilets do not require scavenging. Excreta from the toilet seats flow through covered drains into a biogas plant. The biogas produced is used as a source of energy.

18.9 SANITATION AT PUBLIC PLACES

In our country fairs are organised periodically. A large number of people participate in them. In the same way railway stations, bus depots, airports, hospitals are very busy places. Thousands of people visit them daily. Large amount of waste is generated here. It must be disposed of properly otherwise epidemics could break out.

The government has laid down certain standards of sanitation but, unfortunately, they are not strictly enforced.

However, all of us can contribute in maintaining sanitation at public places. We should not scatter litter anywhere. If there is no dustbin in sight, we should carry the litter home and throw it in the dustbin.



Conclusion

We all have a role to play in keeping our environment clean and healthy. You must realise your responsibility in maintaining the water sources in a healthy state. Adopting good sanitation practices should be our way of life. As an agent of change your individual initiative will make a great difference.

Influence others with your energy, ideas and optimism. A lot can be done if people work together. There is great power in collective action.

Mahatma Gandhi said:

"No one need to wait for anyone else to adopt a humane and enlightened course of action."

Keywords

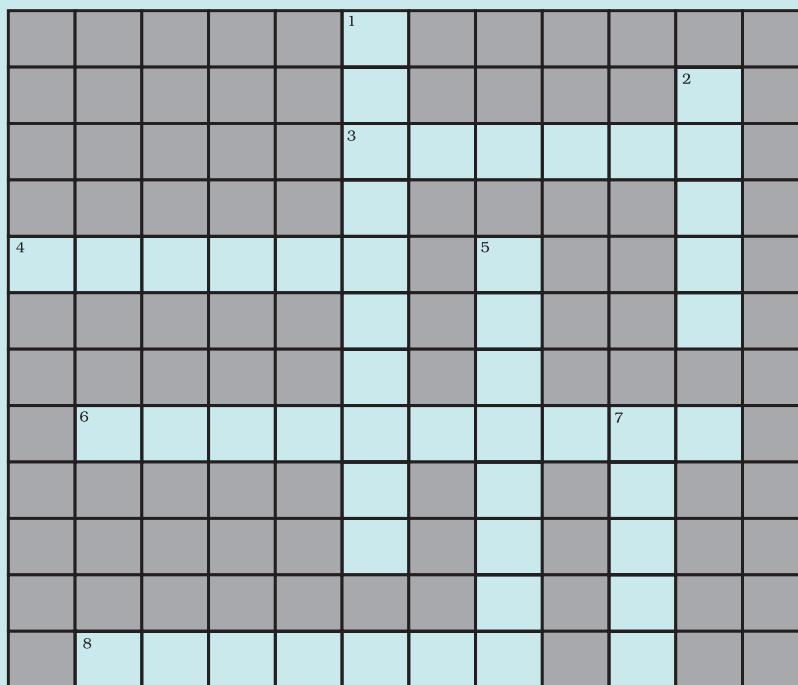
Aeration	Contaminant	Sewerage
Aerobic bacteria	Sanitation	Sludge
Anaerobic bacteria	Sewage	Wastewater
Biogas	Sewer	

What you have learnt

- Used water is wastewater. Wastewater could be reused.
- Wastewater is generated in homes, industries, agricultural fields and in other human activities. This is called sewage.
- Sewage is a liquid waste which causes water and soil pollution.
- Wastewater is treated in a sewage treatment plant.
- Treatment plants reduce pollutants in wastewater to a level where nature can take care of it.
- Where underground sewerage systems and refuse disposal systems are not available, the low cost on-site sanitation system can be adopted.
- By-products of wastewater treatment are sludge and biogas.
- Open drain system is a breeding place for flies, mosquitoes and organisms which cause diseases.
- We should not defecate in the open. It is possible to have safe disposal of excreta by low cost methods.

Exercises

1. Fill in the blanks:
 - (a) Cleaning of water is a process of removing _____.
 - (b) Wastewater released by houses is called _____.
 - (c) Dried _____ is used as manure.
 - (d) Drains get blocked by _____ and _____.
2. What is sewage? Explain why it is harmful to discharge untreated sewage into rivers or seas.
3. Why should oils and fats be not released in the drain? Explain.
4. Describe the steps involved in getting clarified water from wastewater.
5. What is sludge? Explain how it is treated.
6. Untreated human excreta is a health hazard. Explain.
7. Name two chemicals used to disinfect water.
8. Explain the function of bar screens in a wastewater treatment plant.
9. Explain the relationship between sanitation and disease.
10. Outline your role as an active citizen in relation to sanitation.
11. Here is a crossword puzzle: Good luck!



Across

3. Liquid waste products
4. Solid waste extracted in sewage treatment
6. A word related to hygiene
8. Waste matter discharged from human body

Down

1. Used water
 2. A pipe carrying sewage
 5. Micro-organisms which causes cholera
 7. A chemical to disinfect water
12. Study the following statements about ozone:
- (a) It is essential for breathing of living organisms.
 - (b) It is used to disinfect water.
 - (c) It absorbs ultraviolet rays.
 - (d) Its proportion in air is about 3%.

Which of these statements are correct?

- (i) (a), (b) and (c)
- (ii) (b) and (c)
- (iii) (a) and (d)
- (iv) All four

Extended Learning — Activities and Projects

1. Construct a crossword puzzle of your own using the keywords.
2. Then and now: Talk to your grand parents and other elderly people in the neighbourhood. Find out the sewage disposal systems available to them. You can also write letters to people living in far off places to get more information. Prepare a brief report on the information you collected.
3. Visit a sewage treatment plant.

It could be as exciting and enriching as a visit to a zoo, a museum, or a park. To guide your observation here are a few suggestions.

Record in your notepad:

Place _____ Date _____ Time _____

Name of the official at the plant _____ Guide/Teacher _____

- (a) The location of the sewage plant.
- (b) Treatment capacity.
- (c) The purpose of screening as the initial process.
- (d) How is air bubbled through the aeration tank?
- (e) How safe is the water at the end of the treatment? How is it tested?
- (f) Where is the water discharged after treatment?
- (g) What happens to the plant during heavy rains?
- (h) Is biogas consumed within the plant or sold to other consumers?
- (i) What happens to the treated sludge?
- (j) Is there any special effort to protect nearby houses from the plant?
- (k) Other observations.

For more information, consult:

Millennium Development Goals:

<http://www.un.org/millenniumgoals/>

“Water for Life” International Decade for Action:

<http://www.un.org/waterforlifedecade/>

World Water Day - Themes and Importance:

<http://www.worldwaterday.org/>

Through the ages Development of Sanitation:

<http://www.sewerhistory.org/>

<http://www.cep.unep.org/pubs/Techreports/tr43en/Household%20systems.htm>

“By providing clean water and sanitation to the poorest people on the planet, we can reduce poverty and suffering and ensure education for all children.” — UNICEF

An early engineering feat: Indus valley civilisation

One of the ancient civilisations, Harappa and Mohenjodaro had perhaps the world's first urban sanitation system. Within the city individual houses, or groups of houses, obtained water from wells. There was a separate room for bathing, and wastewater was directed to the covered drains which lined the major streets. The oldest toilet made of bricks is about 4500 years old.

We saw in Class VII that Paheli and Boojho had visited the forest along with Prof. Ahmad and Tibu. They were eager to share their experiences with their classmates. Other children in the class were also eager to share their experiences as some of them had visited Bharatpur Sanctuary. Some others had heard about Kaziranga National Park, Lockchao Wildlife Sanctuary, Great Nicobar Biosphere Reserve and Tiger Reserve, etc.



What is the purpose of making national parks, wildlife sanctuaries and biosphere reserves?

7.1 Deforestation and Its Causes

A great variety of plants and animals exists on earth. They are essential for the wellbeing and survival of mankind. Today, a major threat to survival of these organisms is **deforestation**. We know that deforestation means clearing of forests and using that land for other purposes. Trees in the forest are cut for some of the purposes mentioned below:

- Procuring land for cultivation.
- Building houses and factories.
- Making furniture or using wood as fuel.

Some natural causes of deforestation are forest fires and severe droughts.

Activity 7.1

Add more causes of deforestation to your list and classify them into natural and man-made.

7.2 Consequences of Deforestation

Paheli and Boojho recalled the consequences of deforestation. They remembered that deforestation increases the temperature and pollution level on the earth. It increases the level of carbon dioxide in the atmosphere. Ground water level also gets lowered. They know that deforestation disturbs the balance in nature. They were told by Prof. Ahmad that if cutting of trees continues, rainfall and the fertility of the soil will decrease.



How does deforestation reduce rainfall on the one hand and lead to floods on the other?

Moreover, there will be increased chances of natural calamities such as floods and droughts.

Recall that plants need carbon dioxide for photosynthesis. Fewer trees would mean that less carbon dioxide will be used up resulting in its increased

amount in the atmosphere. This will lead to global warming as carbon dioxide traps the heat rays reflected by the earth. The increase in temperature on the earth disturbs the water cycle and may reduce rainfall. This could cause **droughts**.

Deforestation is a major cause which leads to the change in soil properties. Physical properties of the soil get affected by plantation and vegetation. Recall from Class VII how trees prevent soil erosion. Fewer trees result in more soil erosion. Removal of the top layer of the soil exposes the lower, hard and rocky layers. This soil has less humus and is less fertile. Gradually the fertile land gets converted into deserts. It is called **desertification**.

Deforestation also leads to a decrease in the water holding capacity of the soil. The movement of water from the soil surface into the ground (infiltration rate) is reduced. So, there are floods. The other properties of the soil like nutrient content, texture, etc., also change because of deforestation.

We have studied in Class VII that we get many products from forests. List these products. Will we face the shortage of these products if we continue cutting trees?

Activity 7.2

Animal life is also affected by deforestation. How? List the points and discuss them in your class.

7.3 Conservation of Forest and Wildlife

Having become aware of the effects of deforestation, Paheli and Boojho are worried. They go to Prof. Ahmad and ask him how forests and wildlife can be saved.

Prof. Ahmad organises a visit to a biosphere reserve for Paheli, Boojho and their classmates. He selects a place named Pachmarhi Biosphere Reserve. He knows that the plants and animals found here are similar to those of the upper Himalayan peaks and to those belonging to the lower western ghats. Prof. Ahmad believes that the biodiversity found here is unique. He requests Madhavji, a forest employee, to guide the children inside the biosphere reserve. He explains that preserving areas of such biological importance make them a part of our national heritage.

Biosphere is that part of the earth in which living organisms exist or which supports life. Biological diversity or biodiversity, refers to the variety of organisms existing on the earth, their interrelationships and their relationship with the environment.

Madhavji explains to the children that apart from our personal efforts and efforts of the society, government agencies also take care of the forests and animals. The government lays down rules, methods and policies to protect and conserve them. Wildlife sanctuaries, national parks, biosphere reserves, etc., are protected areas for conservation of plants and animals present in that area.

To protect our flora and fauna and their habitats, **protected areas** called sanctuaries, national parks and biosphere reserves have been earmarked. Plantation, cultivation, grazing, felling trees, hunting and poaching are prohibited there.

Sanctuary : Areas where animals are protected from any disturbance to them and their habitat.

National Park : Areas reserved for wild life where they can freely use the habitats and natural resources.

Biosphere Reserve : Large areas of protected land for conservation of wild life, plant and animal resources and traditional life of the tribals living in the area.

Activity 7.3

Find out the number of national parks, wildlife sanctuaries and biosphere reserves in your district, state and country. Record in Table 7.1. Show these areas in an outline map of your state and India.

7.4 Biosphere Reserve

Children along with Prof. Ahmad and Madhavji enter the biosphere reserve area. Madhavji explains that **biosphere reserves** are the areas meant for conservation of biodiversity. As you are aware that biodiversity is the variety of plants, animals and microorganisms generally found in an area. The biosphere reserves help to maintain the biodiversity and culture of that area. A biosphere reserve may also contain other protected areas in it. The Pachmarhi Biosphere Reserve consists of one national park named Satpura and two wildlife sanctuaries named Bori and Pachmarhi (Fig. 7.1).

Table 7.1 : Protected areas for conservation.

Protected Areas —	National Park	Wildlife Sanctuary	Biosphere Reserve
In my district			
In my state			
In my country			



Fig. 7.1 : Pachmarhi Biosphere Reserve

Activity 7.4

List the factors disturbing the biodiversity of your area. Some of these factors and human activities may disturb the biodiversity unknowingly. List these human activities. How can these be checked? Discuss in your class and write a brief report in your notebook.

7.5 Flora and Fauna

As the children walk around the biosphere reserve they appreciate the green wealth of the forest. They are very happy to see tall teak trees and animals inside the forest. Suddenly, Paheli finds

a rabbit and wants to catch it. She starts running after it. Prof. Ahmad stops her. He explains that animals are comfortable and happy in their own habitat. We should not disturb them. Madhavji explains that some animals and plants typically belong to a particular area. The plants and animals found in a particular area are termed **flora** and **fauna** of that area.

Sal, teak, mango, jamun, silver ferns, arjun, etc are the flora and *chinkara, blue-bull, barking deer, cheetal, leopard, wild dog, wolf, etc.* are examples of the fauna of the Pachmarhi Biosphere Reserve (Fig. 7.2).

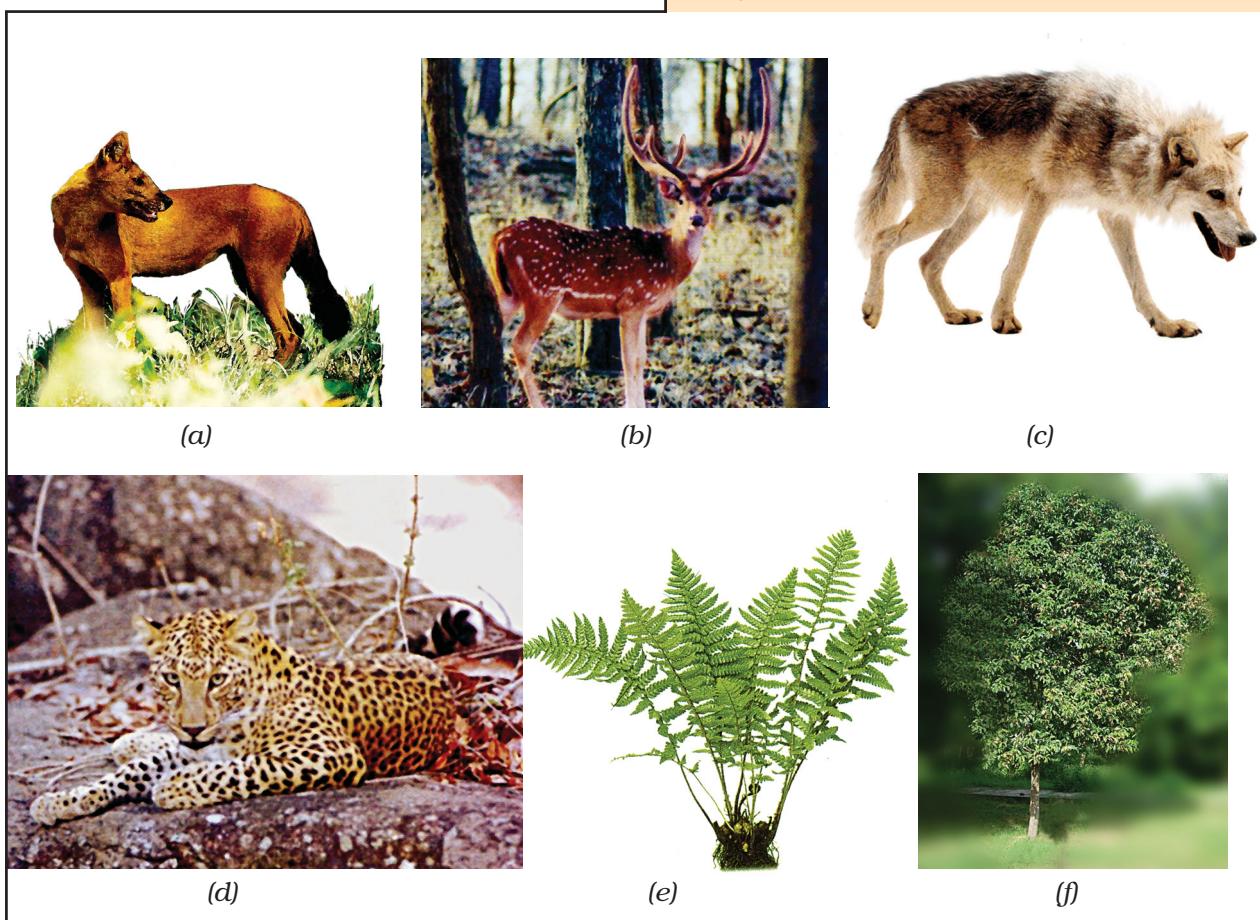


Fig. 7.2 : (a) Wild dog (b) Chital (c) Wolf (d) Leopard (e) Fern (f) Jamun

Activity 7.5

Try to identify the flora and fauna of your area and list them.

7.6 Endemic Species

Soon the group quietly enters the deep forest. Children are surprised to see a very big squirrel. This squirrel has a big fluffy tail. They are very curious to know about it. Madhavji tells them that this is known as the giant squirrel and is endemic to this area.

Endemic species are those species of plants and animals which are found exclusively in a particular area. They are not naturally found anywhere else. A particular type of animal or plant may be endemic to a zone, a state or a country.

Madhavji shows *sal* and wild mango (Fig. 7.3 (a)) as two examples of the



Fig. 7.3 : (a) Wild Mango



I have heard that some of the endemic species may vanish.
Is it true?

endemic flora of the Pachmarhi Biosphere Reserve. Bison, Indian giant squirrel [Fig. 7.3 (b)] and flying squirrel are endemic fauna of this area. Prof. Ahmad explains that the destruction of their habitat, increasing population and introduction of new species may affect the natural habitat of endemic species and endanger their existence.

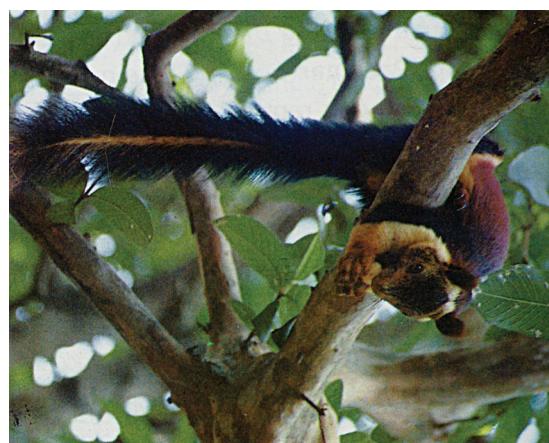


Fig. 7.3 : (b) Giant squirrel

Species is a group of populations which are capable of interbreeding. This means that the members of a species can reproduce fertile offspring only with the members of their own species and not with members of other species. Members of a species have common characteristics.

Activity 7.6

Find out the endemic plants and animals of the region where you live.

7.7 Wildlife Sanctuary

Soon Paheli sees a board with 'Pachmarhi Wildlife Sanctuary' written on it.

Prof. Ahmad explains that, like reserve forests, **wildlife sanctuaries** provide protection and suitable living conditions to wild animals. Madhavji further explains that sanctuaries are places where killing (poaching) or capturing of animals is strictly prohibited.

Some of the threatened wild animals like black buck, white eyed buck, elephant, golden cat, pink headed duck, *gharial*, marsh crocodile, python, rhinoceros, etc. are protected and preserved in our wild life sanctuaries. Indian sanctuaries have unique landscapes—broad level forests, mountain forests and bush lands in deltas of big rivers.

It is a pity that even protected forests are not safe because people living in the neighbourhood encroach upon them and destroy them.

Children are reminded of their visit to the zoo. They recall that zoos are also places where animals receive protection.



What is the difference between a zoo and a wildlife sanctuary?

Activity 7.7

Visit a nearby zoo. Observe the conditions provided to the animals. Were they suitable for the animals? Can animals live in artificial setting

instead of their natural habitat? In your opinion, will the animals be comfortable in a zoo or in their natural habitat?

7.8 National Park

On the roadside there was another board on which was written 'Satpura National Park'.

Children are now eager to go there. Madhavji tells them that these reserves are large and diverse enough to protect whole sets of ecosystems. They preserve flora, fauna, landscape and historic objects of an area. Satpura National Park is the first Reserve Forest of India. The finest Indian teak is found in this forest.

Rock shelters are also found inside the Satpura National Park. These are the prehistoric evidences of human life in these jungles. They give us an idea of the life of the primitive people. Rock paintings are found in these shelters. A total of 55 rock shelters have been identified in Pachmarhi Biosphere Reserve. Figures of animals and men fighting, hunting, dancing, and playing musical instruments are depicted in these paintings. Many tribals still live in the area.

As children move ahead, they see a board with 'Satpura Tiger Reserve' written on it. Madhavji explains that **Project Tiger** was launched by the government to protect the tigers in the country. The objective of this project was to ensure the survival and maintenance of the tiger population in the country.

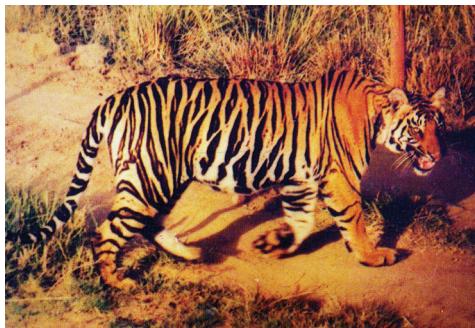


Fig. 7.4 : Tiger



Fig. 7.5 : Wild buffalo



Fig. 7.6 : Barasingha



Are tigers still found in this forest? I hope that I can see a tiger!

Tiger (Fig. 7.4) is one of the many species which are slowly disappearing from our forests. But, the Satpura Tiger Reserve is unique in the sense that a significant increase in the population of tigers has been seen here. Once upon a time, animals like lions, elephants, wild buffaloes (Fig. 7.5) and barasingha (Fig. 7.6) were also found in the Satpura National Park. Animals whose numbers are diminishing to a level that they might face extinction are known as the **endangered animals**. Boojho is reminded of the dinosaurs which became extinct a long time ago. Survival of some animals has become difficult because of disturbances in their natural habitat.

Are only big animals facing the extinction?



Madhavji tells Paheli that small animals are much more in danger of becoming extinct than the bigger animals. At times, we kill snakes, frogs, lizards, bats and owls ruthlessly without realising their importance in the ecosystem. By killing them we are harming ourselves. They might be small in size but their role in the ecosystem cannot be ignored. They form part of food chains and food webs, about which you learnt in Class VII.

An **ecosystem** is made of all the plants, animals and microorganisms in an area along with non-living components such as climate, soil, river deltas, etc.



I wonder if there is any record of the endangered species!

7.9 Red Data Book

Prof. Ahmad explains about Red Data Book to the children. He tells them that **Red Data Book** is the source book which keeps a record of all the endangered animals and plants. There

are different Red Data Books for plants, animals and other species. (For further details about Red Data Book, you can log on to www.wil.gov.in/envis/primates/page102htm/new/nwdc/plants.htm)

7.10 Migration

The excursion party then enters deeper into the forest under the guidance of Madhavji. They sit near the Tawa Reservoir to relax for some time. Paheli observes some of the birds near the river. Madhavji tells the children that these are the migratory birds. These birds have flown here from other parts of the world.

Migratory birds fly to far away areas every year during a particular time because of climatic changes. They fly for laying eggs as the weather in their natural habitat becomes very cold and inhospitable. Birds who cover long distances to reach another land are known as the migratory birds as Paheli learnt in Class VII.



What would happen if we had no wood? Is there any alternative available for wood?

I know that paper is one of the important products we get from forests.

I wonder whether there are any alternatives available for paper!

7.11 Recycling of Paper

Prof. Ahmad draws the attention of the children to another cause of deforestation. He tells them that it takes 17 full grown trees to make one tonne of paper. Therefore, we should save paper. Prof. Ahmad also tells that paper can be recycled five to seven times for use. If each student saves at least one sheet of paper in a day, we can save many trees in a year. We should save, reuse used paper and recycle it. By this we not only save trees but also save energy and water needed for manufacturing paper. Moreover, the amount of harmful chemicals used in paper making will also be reduced.



Is there any permanent solution to the problem of deforestation?

7.12 Reforestation

Prof. Ahmad suggests that the answer to deforestation is reforestation. Reforestation is restocking of the destroyed forests by planting new trees. The planted trees should generally be of the same species which were found in that forest. We should plant at least as many trees as we cut. Reforestation can take place naturally also. If the deforested area is left undisturbed, it re-establishes itself. In natural reforestation there is no role of human beings. We

have already made a tremendous damage to our forests. If we have to retain our green wealth for generations, plantation of more trees is the only option.

Prof. Ahmad told them that in India we have the Forest (Conservation) Act. This act is aimed at preservation and conservation of natural forests and

meeting the basic needs of the people living in or near the forests.

After some rest Madhavji asks children to start moving back because it is not advisable to stay back in the jungle after sunset. On getting back, Prof. Ahmad and the children thank Madhavji for guiding them through this exciting experience.

KEYWORDS

- BIODIVERSITY**
- BIOSPHERE RESERVE**
- DEFORESTATION**
- DESERTIFICATION**
- ECOSYSTEM**
- ENDANGERED SPECIES**
- ENDEMIC SPECIES**
- EXTINCT**
- FAUNA**
- FLORA**
- MIGRATORY BIRDS**
- NATIONAL PARK**
- RED DATA BOOK**
- REFORESTATION**
- SANCTUARY**

WHAT YOU HAVE LEARNT

- ⦿ Wildlife sanctuary, national park and biosphere reserve are names given to the areas meant for conservation and preservation of forest and wild animals.
- ⦿ Biodiversity refers to the variety of living organisms in a specific area.
- ⦿ Plants and animals of a particular area are known as the flora and fauna of that area.
- ⦿ Endemic species are found only in a particular area.
- ⦿ Endangered species are those which are facing the danger of extinction.
- ⦿ Red Data Book contains a record of the endangered species.
- ⦿ Migration is the phenomenon of movement of a species from its own habitat to some other habitat for a particular time period every year for a specific purpose like breeding.
- ⦿ We should save, reuse and recycle paper to save trees, energy and water.
- ⦿ Reforestation is the restocking of destroyed forests by planting new trees.

Exercises

1. Fill in the blanks:
 - (a) A place where animals are protected in their natural habitat is called _____.
 - (b) Species found only in a particular area is known as _____.
 - (c) Migratory birds fly to far away places because of _____ changes.
2. Differentiate between the following:
 - (a) Wildlife sanctuary and biosphere reserve
 - (b) Zoo and wildlife sanctuary
 - (c) Endangered and extinct species
 - (d) Flora and fauna

3. Discuss the effects of deforestation on the following:
 - (a) Wild animals
 - (b) Environment
 - (c) Villages (Rural areas)
 - (d) Cities (Urban areas)
 - (e) Earth
 - (f) The next generation
4. What will happen if:
 - (a) we go on cutting trees.
 - (b) the habitat of an animal is disturbed.
 - (c) the top layer of soil is exposed.
5. Answer in brief:
 - (a) Why should we conserve biodiversity?
 - (b) Protected forests are also not completely safe for wild animals. Why?
 - (c) Some tribals depend on the jungle. How?
 - (d) What are the causes and consequences of deforestation?
 - (e) What is Red Data Book?
 - (f) What do you understand by the term migration?
6. In order to meet the ever-increasing demand in factories and for shelter, trees are being continually cut. Is it justified to cut trees for such projects? Discuss and prepare a brief report.
7. How can you contribute to the maintenance of green wealth of your locality? Make a list of actions to be taken by you.
8. Explain how deforestation leads to reduced rainfall.
9. Find out the information about the national parks in your state. Identify and show their location on the outline map of India.
10. Why should paper be saved? Prepare a list of ways by which you can save paper.

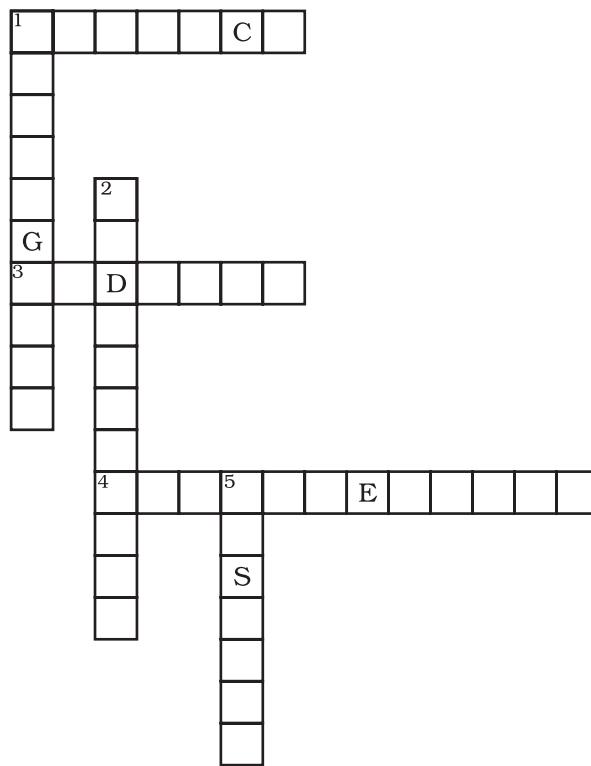
11. Complete the word puzzle:

Down

 1. Species on the verge of extinction.
 2. A book carrying information about endangered species.
 5. Consequence of deforestation.

Across

 1. Species which have vanished.
 3. Species found only in a particular habitat.
 4. Variety of plants, animals and microorganisms found in an area.



Extended Learning - Activities and Projects

1. Plant at least five different plants in your locality during this academic year and ensure their maintenance till they grow.
 2. Promise yourself that this year you will gift at least 5 plants to your friends and relatives on their achievements, or on occasions like birthdays. Ask your friends to take proper care of these gifted plants and encourage them to gift five plants to their friends on such occasions. At the end of the year count the plants that have been gifted through this chain.

3. Is it justifiable to prevent tribals from staying in the core area of the forest? Discuss the matter in your class and note down the points for and against the motion in your notebook.
4. Study the biodiversity of a park nearby. Prepare a detailed report with photographs and sketches of flora and fauna.
5. Make a list of the new information you have gathered from this chapter. Which information did you like the most and why?
6. Make a list of various uses of papers. Observe currency notes carefully. Do you find any difference between a currency paper and paper of your notebook? Find out where currency paper is made.
7. Karnataka Government had launched 'Project Elephant' to save Asian elephants in the state. Find out about this and other such campaigns launched to protect threatened species.

Did You Know?

1. India has more than half of the world's wild tigers, 65% of the Asian elephants, 85% of the great one-horned rhinoceros and 100% of the Asian lions.
2. India is sixth on a list of 12 mega-biodiversity countries in the world. It contains two of the 13 biodiversity hot spots of the world – North-East India and the Western Ghats. These areas are very rich in biodiversity.
3. One of the most important factors that threatens wildlife today is habitat destruction due to encroachment.
4. India contains 172 species of animals considered globally threatened or 2.9% of the world's total number of threatened species. This includes 53 species of mammals, 69 of birds, 23 of reptiles and 3 species of amphibians. India contains globally important populations of some of Asia's rarest animals such as the *Bengal fox*, *Marbled cat*, *Asiatic lion*, *Indian elephant*, *Asiatic wild ass*, *Indian rhinoceros*, *gaur*, *Wild asiatic water buffalo*, etc.

For knowing more, you may contact:

- Ministry of Environment and Forests, Govt. of India
Environment, Forest and Wildlife Department
Parivarayan Bhavan, CGO Complex, Block – B,
Lodhi Road, New Delhi – 110003,
Website : <http://envfor.nic.in>
- Project Tiger : www.kidsfortigers.org/raisingtigers/projecttiger.php
- Biodiversity Hotspots : www.biodiversityhotspots.org

Paheli and Boojho were very excited to hear the news that Taj Mahal in Agra is now one of the seven wonders of the world. But they were disappointed to hear that the beauty of this monument in white marble is being threatened by air pollution in the area surrounding the Taj. They were eager to know if something can be done to fight the air and water pollution.

We are all aware that our environment is not what it used to be. Our elders talk about the blue sky, clean water and fresh air that was available in their times. Now the media regularly reports on the falling quality of the environment. We ourselves feel the impact of the falling quality of air and water in our lives. The number of people suffering from diseases of the respiratory system, for example, is steadily rising.

We dread to imagine a time when clean air and water may no longer be available! You have learnt about the importance of air and water in your previous classes. In this chapter, we will study about the harmful changes taking place in our surroundings and their effects on our lives.

18.1 Air Pollution

We can survive for some time without food, but we cannot survive even for a few minutes without air. This simple fact tells us how important clean air is to us.

You already know that air consists of a mixture of gases. By volume, about 78% of this mixture is nitrogen and about 21% is oxygen. Carbon dioxide, argon, methane, ozone and water vapour are also present in very small quantities.

Activity 18.1

You may have covered your nose while passing a brick kiln emitting smoke or started coughing while walking on a busy road (Fig. 18.1). On the basis of your experience, compare the quality of air at the places given below:

- A park and a busy road.
- A residential area and an industrial area.
- A busy traffic intersection at different times of the day e.g. early morning, afternoon and evening.
- A village and a town.



Fig. 18.1 : A congested road in a city

One of your observations in the above activity could be the differences in the amount of smoke in the atmosphere. Do you know where the smoke could have come from? Addition of such substances to the atmosphere modifies it. When air is contaminated by unwanted substances which have a harmful effect on both the living and the non-living, it is referred to as **air pollution**.

18.2 How does Air Get Polluted?

The substances which contaminate the air are called **air pollutants**. Sometimes, such substances may come from natural sources like smoke and dust arising from forest fires or volcanic eruptions. Pollutants are also added to the atmosphere by human activities. The sources of air pollutants are factories (Fig. 18.2), power plants, automobile exhausts and burning of firewood and dung cakes.



Fig. 18.2 : Smoke from a factory

Activity 18.2

You might have read in the newspapers that respiratory problems amongst children are rising day by day. Conduct a survey of households in your neighbourhood and among friends to find out how many children are suffering from respiratory problems.

Many respiratory problems are caused by air pollution. Let us now try to find out the substances or pollutants which are present in the polluted air.

Have you noticed how rapidly the number of vehicles is increasing in our cities?

Vehicles produce high levels of pollutants like carbon monoxide, carbon dioxide, nitrogen oxides and smoke (Fig. 18.3). Carbon monoxide is produced from incomplete burning of fuels such as petrol and diesel. It is a poisonous gas. It reduces the oxygen-carrying capacity of the blood.



Fig. 18.3 : Air pollution due to automobiles

Do you know?

If the vehicles registered in Delhi are lined up one after the other, the total length would be nearly equal to the combined lengths of the two longest rivers in the world, Nile and Amazon!

Boojho remembers seeing a thick fog-like layer in the atmosphere, especially during winters. This is **smog** which is made up of smoke and fog. Smoke may contain oxides of nitrogen which combine with other air pollutants and fog to form smog. The smog causes breathing difficulties such as asthma, cough and wheezing in children.

Many industries are also responsible for causing air pollution. Petroleum refineries are a major source of gaseous pollutants like sulphur dioxide and nitrogen dioxide. Sulphur dioxide is produced by combustion of fuels like coal in power plants. It can cause respiratory problems, including permanent lung damage. You have already studied about the burning of fossil fuels in Chapter 5.

Other kinds of pollutants are **chlorofluorocarbons** (CFCs) which are used in refrigerators, air conditioners and aerosol sprays. CFCs damage the ozone layer of the atmosphere. Recall that the ozone layer protects us from harmful ultraviolet rays of the sun. Have you heard of the ozone hole? Try to find out about it. Thankfully, less harmful chemicals are now being used in place of CFCs.

In addition to the above mentioned gases, automobiles which burn diesel and petrol, also produce tiny particles which remain suspended in air for long periods (Fig. 18.3). They reduce visibility. When inhaled, they cause diseases. Such particles are also produced during industrial processes like steel making and mining. Power plants give out tiny ash particles which also pollute the atmosphere.

Activity 18.3

Prepare a table using the pollutants mentioned above. You may even add more data to the following Table.

Table 18.1

Air Pollutants	Sources	Effects

18.3 Case Study : The Taj Mahal

Over the past 2 decades, India's most famous tourist attraction, Taj Mahal located in Agra (Fig. 18.4), has become a matter of concern. Experts have warned that pollutants in air are discolouring its white marble. So, it is not only living organisms that get affected by polluted air but non-living things like buildings, monuments and statues also get affected.

The industries located in and around Agra like rubber processing, automobile, chemicals and especially the Mathura oil refinery, have been responsible for producing pollutants like sulphur dioxide and nitrogen dioxide. These gases react with the water vapour present in the atmosphere to form sulphuric acid and nitric acid. The acids drop down with rain, making the rain acidic. This is called **acid rain**. Acid rain corrodes the marble of the monument. The phenomenon is also called "Marble cancer". Suspended particulate matter, such as the soot particles emitted by Mathura oil refinery, has contributed towards yellowing of the marble.

The Supreme Court has taken several steps to save the Taj. It has

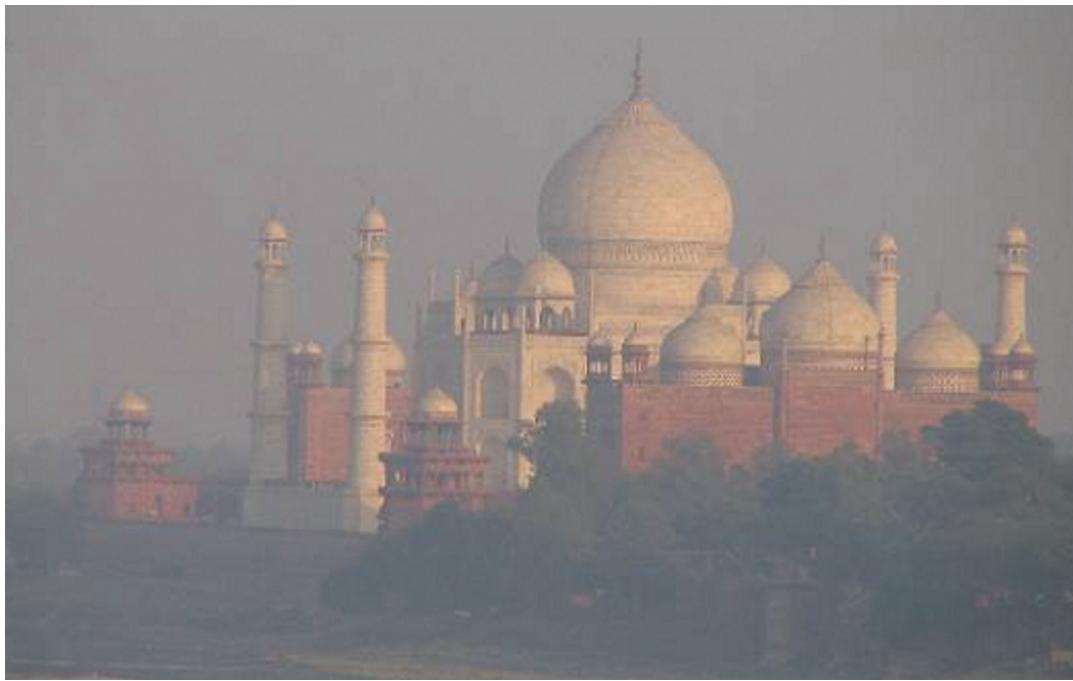


Fig. 18.4 : Taj Mahal

ordered the industries to switch to cleaner fuels like CNG (Compressed Natural Gas) and LPG (Liquefied Petroleum Gas). Moreover, the automobiles should switch over to unleaded petrol in the Taj zone.

Discuss with your elders and see what they have to say about the condition of the Taj, 20 or 30 years ago! Try to procure a picture of the Taj Mahal for your scrap book.



I am reminded of the chapter on crops. I wonder whether acid rain affects the soil and plants also.

18.4 Greenhouse Effect

You know that the sun's rays warm the earth's surface. A part of the radiation that falls on the earth is absorbed by it

and a part is reflected back into space. A part of the reflected radiation is trapped by the atmosphere. The trapped radiations further warm the earth. If you have seen a greenhouse in a nursery or elsewhere, recall that the sun's heat is allowed to get in but is not allowed to go out. The trapped heat warms the green house. The trapping of radiations by the earth's atmosphere is similar. That is why it is called the **greenhouse effect**. Without this process, life would not have been possible on the earth. But now it threatens life. CO_2 is one of the gases responsible for this effect.

You know that CO_2 is one of the components of air. You have also studied



But how does CO_2 content rise in the atmosphere and become excessive?

the role of carbon dioxide in plants. But if there is excess of CO₂ in the air, it acts as a pollutant.

Can you help Paheli find out the answer to her question?

On the one hand, CO₂ is continuously being released because of human activities. On the other hand, area under forests is decreasing. Plants utilise CO₂ from the atmosphere for photosynthesis, thereby decreasing the amount of CO₂ in the air. Deforestation leads to an increase in the amount of CO₂ in the air because the number of trees which consume CO₂ is reduced. Human activities, thus, contribute to the accumulation of CO₂ in the atmosphere. CO₂ traps heat and does not allow it to escape into space. As a result, the average temperature of the earth's atmosphere is gradually increasing. This is called **global warming**.

Other gases like methane, nitrous oxide and water vapour also contribute

Global Warming

A Serious Threat!

Global warming can cause sea levels to rise dramatically. In many places, coastal areas have already been flooded. Global warming could result in wide ranging effects on rainfall patterns, agriculture, forests, plants and animals. Majority of people living in regions which are threatened by global warming are in Asia. A recent climate change report gives us only a limited time to keep the greenhouse gases at the present level. Otherwise, the temperature may rise by more than 2 degrees Celsius by the end of the century, a level considered dangerous.

towards this effect. Like CO₂, they are also called **greenhouse gases**.

Global warming has become a major concern for governments worldwide. Many countries have reached an agreement to reduce the emission of greenhouse gases. The Kyoto Protocol is one such agreement.

Boojho is surprised to hear that an increase in the earth's temperature by even as little as 0.5 °C can have such a serious effect! Paheli tells him that she had read in the newspapers recently that the Gangotri glacier in the Himalayas has started melting because of global warming.

18.5 What can be Done?

What can we do to reduce air pollution?

There are many success stories in our fight against air pollution. For example, a few years ago, Delhi was one of the most polluted cities in the world. It was being choked by fumes released from automobiles running on diesel and petrol. A decision was taken to switch to fuels like CNG (Fig. 18.5) and



Fig. 18.5 : A public transport bus powered by CNG

unleaded petrol. These measures have resulted in cleaner air for the city. You might know of some other examples from your area regarding reduction of air pollution. Share these with your friends.

Do you know about the “Say no to crackers” campaign which was organised by children from many schools? This made a big difference to the air pollution levels around Diwali.

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.

Activity 18.4

You have various options of commuting to your school such as walking, going by bicycle, travelling by bus or other public transport, using a car individually, travelling by car pool. Discuss in your class the impact of each of these options on the quality of air.

Small contributions on our part can make a huge difference in the state of the environment. We can plant trees and nurture the ones already present in the neighbourhood. Do you know about Van Mahotsav, when lakhs of trees are planted in July every year (Fig. 18.6)?



Fig. 18.6 : Children planting saplings

Boojho and Paheli once happened to go to an area where some people were burning dry leaves. They started coughing because the entire area was full of smoke. Paheli thought it would be a better option to put them in a compost pit rather than burning. What do you think?

18.6 Water Pollution

In Class VII you learnt that water is a precious resource. Think and list the various activities in which we need water. We saw that water is becoming scarce due to increase in population, industries and agricultural activities. You have also studied how water becomes "dirty" after we use it for washing clothes, bathing, etc. This means that we are adding some materials to the water, which spoil its quality and change its smell and colour.

Whenever harmful substances such as sewage, toxic chemicals, silt, etc., get mixed with water, the water becomes polluted. The substances that pollute water are called **water pollutants**.

Activity 18.5

Try to collect samples of water from a tap, pond, river, well and lake. Pour each into separate glass containers. Compare these for smell, acidity and colour. Complete the following Table.

Table 18.2

	Smell	Acidity	Colour
Tap Water			
Pond Water			
River Water			
Well Water			
Lake Water			

18.7 How does Water Get Polluted?

Case Study

Ganga is one of the most famous rivers of India (Fig. 18.7). It sustains most of the northern, central and eastern Indian population. Millions of people depend on it for their daily needs and

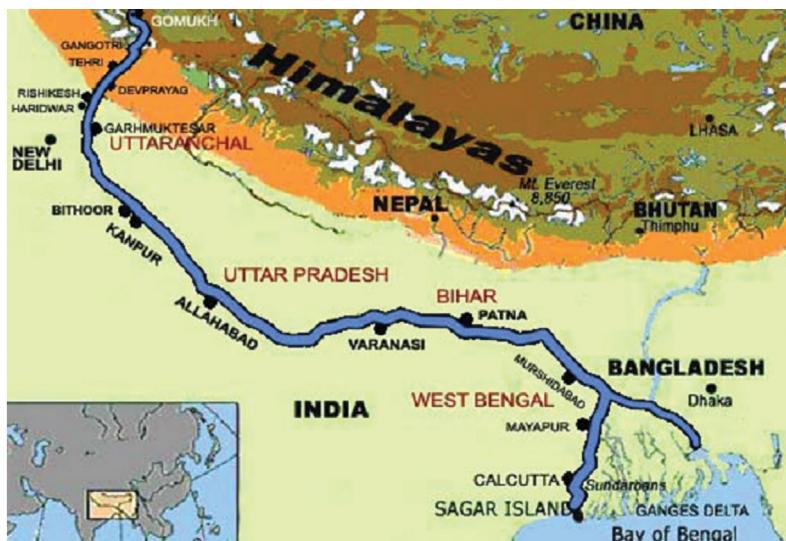


Fig. 18.7 : Course of the river Ganga

livelihood. However, recently a study by the World Wide Fund for Nature (WWF) found that Ganga is one of the ten most endangered rivers in the world. The pollution levels have been rising for many years. We have reached this stage because the towns and cities, through which the river flows, throw large quantities of garbage, untreated sewage, dead bodies, and many other harmful things, directly into the river. In fact the river is "dead" at many places where the pollution levels are so high that aquatic life cannot survive.

An ambitious plan to save the river, called the **Ganga Action Plan** was launched in 1985. It aimed to reduce the pollution levels in the river. However, the increasing population and industrialisation have already damaged this mighty river beyond repair.

Let us take a specific example to understand the situation. The Ganga at Kanpur in Uttar Pradesh (U.P.), has one of the most polluted stretches of the river (Fig. 18.8). Kanpur is one of the most populated towns in U.P. People can be seen bathing, washing clothes

and defecating in the river. They also throw garbage, flowers, idols of gods and goddesses and non-biodegradable polythene bags into the river.

At Kanpur the amount of water is comparatively small and the flow of the river is very slow. In addition, Kanpur has more than 5000 industries. These include fertiliser, detergent, leather and paint industries. These industrial units discharge toxic chemical wastes into the river.

Based on the above information think of the answers to the following questions :

- ➲ What are the factors responsible for pollution of the river ?
- ➲ What steps can be taken to restore the river Ganga to its past glory ?
- ➲ How would the disposal of garbage, etc., affect the living organisms in the river ?

Many industries discharge harmful chemicals into rivers and streams, causing the pollution of water (Fig. 18.9). Examples are oil refineries, paper factories, textile and sugar mills



Fig. 18.8 : A polluted stretch of the river Ganga



Fig. 18.9 : Industrial waste discharged into a river

and chemical factories. These industries cause chemical contamination of water. The chemicals released include arsenic, lead and fluorides which lead to toxicity in plants and animals. There are regulations to prevent this. Industries are supposed to treat the waste produced before discharging it into waters, but quite often the rules are not followed. The soil is also affected by impure water, causing changes in acidity, growth of worms, etc.

We have learnt in Chapter 1 the importance of pesticides and weedicides for the protection of crops. However, all these chemicals dissolve in water and are washed into water bodies from the fields. They also seep into the ground to pollute ground water.

Have you seen ponds which look green from a distance because they have a lot of algae growing in them? This is caused by excessive quantities of chemicals which get washed from the fields. These act as nutrients for algae to flourish. Once these algae die, they serve as food for decomposers like bacteria. A lot of oxygen in the water body gets used up. This results in a decrease in the oxygen level which may kill aquatic organisms.

Recall Activity 18.6

You had investigated the sewage disposal system of your locality in Class VII.

Do you remember how the sewage was collected from your home and where it went thereafter.

Sometimes untreated sewage is thrown directly into rivers. It contains

food wastes, detergents, microorganisms, etc. Can ground water get polluted by sewage? How? Water contaminated with sewage may contain bacteria, viruses, fungi and parasites which cause diseases like cholera, typhoid and jaundice.

The bacteria present in the faeces of mammals are indicators of the quality of water. If water has these bacteria, it means that it has been contaminated by fecal matter. If such water is used by us, it can cause various infections.

Do you know?

Hot water can also be a pollutant ! This is usually water from power plants and industries. It is released into the rivers. It raises the temperature of the waterbody, adversely affecting the animals and plants living in it.

18.8 What is Potable Water and How is Water Purified ?

Activity 18.7

Let us construct a water filter with simple, everyday materials.

Take a plastic bottle and cut it into 2 halves at the centre. Use the upper half as a funnel by putting it upside down in the lower half. Make layers in it with paper napkin or a fine cloth followed by, cotton, sand and then gravel. Now pour dirty water through the filter and observe the filtered water.

Discuss the following questions amongst yourselves and with your teacher:

- ➲ Why do we need to filter water before drinking ?
- ➲ Where do you get your drinking water from?
- ➲ What will happen if we drink polluted water?

Boojho is very upset. He tells Paheli that he drank water which looked clear and was without any smell, but still he fell sick !

Paheli explains that water which looks clean may still have disease-carrying microorganisms and dissolved impurities. So, it is essential to purify water before drinking, for example, by boiling.

Water which is suitable for drinking is called **potable water**. You have seen how various physical and chemical processes in the sewage treatment plants help to clean water before discharging it into water bodies. Similarly, municipal bodies treat the water before supplying it to households.

Do you know?

25% of the world's population is without safe drinking water !

Let us see how water can be made safe for drinking:

- ➲ You have already seen how water is filtered. This is a physical method of removing impurities. A popular household filter is a candle type filter.
- ➲ Many households use boiling as a method for obtaining safe drinking

water. Boiling kills the germs present in the water.

- ➲ Chlorination is a commonly used chemical method for purifying water. It is done by adding chlorine tablets or bleaching powder to the water. **We must be cautious. We should not use more chlorine tablets than specified.**

18.9 What can be Done?

Activity 18.8

Investigate the level of awareness about water pollution in your area. Collect data on the sources of drinking water and the methods of sewage disposal.

What are the common water-borne diseases in the community? You can consult your local doctor/health worker for this.

Which are the governmental and non-governmental organisations working in this field? What are the measures being taken by them for generating awareness?

Laws for industrial units should be strictly implemented so that polluted water is not disposed off directly into rivers and lakes. Water treatment plants should be installed in all industrial areas (Fig. 18.10). At our individual levels we should consciously save water and not waste it. **Reduce, reuse and recycle** should be our mantra !

Think of your daily routine – How can you save water?

We can think of creative ideas like reusing water used for washing and for other household tasks. For example,



Fig. 18.10 : Water treatment plant

water used for washing vegetables may be used to water plants in the garden.

Pollution is no longer a distant phenomenon. It is affecting the quality

of our daily lives. Unless we all realise our responsibility and start using environment-friendly processes, the very survival of our planet is in danger.

Do you know?

While brushing your teeth, leaving the tap running may waste several litres of water. A tap that drips once every second wastes a few thousand litres of water every year. Think about it !

KEYWORDS

ACID RAIN

AIR POLLUTION

CHEMICAL

CONTAMINATION

GLOBAL WARMING

**GREENHOUSE
EFFECT**

POLLUTANTS

POTABLE WATER

WATER POLLUTION

WHAT YOU HAVE LEARNT

- ➲ Air pollution is the contamination of air by impurities which may have a harmful impact on the living organisms and the non-living components.
- ➲ Pollutants are the substances which contaminate air and water.
- ➲ Carbon monoxide, nitrogen oxides, carbon dioxide, methane and sulphur dioxide are the major pollutants of air.
- ➲ Increasing levels of greenhouse gases like CO₂ are leading to global warming.
- ➲ Water pollution is the contamination of water by substances harmful to life.
- ➲ Sewage, agricultural chemicals and industrial waste are some of the major contaminants of water.
- ➲ Water which is purified and fit for drinking is known as potable water.
- ➲ Water is a precious natural resource. We must learn to conserve it.

Exercises

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. Prepare a brief speech on global warming that you have to make in your class.
 10. Describe the threat to the beauty of the Taj Mahal.
 11. Why does the increased level of nutrients in the water affect the survival of aquatic organisms?

Extended Learning — Activities and Projects

1. In some cities, a pollution check has been made compulsory for vehicles. Visit a petrol pump in order to learn about the process of conducting a pollution check. You may systematically record your findings in the following areas:
 - ⌚ Average number of vehicles checked per month.
 - ⌚ Time taken to check each vehicle.
 - ⌚ Pollutants checked for.
 - ⌚ The process of testing.
 - ⌚ Permissible levels of emission of various gases.
 - ⌚ Measures taken if the emitted gases are above the permissible limits.
 - ⌚ How frequently is a pollution check required ?
2. Conduct a survey in your school to investigate various environment related activities that have been undertaken. The class can divide itself into two groups, with each group looking at a different area. For example, one group can find out whether there is an environment club in the school. What are its objectives ? What is its calendar of events ? How can you become a member ?
If your school does not have such a club, you can even think of starting one along with a few of your friends.
3. Organise a field visit to a river in or around your town with the help of your teachers.

Observations followed by discussion could focus on :

- ⇒ The history of the river.
 - ⇒ Cultural traditions.
 - ⇒ Role of the river in meeting the town's water needs.
 - ⇒ Pollution concerns.
 - ⇒ Sources of pollution.
 - ⇒ Effects of pollution on the people living by the riverside as well as those living far away.
4. Find out with the help of your teachers and the internet (if possible), whether there are any international agreements to control global warming. Which are the gases covered under these agreements?
- www.edugreen.teri.res.in/explore/air/air.htm
 - www.edugreen.teri.res.in/explore/water/pollu.htm
 - www.cpcb.nic.in/citizen's%Charter/default_citizen's.html
 - coe.mse.ac.in/kidswater.asp
 - coe.mse.ac.in/kidsair.asp

Chapter 14

NATURAL RESOURCES

Our planet, Earth is the only one on which life, as we know it, exists. Life on Earth is dependent on many factors. Most life-forms we know need an ambient temperature, water, and food. The resources available on the Earth and the energy from the Sun are necessary to meet the basic requirements of all life-forms on the Earth.

What are these resources on the Earth?

These are the land, the water and the air. The outer crust of the Earth is called the lithosphere. Water covers 75% of the Earth's surface. It is also found underground. These comprise the hydrosphere. The air that covers the whole of the Earth like a blanket, is called the atmosphere. Living things are found where these three exist. This life-supporting zone of the Earth where the atmosphere, the hydrosphere and the lithosphere interact and make life possible, is known as the biosphere.

Living things constitute the biotic component of the biosphere. The air, the water and the soil form the non-living or abiotic component of the biosphere. Let us study these abiotic components in detail in order to understand their role in sustaining life on Earth.

14.1 The Breath of Life: Air

We have already talked about the composition of air in the first chapter. It is a mixture of many gases like nitrogen, oxygen, carbon dioxide and water vapour. It is interesting to note that even the composition of air is the result of life on Earth. In planets such as Venus and Mars, where no life is known to exist, the major component of the atmosphere is found to be carbon dioxide. In fact, carbon

dioxide constitutes up to 95-97% of the atmosphere on Venus and Mars.

Eukaryotic cells and many prokaryotic cells, discussed in Chapter 5, need oxygen to break down glucose molecules and get energy for their activities. This results in the production of carbon dioxide. Another process which results in the consumption of oxygen and the concomitant production of carbon dioxide is combustion. This includes not just human activities, which burn fuels to get energy, but also forest fires.

Despite this, the percentage of carbon dioxide in our atmosphere is a mere fraction of a percent because carbon dioxide is 'fixed' in two ways: (i) Green plants convert carbon dioxide into glucose in the presence of Sunlight and (ii) many marine animals use carbonates dissolved in sea-water to make their shells.

14.1.1 THE ROLE OF THE ATMOSPHERE IN CLIMATE CONTROL

We have talked of the atmosphere covering the Earth, like a blanket. We know that air is a bad conductor of heat. The atmosphere keeps the average temperature of the Earth fairly steady during the day and even during the course of the whole year. The atmosphere prevents the sudden increase in temperature during the daylight hours. And during the night, it slows down the escape of heat into outer space. Think of the moon, which is about the same distance from the Sun that the Earth is. Despite that, on the surface of the moon, with no atmosphere, the temperature ranges from -190° C to 110° C.

Activity 14.1

- Measure the temperature of the following :
Take (i) a beaker full of water, (ii) a beaker full of soil/sand and (iii) a closed bottle containing a thermometer. Keep them in bright Sunlight for three hours. Now measure the temperature of all 3 vessels. Also, take the temperature reading in shade at the same time.

Now answer

- Is the temperature reading more in activity (i) or (ii)?
- Based on the above finding, which would become hot faster – the land or the sea?
- Is the thermometer reading of the temperature of air (in shade) the same as the temperature of sand or water? What do you think is the reason for this? And why does the temperature have to be measured in the shade?
- Is the temperature of air in the closed glass vessel/bottle the same as the temperature taken in open air? (i) What do you think is the reason for this? (ii) Do we ever come across this phenomenon in daily life?

As we have seen above, sand and water do not heat up at the same rate. What do you think will be their rates of cooling? Can we think of an experiment to test the prediction?

14.1.2 THE MOVEMENT OF AIR: WINDS

We have all felt the relief brought by cool evening breezes after a hot day. And sometimes, we are lucky enough to get rains after some days of really hot weather. What causes the movement of air, and what decides whether this movement will be in the form of a gentle breeze, a strong wind or a terrible storm? What brings us the welcome rains?

All these phenomena are the result of changes that take place in our atmosphere due to the heating of air and the formation of water vapour. Water vapour is formed due to

the heating of water bodies and the activities of living organisms. The atmosphere can be heated from below by the radiation that is reflected back or re-radiated by the land or water bodies. On being heated, convection currents are set up in the air. In order to gain some understanding of the nature of convection currents, let us perform the following activity:

Activity 14.2

- Place a candle in a beaker or wide-mouthed bottle and light it. Light an incense stick and take it to the mouth of the above bottle (Figure 14.1).
- Which way does the smoke flow when the incense stick is kept near the edge of the mouth?
- Which way does the smoke flow when the incense stick is kept a little above the candle?
- Which way does the smoke flow when the incense stick is kept in other regions?

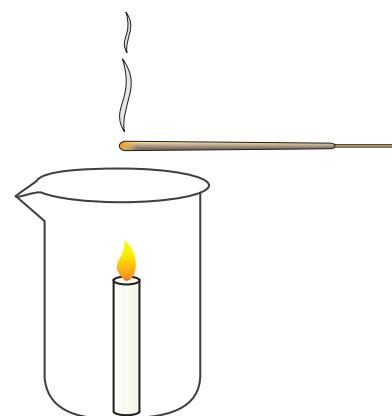


Fig. 14.1: Air currents being caused by the uneven heating of air.

The patterns revealed by the smoke show us the directions in which hot and cold air move. In a similar manner, when air is heated by radiation from the heated land or water, it rises. But since land gets heated faster than water, the air over land would also be heated faster than the air over water bodies.

So, if we look at the situation in coastal regions during the day, the air above the land

gets heated faster and starts rising. As this air rises, a region of low pressure is created and air over the sea moves into this area of low pressure. The movement of air from one region to the other creates winds. During the day, the direction of the wind would be from the sea to the land.

At night, both land and sea start to cool. Since water cools down slower than the land, the air above water would be warmer than the air above land.

On the basis of the above discussion, what can you say about:

1. the appearance of areas of low and high pressure in coastal areas at night?
2. the direction in which air would flow at night in coastal areas?

Similarly, all the movements of air resulting in diverse atmospheric phenomena are caused by the uneven heating of the atmosphere in different regions of the Earth. But various other factors also influence these winds – the rotation of the Earth and the presence of mountain ranges in the paths of the wind are a couple of these factors. We will not go into these factors in detail in this chapter, but think about this: how do the presence of the Himalayas change the flow of a wind blowing from Allahabad towards the north?

14.1.3 RAIN

Let us go back now to the question of how clouds are formed and bring us rain. We could start by doing a simple experiment which demonstrates some of the factors influencing these climatic changes.

Activity 14.3

- Take an empty bottle of the sort in which bottled water is sold. Pour about 5–10 mL of water into it and close the bottle tightly. Shake it well or leave it out in the Sun for ten minutes. This causes the air in the bottle to be saturated with water vapour.
- Now, take a lighted incense stick. Open the cap of the bottle and allow some of the smoke from the incense stick to

enter the bottle. Quickly close the bottle once more. Make sure that the cap is fitting tightly. Press the bottle hard between your hands and crush it as much as possible. Wait for a few seconds and release the bottle. Again press the bottle as hard as you can.

Now answer

1. *When did you observe that the air inside seemed to become ‘foggy’?*
2. *When does this fog disappear?*
3. *When is the pressure inside the bottle higher?*
4. *Is the ‘fog’ observed when the pressure in the bottle is high or when it is low?*
5. *What is the need for smoke particles inside the bottle for this experiment?*
6. *What might happen if you do the experiment without the smoke from the incense stick? Now try it and check if the prediction was correct. What might be happening in the above experiment in the absence of smoke particles?*

The above experiment replicates, on a very small scale, what happens when air with a very high content of water vapour goes from a region of high pressure to a region of low pressure or vice versa.

When water bodies are heated during the day, a large amount of water evaporates and goes into the air. Some amount of water vapour also gets into the atmosphere because of various biological activities. This air also gets heated. The hot air rises up carrying the water vapour with it. As the air rises, it expands and cools. This cooling causes the water vapour in the air to condense in the form of tiny droplets. This condensation of water is facilitated if some particles could act as the ‘nucleus’ for these drops to form around. Normally dust and other suspended particles in the air perform this function.

Once the water droplets are formed, they grow bigger by the ‘condensation’ of these water droplets. When the drops have grown big and heavy, they fall down in the form of rain. Sometimes, when the temperature of air

is low enough, precipitation may occur in the form of snow, sleet or hail.

Rainfall patterns are decided by the prevailing wind patterns. In large parts of India, rains are mostly brought by the south-west or north-east monsoons. We have also heard weather reports that say 'depressions' in the Bay of Bengal have caused rains in some areas (Figure 14.2).



Fig. 14.2: Satellite picture showing clouds over India.

Activity _____ 14.4

- Collect information from newspapers or weather reports on television about rainfall patterns across the country. Also find out how to construct a rain-gauge and make one. What precautions are necessary in order to get reliable data from this rain-gauge? Now answer the following questions :
 - In which month did your city/town/village get the maximum rainfall?
 - In which month did your state/union territory get the maximum rainfall?
 - Is rain always accompanied by thunder and lightning? If not, in which season do you get more of thunder and lightning with the rain?

Activity _____ 14.5

- Find out more about monsoons and cyclones from the library. Try and find out the rainfall pattern of any other country. Is the monsoon responsible for rains the world over?

14.1.4 AIR POLLUTION

We keep hearing of the increasing levels of oxides of nitrogen and sulphur in the news. People often bemoan the fact that the quality of air has gone down since their childhood. How is the quality of air affected and how does this change in quality affect us and other life forms?

The fossil fuels like coal and petroleum contain small amounts of nitrogen and sulphur. When these fuels are burnt, nitrogen and sulphur too are burnt and this produces different oxides of nitrogen and sulphur. Not only is the inhalation of these gases dangerous, they also dissolve in rain to give rise to acid rain. The combustion of fossil fuels also increases the amount of suspended particles in air. These suspended particles could be unburnt carbon particles or substances called hydrocarbons. Presence of high levels of all these pollutants cause visibility to be lowered, especially in cold weather when water also condenses out of air. This is known as smog and is a visible indication of air pollution. Studies have shown that regularly breathing air that contains any of these substances increases the incidence of allergies, cancer and heart diseases. An increase in the content of these harmful substances in air is called air pollution.

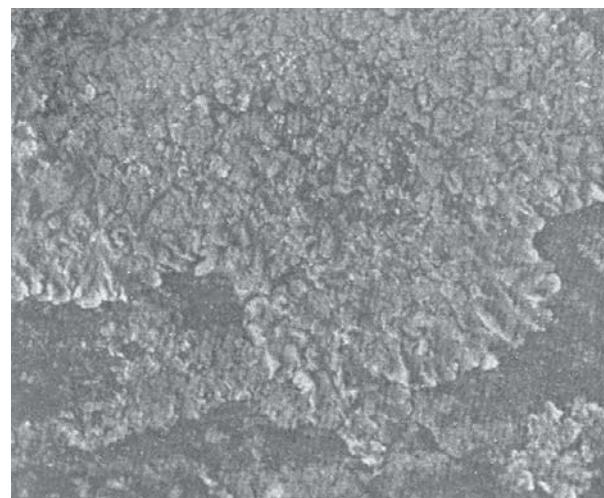


Fig. 14.3: Lichen

Activity 14.6

- Organisms called lichens are found to be very sensitive to the levels of contaminants like sulphur dioxide in the air. As discussed earlier in section 7.3.3, lichens can be commonly found growing on the barks of trees as a thin greenish-white crust. See if you can find lichen growing on the trees in your locality.
- Compare the lichen on trees near busy roads and trees some distance away. On the trees near roads, compare the incidence of lichen on the side facing the road and on the side away from the road.

What can you say about the levels of polluting substances near roads and away from roads on the basis of your findings above?



Questions

- How is our atmosphere different from the atmospheres on Venus and Mars?
- How does the atmosphere act as a blanket?
- What causes winds?
- How are clouds formed?
- List any three human activities that you think would lead to air pollution.

14.2 Water: A Wonder Liquid

Water occupies a very large area of the Earth's surface and is also found underground. Some amount of water exists in the form of water vapour in the atmosphere. Most of the water on Earth's surface is found in seas and oceans and is saline. Fresh water is found frozen in the ice-caps at the two poles and on snow-covered mountains. The underground water and the water in rivers, lakes and ponds is also fresh. However, the availability of fresh water varies from place to place. Practically every summer, most places have to face a shortage of water. And in rural areas, where water supply systems have not been installed,

people are forced to spend considerable amounts of time in fetching water from far-away sources.

Activity 14.7

- Many municipal corporations are trying water-harvesting techniques to improve the availability of water.
- Find out what these techniques are and how they would increase the water that is available for use.

But why is water so necessary? And do all organisms require water? All cellular processes take place in a water medium. All the reactions that take place within our body and within the cells occur between substances that are dissolved in water. Substances are also transported from one part of the body to the other in a dissolved form. Hence, organisms need to maintain the level of water within their bodies in order to stay alive. Terrestrial life-forms require fresh water for this because their bodies cannot tolerate or get rid of the high amounts of dissolved salts in saline water. Thus, water sources need to be easily accessible for animals and plants to survive on land.

Activity 14.8

- Select a small area (say, 1 m²) near a water-body, it may be a river, stream, lake or pond. Count the number of different animals and plants in this area. Also, check the number of individuals of each type or species.
- Compare this with the number of individuals (both animals and plants) found in an area of the same size in a dry, rocky region.
- Is the variety of plant and animal life the same in both these areas?

Activity 14.9

- Select and mark out a small area (about 1 m²) in some unused land in or near your school.
- As in the above activity, count the number of different animals and plants in this area and the number of individuals of each species.

- Remember to do this in the same place twice in a year, once during summer or the dry season and once after it has rained.

Now answer

- Were the numbers similar both times?*
- In which season did you find more variety of plants and animals?*
- In which season did you find more number of individuals of each variety?*

After compiling the results of the above two activities, think if there is any relationship between the amount of available water and the number and variety of plants and animals that can live in a given area. If there is a relationship, where do you think you would find a greater variety and abundance of life – in a region that receives 5 cm of rainfall in a year or a region that receives 200 cm of rainfall in a year? Find the map showing rainfall patterns in the atlas and predict which States in India would have the maximum biodiversity and which would have the least. Can we think of any way of checking whether the prediction is correct?

The availability of water decides not only the number of individuals of each species that are able to survive in a particular area, but it also decides the diversity of life there. Of course, the availability of water is not the only factor that decides the sustainability of life in a region. Other factors like the temperature and nature of soil also matter. But water is one of the major resources which determine life on land.

14.2.1 WATER POLLUTION

Water dissolves the fertilisers and pesticides that we use on our farms. So some percentage of these substances are washed into the water bodies. Sewage from our towns and cities and the waste from factories are also dumped into rivers or lakes. Specific industries also use water for cooling in various operations and later return this hot water to water-bodies. Another manner in which the temperature of

the water in rivers can be affected is when water is released from dams. The water inside the deep reservoir would be colder than the water at the surface which gets heated by the Sun.

All this can affect the life-forms that are found in these water bodies in various ways. It can encourage the growth of some life-forms and harm some other life-forms. This affects the balance between various organisms which had been established in that system. So we use the term water-pollution to cover the following effects:

- The addition of undesirable substances to water-bodies. These substances could be the fertilisers and pesticides used in farming or they could be poisonous substances, like mercury salts which are used by paper-industries. These could also be disease-causing organisms, like the bacteria which cause cholera.
- The removal of desirable substances from water-bodies. Dissolved oxygen is used by the animals and plants that live in water. Any change that reduces the amount of this dissolved oxygen would adversely affect these aquatic organisms. Other nutrients could also be depleted from the water bodies.
- A change in temperature. Aquatic organisms are used to a certain range of temperature in the water-body where they live, and a sudden marked change in this temperature would be dangerous for them or affect their breeding. The eggs and larvae of various animals are particularly susceptible to temperature changes.

Questions

- Why do organisms need water?*
- What is the major source of fresh water in the city/town/village where you live?*
- Do you know of any activity which may be polluting this water source?*

14.3 Mineral Riches in the Soil

Soil is an important resource that decides the diversity of life in an area. But what is the soil and how is it formed? The outermost layer of our Earth is called the crust and the minerals found in this layer supply a variety of nutrients to life-forms. But these minerals will not be available to the organisms if the minerals are bound up in huge rocks. Over long periods of time, thousands and millions of years, the rocks at or near the surface of the Earth are broken down by various physical, chemical and some biological processes. The end product of this breaking down is the fine particles of soil. But what are the factors or processes that make soil?

- The Sun: The Sun heats up rocks during the day so that they expand. At night, these rocks cool down and contract. Since all parts of the rock do not expand and contract at the same rate, this results in the formation of cracks and ultimately the huge rocks break up into smaller pieces.
- Water: Water helps in the formation of soil in two ways. One, water could get into the cracks in the rocks formed due to uneven heating by the Sun. If this water later freezes, it would cause the cracks to widen. Can you think why this should be so? Two, flowing water wears away even hard rock over long periods of time. Fast flowing water often carries big and small particles of rock downstream. These rocks rub against other rocks and the resultant abrasion causes the rocks to wear down into smaller and smaller particles. The water then takes these particles along with it and deposits it further down its path. Soil is thus found in places far away from its parent-rock.
- Wind: In a process similar to the way in which water rubs against rocks and wears them down, strong winds also erode rocks down. The wind also

carries sand from one place to the other like water does.

- Living organisms also influence the formation of soil. The lichen that we read about earlier, also grows on the surface of rocks. While growing, they release certain substances that cause the rock surface to powder down and form a thin layer of soil. Other small plants like moss, are able to grow on this surface now and they cause the rock to break up further. The roots of big trees sometimes go into cracks in the rocks and as the roots grow bigger, the crack is forced bigger.

Activity 14.10

- Take some soil and put it into a beaker containing water. The water should be at least five times the amount of soil taken. Stir the soil and water vigorously and allow the soil to settle down. Observe after some time.
Is the soil at the bottom of the beaker homogenous or have layers formed?
If layers have formed, how is one layer different from another?
Is there anything floating on the surface of the water?
Do you think some substances would have dissolved in the water? How would you check?

As you have seen, soil is a mixture. It contains small particles of rock (of different sizes). It also contains bits of decayed living organisms which is called humus. In addition, soil also contains various forms of microscopic life. The type of soil is decided by the average size of particles found in it and the quality of the soil is decided by the amount of humus and the microscopic organisms found in it. Humus is a major factor in deciding the soil structure because it causes the soil to become more porous and allows water and air to penetrate deep underground. The mineral nutrients that are found in a particular soil depends on the rocks it was formed from. The nutrient content of a soil, the amount of humus present in it and the depth of the soil are

some of the factors that decide which plants will thrive on that soil. Thus, the topmost layer of the soil that contains humus and living organisms in addition to the soil particles is called the topsoil. The quality of the topsoil is an important factor that decides biodiversity in that area.

Modern farming practices involve the use of large amounts of fertilizers and pesticides. Use of these substances over long periods of time can destroy the soil structure by killing the soil micro-organisms that recycle nutrients in the soil. It also kills the Earthworms which are instrumental in making the rich humus. Fertile soil can quickly be turned barren if sustainable practices are not followed. Removal of useful components from the soil and addition of other substances, which adversely affect the fertility of the soil and kill the diversity of organisms that live in it, is called soil pollution.

The soil that we see today in one place has been created over a very long period of time. However, some of the factors that created the soil in the first place and brought the soil to that place may be responsible for the removal of the soil too. The fine particles of soil may be carried away by flowing water or wind. If all the soil gets washed away and the rocks underneath are exposed, we have lost a valuable resource because very little will grow on the rock.

Activity 14.11

- Take two identical trays and fill them with soil. Plant mustard or green gram or paddy in one of the trays and water both the trays regularly for a few days, till the first tray is covered by plant growth. Now, tilt both the trays and fix them in that position. Make sure that both the trays are tilted at the same angle. Pour equal amount of water gently on both trays such that the water flows out of the trays (Fig. 14.4).
- Study the amount of soil that is carried out of the trays. Is the amount the same in both the trays?
- Now pour equal amounts of water on both the trays from a height. Pour three or four times the amount that you poured earlier.

- Study the amount of soil that is carried out of the trays now. Is the amount the same in both the trays? Is the amount of soil that is carried out more or less or equal to the amount washed out earlier?

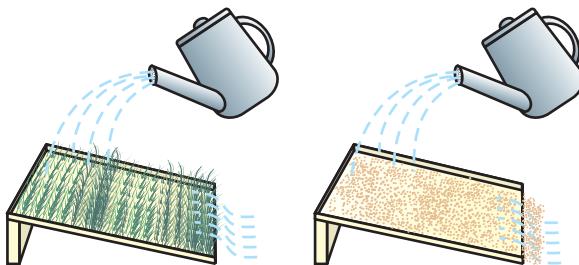


Fig. 14.4: Effect of flowing water on the top-soil

The roots of plants have an important role in preventing soil erosion. The large-scale deforestation that is happening all over the world not only destroys biodiversity, it also leads to soil erosion. Topsoil that is bare of vegetation, is likely to be removed very quickly. And this is accelerated in hilly or mountainous regions. This process of soil erosion is very difficult to reverse. Vegetative cover on the ground has a role to play in the percolation of water into the deeper layers too.

Questions

- How is soil formed?
- What is soil erosion?
- What are the methods of preventing or reducing soil erosion?

14.4 Biogeochemical Cycles

A constant interaction between the biotic and abiotic components of the biosphere makes it a dynamic, but stable system. These interactions consist of a transfer of matter and energy between the different components of the biosphere. Let us look at some processes involved in the maintenance of the above balance.

14.4.1 THE WATER-CYCLE

You have seen how the water evaporates from the water bodies and subsequent condensation of this water vapour leads to rain. But we don't see the seas and oceans drying up. So, how is the water returning to these water bodies? The whole process in which water evaporates and falls on the land as rain and later flows back into the sea via rivers is known as the water-cycle. This cycle is not as straight-forward and simple as this statement seems to imply. All of the water that falls on the land does not immediately flow back into the sea. Some of it seeps into the soil and becomes part of the underground reservoir of fresh-water. Some of this underground water finds its way to the surface through springs. Or we bring it to the surface for our use through wells or tube-wells. Water is also used by terrestrial animals and plants for various life-processes (Fig. 14.5).

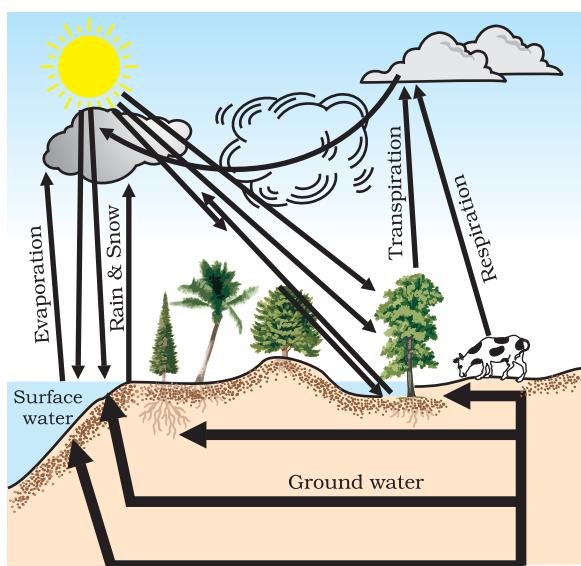


Fig. 14.5: Water-cycle in nature

Let us look at another aspect of what happens to water during the water-cycle. As you know, water is capable of dissolving a large number of substances. As water flows through or over rocks containing soluble minerals, some of them get dissolved in the

water. Thus rivers carry many nutrients from the land to the sea, and these are used by the marine organisms.

14.4.2 THE NITROGEN-CYCLE

Nitrogen gas makes up 78% of our atmosphere and nitrogen is also a part of many molecules essential to life like proteins, nucleic acids (DNA and RNA) and some vitamins. Nitrogen is found in other biologically important compounds such as alkaloids and urea too. Nitrogen is thus an essential nutrient for all life-forms and life would be simple if all these life-forms could use the atmospheric nitrogen directly. However, other than a few forms of bacteria, life-forms are not able to convert the comparatively inert nitrogen molecule into forms like nitrates and nitrites which can be taken up and used to make the required molecules. These 'nitrogen-fixing' bacteria may be free-living or be associated with some species of dicot plants. Most commonly, the nitrogen-fixing bacteria are found in the roots of legumes (generally the plants which give us pulses) in special structures called root-nodules. Other than these bacteria, the only other manner in which the nitrogen molecule is converted to nitrates and nitrites is by a physical process. During lightning, the high temperatures and pressures created in the air convert nitrogen into oxides of nitrogen. These oxides dissolve in water to give nitric and nitrous acids and fall on land along with rain. These are then utilised by various life-forms.

What happens to the nitrogen once it is converted into forms that can be taken up and used to make nitrogen-containing molecules? Plants generally take up nitrates and nitrites and convert them into amino acids which are used to make proteins. Some other biochemical pathways are used to make the other complex compounds containing nitrogen. These proteins and other complex compounds are subsequently consumed by animals. Once the animal or the plant dies, other bacteria in the soil convert the various compounds of nitrogen back into nitrates and

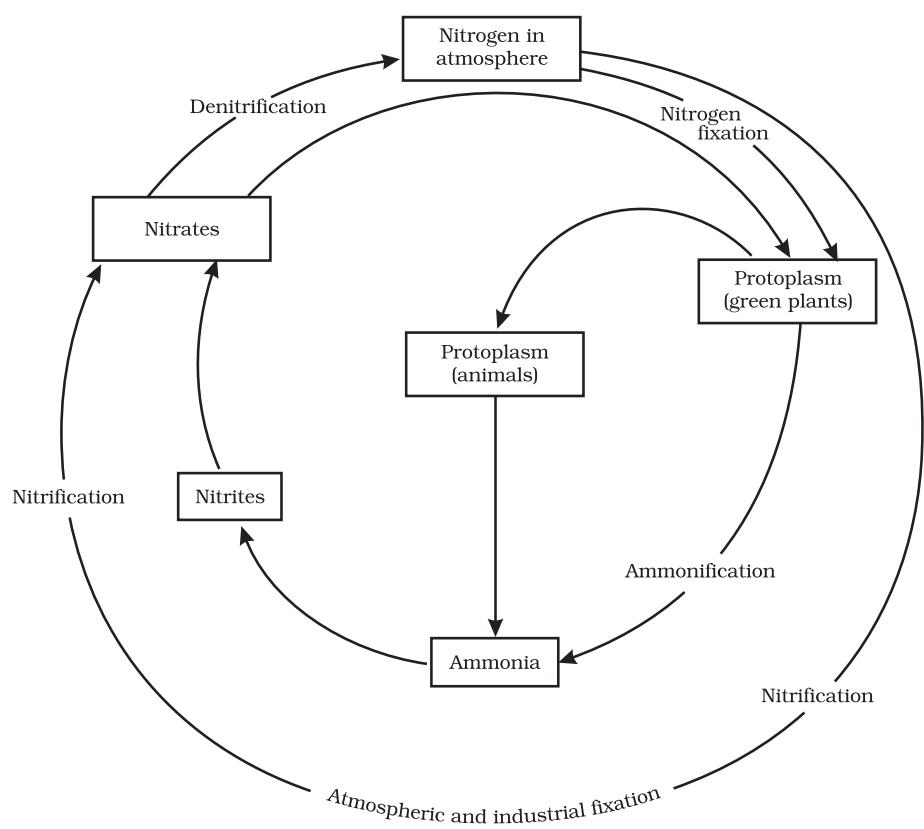


Fig. 14.6: Nitrogen-cycle in nature

nitrites. A different type of bacteria converts the nitrates and nitrites into elemental nitrogen. Thus, there is a nitrogen-cycle in nature in which nitrogen passes from its elemental form in the atmosphere into simple molecules in the soil and water, which get converted to more complex molecules in living beings and back again to the simple nitrogen molecule in the atmosphere.

14.4.3 THE CARBON-CYCLE

Carbon is found in various forms on the Earth. It occurs in the elemental form as diamonds and graphite. In the combined state, it is found as carbon dioxide in the atmosphere, as carbonate and hydrogen-carbonate salts in various minerals, while all life-forms are based on carbon-containing molecules like proteins, carbohydrates, fats,

nucleic acids and vitamins. The endoskeletons and exoskeletons of various animals are also formed from carbonate salts. Carbon is incorporated into life-forms through the basic process of photosynthesis which is performed in the presence of Sunlight by all life-forms that contain chlorophyll. This process converts carbon dioxide from the atmosphere or dissolved in water into glucose molecules. These glucose molecules are either converted into other substances or used to provide energy for the synthesis of other biologically important molecules (Fig. 14.7).

The utilisation of glucose to provide energy to living things involves the process of respiration in which oxygen may or may not be used to convert glucose back into carbon dioxide. This carbon dioxide then goes back into the atmosphere. Another process that

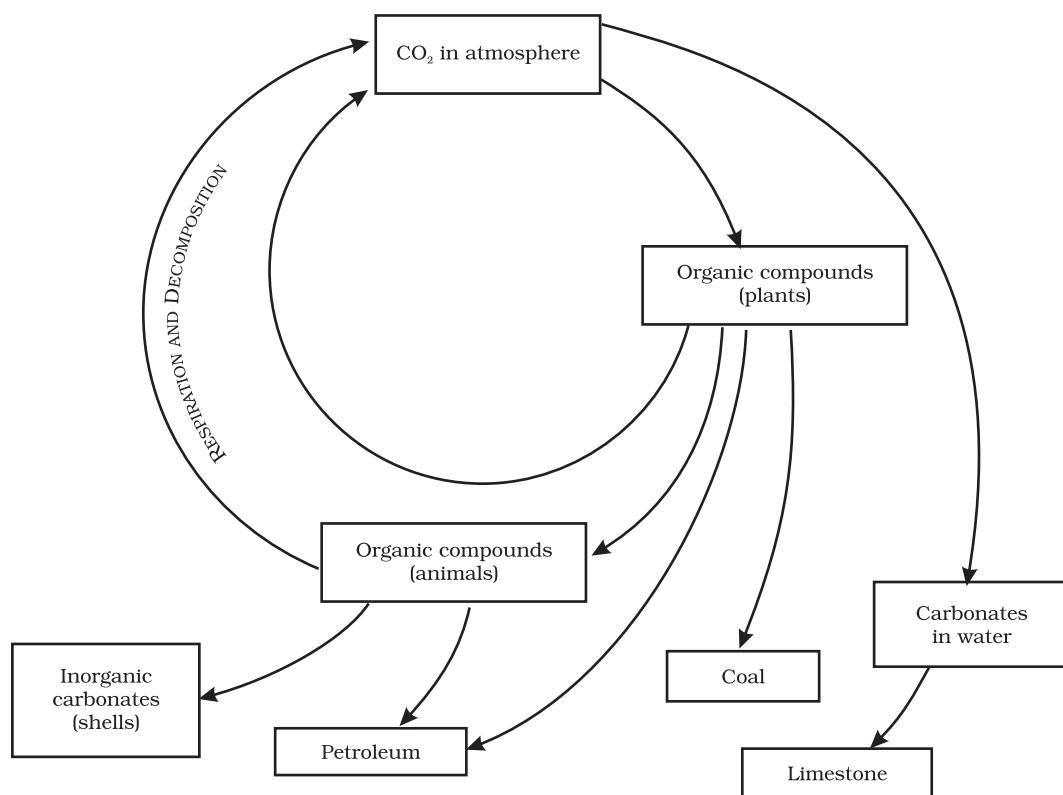


Fig. 14.7: Carbon-cycle in nature

adds to the carbon dioxide in the atmosphere is the process of combustion where fuels are burnt to provide energy for various needs like heating, cooking, transportation and industrial processes. In fact, the percentage of carbon dioxide in the atmosphere is said to have doubled since the industrial revolution when human beings started burning fossil fuels on a very large scale. Carbon, like water, is thus cycled repeatedly through different forms by the various physical and biological activities.

14.4.3 (i) THE GREENHOUSE EFFECT

Recall the reading taken by you under (iii) in Activity 14.1. Heat is trapped by glass, and hence the temperature inside a glass enclosure will be much higher than the surroundings. This phenomenon was used to create an enclosure where tropical plants

could be kept warm during the winters in colder climates. Such enclosures are called greenhouses. Greenhouses have also lent their name to an atmospheric phenomenon. Some gases prevent the escape of heat from the Earth. An increase in the percentage of such gases in the atmosphere would cause the average temperatures to increase worldwide and this is called the greenhouse effect. Carbon dioxide is one of the greenhouse gases. An increase in the carbon dioxide content in the atmosphere would cause more heat to be retained by the atmosphere and lead to global warming.

Activity _____ 14.12

- Find out what the consequences of global warming would be.
- Also, find out the names of some other greenhouse gases.

14.4.4 THE OXYGEN-CYCLE

Oxygen is a very abundant element on our Earth. It is found in the elemental form in the atmosphere to the extent of 21%. It also occurs extensively in the combined form in the Earth's crust as well as also in the air in the form of carbon dioxide. In the crust, it is found as the oxides of most metals and silicon, and also as carbonate, sulphate, nitrate and other minerals. It is also an essential component of most biological molecules like carbohydrates, proteins, nucleic acids and fats (or lipids).

But when we talk of the oxygen-cycle, we are mainly referring to the cycle that maintains the levels of oxygen in the atmosphere. Oxygen from the atmosphere is used up in three processes, namely combustion, respiration and in the formation of oxides of nitrogen. Oxygen is returned to the atmosphere in only one major process, that is, photosynthesis. And this forms the broad outline of the oxygen-cycle in nature (Fig. 14.8).

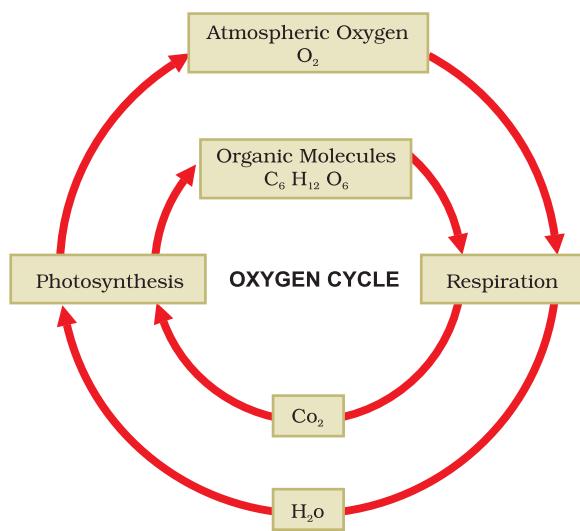


Fig. 14.8: Oxygen-cycle in nature

Though we usually think of oxygen as being necessary to life in the process of respiration, it might be of interest to you to learn that some forms of life, especially

bacteria, are poisoned by elemental oxygen. In fact, even the process of nitrogen-fixing by bacteria does not take place in the presence of oxygen.

14.5 Ozone Layer

Elemental oxygen is normally found in the form of a diatomic molecule. However, in the upper reaches of the atmosphere, a molecule containing three atoms of oxygen is found. This would mean a formula of O₃ and this is called ozone. Unlike the normal diatomic molecule of oxygen, ozone is poisonous and we are lucky that it is not stable nearer to the Earth's surface. But it performs an essential function where it is found. It absorbs harmful radiations from the Sun. This prevents those harmful radiations from reaching the surface of the Earth where they may damage many forms of life.

Recently it was discovered that this ozone layer was getting depleted. Various man-made compounds like CFCs (carbon compounds having both fluorine and chlorine which are very stable and not degraded by any biological process) were found to persist in the atmosphere. Once they reached the ozone layer, they would react with the ozone molecules. This resulted in a reduction of the ozone layer and recently they have discovered a hole in the ozone layer above the Antarctica. It is difficult to imagine the consequences for life on Earth if the ozone layer dwindles further, but many people think that it would be better not to take chances. These people advocate working towards stopping all further damage to the ozone layer.

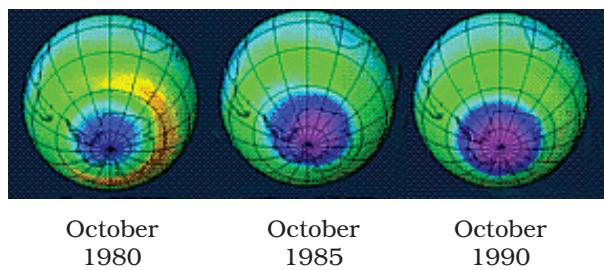


Fig. 14.9: Satellite picture showing the hole (magenta colour) in the ozone layer over Antarctica

Activity _____ 14.13

- Find out which other molecules are thought to damage the ozone layer.
- Newspaper reports often talk about the hole in the ozone layer.
- Find out whether the size of this hole is changing and in what manner scientists think this would affect life on Earth (Fig. 14.9).



Questions

1. *What are the different states in which water is found during the water cycle?*
2. *Name two biologically important compounds that contain both oxygen and nitrogen.*
3. *List any three human activities which would lead to an increase in the carbon dioxide content of air.*
4. *What is the greenhouse effect?*
5. *What are the two forms of oxygen found in the atmosphere?*



What you have learnt

- Life on Earth depends on resources like soil, water and air, and energy from the Sun.
- Uneven heating of air over land and water-bodies causes winds.
- Evaporation of water from water-bodies and subsequent condensation give us rain.
- Rainfall patterns depend on the prevailing wind patterns in an area.
- Various nutrients are used again and again in a cyclic fashion. This leads to a certain balance between the various components of the biosphere.
- Pollution of air, water and soil affect the quality of life and harm the biodiversity.
- We need to conserve our natural resources and use them in a sustainable manner.



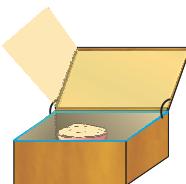
Exercises

1. Why is the atmosphere essential for life?
2. Why is water essential for life?
3. How are living organisms dependent on the soil? Are organisms that live in water totally independent of soil as a resource?
4. You have seen weather reports on television and in newspapers. How do you think we are able to predict the weather?

5. We know that many human activities lead to increasing levels of pollution of the air, water-bodies and soil. Do you think that isolating these activities to specific and limited areas would help in reducing pollution?
6. Write a note on how forests influence the quality of our air, soil and water resources.

CHAPTER 14

Sources of Energy



In Class IX, we learnt that the total energy during a physical or chemical process is conserved. Why, then, do we hear so much about the energy crisis? If energy can neither be created nor destroyed, we should have no worries! We should be able to perform endless activities without thinking about energy resources!

This riddle can be solved if we recall what else we learnt about energy. Energy comes in different forms and one form can be converted to another. For example, if we drop a plate from a height, the potential energy of the plate is converted mostly to sound energy when it hits the ground. If we light a candle, the process is highly exothermic so that the chemical energy in the wax is converted to heat energy and light energy on burning. What other products are obtained when we burn a candle?

The total energy during a physical or chemical process remains the same but suppose we consider the burning candle again – can we somehow put together the heat and light generated along with the products of the reaction to get back the chemical energy in the form of wax?

Let us consider another example. Suppose we take 100 mL of water which has a temperature of 348 K (75°C) and leave it in a room where the temperature is 298 K (25°C). What will happen? Is there any way of collecting all the heat lost to the environment and making the water hot once it has cooled down?

In any example that we consider, we will see that energy, in the usable form, is dissipated to the surroundings in less usable forms. Hence, any source of energy we use, to do work, is consumed and cannot be used again.

14.1 WHAT IS A GOOD SOURCE OF ENERGY?

What can then be considered a good source of energy? We, in our daily lives, use energy from various sources for doing work. We use diesel to run our trains. We use electricity to light our street-lamps. Or we use energy in our muscles to cycle to school.

Activity 14.1

- List four forms of energy that you use from morning, when you wake up, till you reach the school.
- From where do we get these different forms of energy?
- Can we call these 'sources' of energy? Why or why not?

The muscular energy for carrying out physical work, electrical energy for running various appliances, chemical energy for cooking food or running a vehicle all come from some source. We need to know how do we select the source needed for obtaining the energy in its usable form.

Activity 14.2

- Consider the various options we have when we choose a fuel for cooking our food.
- What are the criteria you would consider when trying to categorise something as a good fuel?
- Would your choice be different if you lived
 - (a) in a forest?
 - (b) in a remote mountain village or small island?
 - (c) in New Delhi?
 - (d) lived five centuries ago?
- How are the factors different in each case?

After going through the two activities above, we can see that the particular source of energy, or fuel, we select for performing some work depends on many different factors. For example, while selecting a fuel, we would ask ourselves the following questions.

- (i) How much heat does it release on burning?
- (ii) Does it produce a lot of smoke?
- (iii) Is it easily available?

Can you think of three more relevant questions to ask about a fuel?

Given the range of fuels we have today, what are the factors which would limit our choices when it comes to a particular task like cooking our food? Would the fuel selected also depend on the work to be done? For example, would we choose one fuel for cooking and another for heating the room in winter?

We could then say that a good source of energy would be one

- which would do a large amount of work per unit volume or mass,
- be easily accessible,
- be easy to store and transport, and
- perhaps most importantly, be economical.

Q U E S T I O N S

1. *What is a good source of energy?*
2. *What is a good fuel?*
3. *If you could use any source of energy for heating your food, which one would you use and why?*



14.2 CONVENTIONAL SOURCES OF ENERGY

14.2.1 Fossil Fuels

In ancient times, wood was the most common source of heat energy. The energy of flowing water and wind was also used for limited activities. Can you think of some of these uses? The exploitation of coal as a source of energy made the industrial revolution possible. Increasing industrialisation has led to a better quality of life all over the world. It has also caused the global demand for energy to grow at a tremendous rate. The growing demand for energy was largely met by the fossil fuels – coal and petroleum. Our technologies were also developed for using these energy sources. But these fuels were formed over millions of years ago and there are only limited reserves. The fossil fuels are non-renewable

sources of energy, so we need to conserve them. If we were to continue consuming these sources at such alarming rates, we would soon run out of energy! In order to avoid this, alternate sources of energy were explored. But we continue to be largely dependent on fossil fuels for most of our energy requirements (Fig. 14.1).

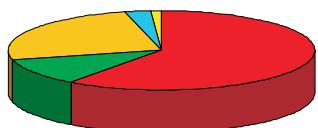


Figure 14.1

Pie-chart showing the major sources of energy for our requirements in India

- Coal
- Petroleum and Natural Gas
- Hydro
- Nuclear
- Wind

Burning fossil fuels has other disadvantages too. We learnt in Class IX about the air pollution caused by burning of coal or petroleum products. The oxides of carbon, nitrogen and sulphur that are released on burning fossil fuels are acidic oxides. These lead to acid rain which affects our water and soil resources. In addition to the problem of air pollution, recall the green-house effect of gases like carbon dioxide.

Think it over

How would our lives change if we could no longer get electricity supply?

The availability of electrical energy to each individual in a country is one of the parameters to measure the growth of the country.

The pollution caused by burning fossil fuels can be somewhat reduced by increasing the efficiency of the combustion process and using various techniques to reduce the escape of harmful gases and ashes into the surroundings. Besides being used directly for various purposes – in gas stoves and vehicles, do you know fossil fuels are the major fuels used for generating electricity? Let us produce some electricity at our own small plant in the class and see what goes into producing our favourite form of energy.

Activity 14.3

- Take a table-tennis ball and make three slits into it.
- Put semicircular (---) fins cut out of a metal sheet into these slits.
- Pivot the tennis ball on an axle through its centre with a straight metal wire fixed to a rigid support. Ensure that the tennis ball rotates freely about the axle.

- Now connect a cycle dynamo to this.
- Connect a bulb in series.
- Direct a jet of water or steam produced in a pressure cooker at the fins (Fig. 14.2). What do you observe?

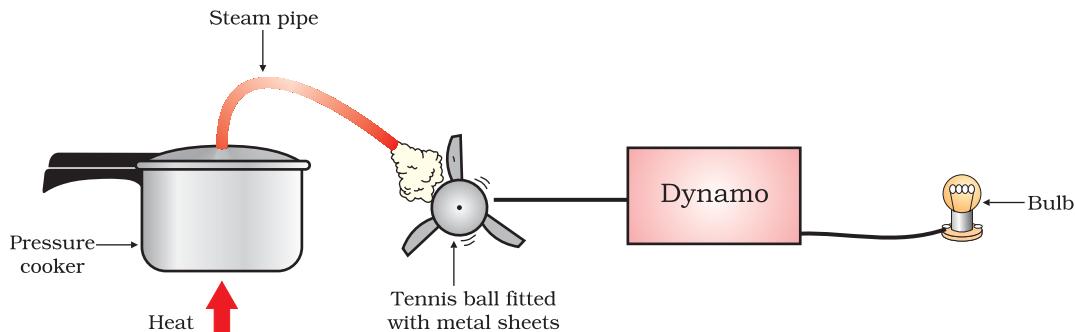


Figure 14.2 A model to demonstrate the process of thermoelectric production

This is our turbine for generating electricity. The simplest turbines have one moving part, a rotor-blade assembly. The moving fluid acts on the blades to spin them and impart energy to the rotor. Thus, we see that basically we need to move the fan, the rotor blade, with speed which would turn the shaft of the dynamo and convert the mechanical energy into electrical energy — the form of energy which has become a necessity in today's scenario. The various ways in which this can be done depends upon availability of the resources. We will see how various sources of energy can be harnessed to run the turbine and generate electricity in the following sections.

14.2.2 Thermal Power Plant

Large amount of fossil fuels are burnt every day in power stations to heat up water to produce steam which further runs the turbine to generate electricity. The transmission of electricity is more efficient than transporting coal or petroleum over the same distance. Therefore, many thermal power plants are set up near coal or oil fields. The term thermal power plant is used since fuel is burnt to produce heat energy which is converted into electrical energy.

14.2.3 Hydro Power Plants

Another traditional source of energy was the kinetic energy of flowing water or the potential energy of water at a height. Hydro power plants convert the potential energy of falling water into electricity. Since there are very few water-falls which could be used as a source of potential energy, hydro power plants are associated with dams. In the last century, a large number of dams were built all over the world. As we can see from Fig. 14.1, a quarter of our energy requirement in India is met by hydro power plants.

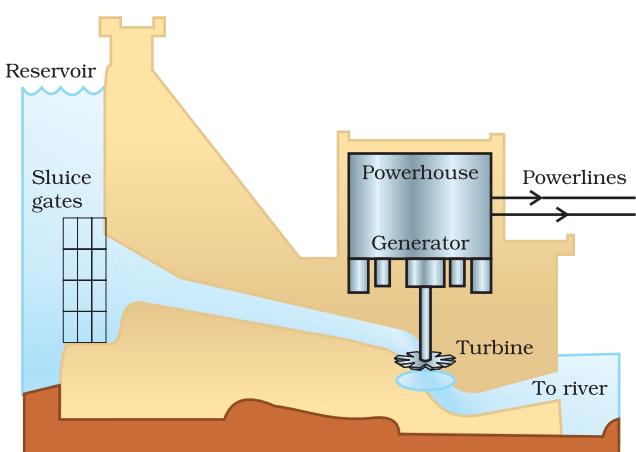


Figure 14.3
A schematic view of a hydro power plant

In order to produce hydel electricity, high-rise dams are constructed on the river to obstruct the flow of water and thereby collect water in larger reservoirs. The water level rises and in this process the kinetic energy of flowing water gets transformed into potential energy. The water from the high level in the dam is carried through pipes, to the turbine, at the bottom of the dam (Fig. 14.3). Since the water in the reservoir would be refilled each time it rains (hydro power is a renewable source of energy) we would not have to worry about hydro electricity sources getting used up the way fossil fuels would get finished one day.

But, constructions of big dams have certain problems associated with it. The dams can be constructed only in a limited number of places, preferably in hilly terrains. Large areas of agricultural land and human habitation are to be sacrificed as they get submerged. Large eco-systems are destroyed when submerged under the water in dams. The vegetation which is submerged rots under anaerobic conditions and gives rise to large amounts of methane which is also a green-house gas. It creates the problem of satisfactory rehabilitation of displaced people. Opposition to the construction of Tehri Dam on the river Ganga and Sardar Sarovar project on the river Narmada are due to such problems.

14.2.4 Improvements in the Technology for using Conventional Sources of Energy

Bio-Mass

We mentioned earlier that wood has been used as a fuel for a long time. If we can ensure that enough trees are planted, a continuous supply of fire-wood can be assured. You must also be familiar with the use of cow-dung cakes as a fuel. Given the large live-stock population in India, this can also assure us a steady source of fuel. Since these fuels are plant and animal products, the source of these fuels is said to be bio-mass. These fuels, however, do not produce much heat on burning and a lot of smoke is given out when they are burnt. Therefore, technological inputs to improve the efficiency of these fuels are necessary. When wood is burnt in a limited supply of oxygen, water and volatile materials present in it get removed and charcoal is left behind as the residue. Charcoal burns without flames, is comparatively smokeless and has a higher heat generation efficiency.

Similarly, cow-dung, various plant materials like the residue after harvesting the crops, vegetable waste and sewage are decomposed in the absence of oxygen to give bio-gas. Since the starting material is mainly cow-dung, it is popularly known as 'gobar-gas'. Bio-gas is produced in a plant as shown in Fig. 14.4.

The plant has a dome-like structure built with bricks. A slurry of cow-dung and water is made in the mixing tank from where it is fed into the digester. The digester is a sealed chamber in which there is no oxygen. Anaerobic micro-organisms that do not require oxygen decompose or break down complex compounds of the cow-dung slurry. It takes a few days for the decomposition process to be complete and generate gases like methane, carbon dioxide, hydrogen and hydrogen sulphide. The bio-gas is stored in the gas tank above the digester from which they are drawn through pipes for use.

Bio-gas is an excellent fuel as it contains up to 75% methane. It burns without smoke, leaves no residue like ash in wood, charcoal and coal burning. Its heating capacity is high. Bio-gas is also used for lighting. The slurry left behind is removed periodically and used as excellent manure, rich in nitrogen and phosphorous. The large-scale utilisation of bio-waste and sewage material provides a safe and efficient method of waste-disposal besides supplying energy and manure. Do you think that bio-mass is a renewable source of energy?

Wind Energy

We saw in Class IX how unequal heating of the landmass and water bodies by solar radiation generates air movement and causes winds to blow. This kinetic energy of the wind can be used to do work. This energy was harnessed by windmills in the past to do mechanical work. For example, in a water-lifting pump, the rotatory motion of windmill is utilised to lift water from a well. Today, wind energy is also used to generate electricity. A windmill essentially consists of a structure similar to a large electric fan that is erected at some height on a rigid support (Fig. 14.5).

To generate electricity, the rotatory motion of the windmill is used to turn the turbine of the electric generator. The output of a single windmill is quite small and cannot be used for commercial purposes. Therefore, a number of windmills are erected over a large area, which is known as wind energy farm. The energy output of each windmill in a farm is coupled together to get electricity on a commercial scale.

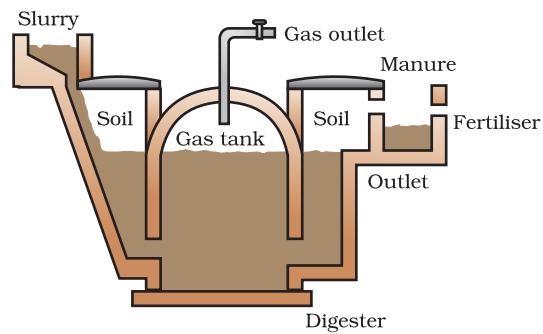


Figure 14.4
Schematic diagram of a bio-gas plant

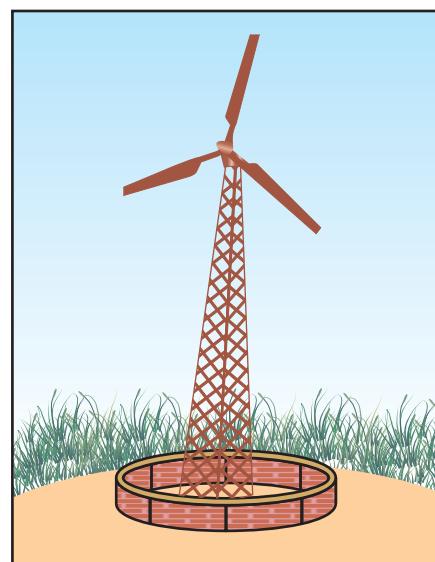


Figure 14.5 A windmill

Do You Know?

Denmark is called the country of ‘winds’. More than 25% of their electricity needs are generated through a vast network of windmills. In terms of total output, Germany is the leader, while India is ranked fifth in harnessing wind energy for the production of electricity. It is estimated that nearly 45,000 MW of electrical power can be generated if India’s wind potential is fully exploited. The largest wind energy farm has been established near Kanyakumari in Tamil Nadu and it generates 380 MW of electricity.

Wind energy is an environment-friendly and efficient source of renewable energy. It requires no recurring expenses for the production of electricity. But there are many limitations in harnessing wind energy. Firstly, wind energy farms can be established only at those places where wind blows for the greater part of a year. The wind speed should also be higher than 15 km/h to maintain the required speed of the turbine. Furthermore, there should be some back-up facilities (like storage cells) to take care of the energy needs during a period when there is no wind. Establishment of wind energy farms requires large area of land. For a 1 MW generator, the farm needs about 2 hectares of land. The initial cost of establishment of the farm is quite high. Moreover, since the tower and blades are exposed to the vagaries of nature like rain, Sun, storm and cyclone, they need a high level of maintenance.

Q U E S T I O N S

1. What are the disadvantages of fossil fuels?
2. Why are we looking at alternate sources of energy?
3. How has the traditional use of wind and water energy been modified for our convenience?



14.3 ALTERNATIVE OR NON-CONVENTIONAL SOURCES OF ENERGY

With technological progress, our demand for energy increases day by day. Our life-styles are also changing, we use machines to do more and more of our tasks. Our basic requirements are also increasing as industrialisation improves our living standards.

Activity 14.4

- Find out from your grand-parents or other elders –
 - (a) how did they go to school?
 - (b) how did they get water for their daily needs when they were young?
 - (c) what means of entertainment did they use?
- Compare the above answers with how you do these tasks now.
- Is there a difference? If yes, in which case more energy from external sources is consumed?

As our demand for energy increases, we need to look for more and more sources of energy. We could develop the technology to use the available or known sources of energy more efficiently and also look to new sources of energy. Any new source of energy we seek to exploit would need specific devices developed with that source in mind. We shall now look at some of the latest sources of energy that we seek to tap, and the technology designed to capture and store energy from that source.

Think it over!

Some people say that if we start living as our ancestors, this would conserve energy and our ecosystem. Do you think this idea is feasible?

14.3.1 Solar Energy

The Sun has been radiating an enormous amount of energy at the present rate for nearly 5 billion years and will continue radiating at that rate for about 5 billion years more. Only a small part of solar energy reaches the outer layer of the earth's atmosphere. Nearly half of it is absorbed while passing through the atmosphere and the rest reaches the earth's surface.

Do You Know?

India is lucky to receive solar energy for greater part of the year. It is estimated that during a year India receives the energy equivalent to more than 5,000 trillion kWh. Under clear (cloudless) sky conditions, the daily average varies from 4 to 7 kWh/m². The solar energy reaching unit area at outer edge of the earth's atmosphere exposed perpendicularly to the rays of the Sun at the average distance between the Sun and earth is known as the solar constant. It is estimated to be approximately 1.4 kJ per second per square metre or 1.4 kW/m².

Activity 14.5

- Take two conical flasks and paint one white and the other black. Fill both with water.
- Place the conical flasks in direct sunlight for half an hour to one hour.
- Touch the conical flasks. Which one is hotter? You could also measure the temperature of the water in the two conical flasks with a thermometer.
- Can you think of ways in which this finding could be used in your daily life?

A black surface absorbs more heat as compared to a white or a reflecting surface under identical conditions. Solar cookers (Fig. 14.6) and solar water heaters use this property in their working. Some solar cookers achieve a higher temperature by using mirrors to focus the rays of the Sun. Solar cookers are covered with a glass plate. Recall what we have learnt about the green-house effect. Does this explain why a glass plate is used?

Activity 14.6

- Study the structure and working of a solar cooker and/or a solar water-heater, particularly with regard to how it is insulated and maximum heat absorption is ensured.

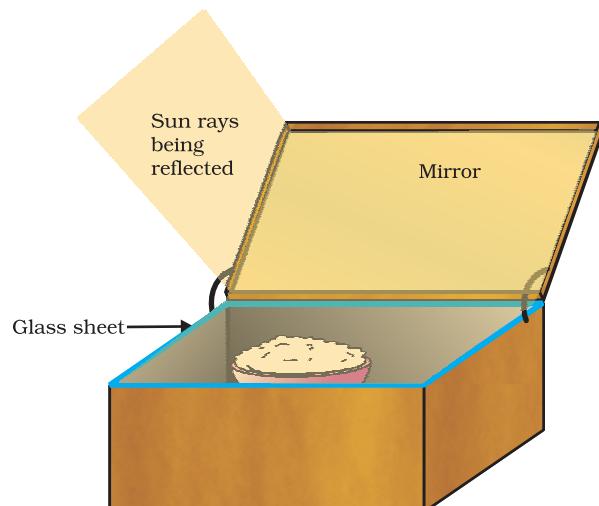


Figure 14.6 A solar cooker

- Design and build a solar cooker or water-heater using low-cost material available and check what temperatures are achieved in your system.
- Discuss what would be the advantages and limitations of using the solar cooker or water-heater.

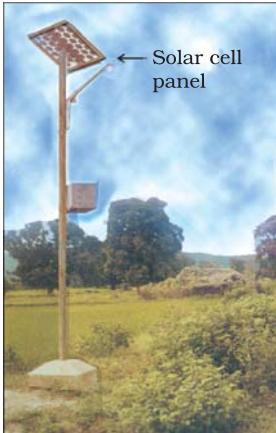


Figure 14.7
A solar cell panel

It is easy to see that these devices are useful only at certain times during the day. This limitation of using solar energy is overcome by using solar cells that convert solar energy into electricity. A typical cell develops a voltage of 0.5–1 V and can produce about 0.7 W of electricity when exposed to the Sun. A large number of solar cells are, combined in an arrangement called solar cell panel (Fig. 14.7) that can deliver enough electricity for practical use.

The principal advantages associated with solar cells are that they have no moving parts, require little maintenance and work quite satisfactorily without the use of any focussing device. Another advantage is that they can be set up in remote and inaccessible hamlets or very sparsely inhabited areas in which laying of a power transmission line may be expensive and not commercially viable.

Silicon, which is used for making solar cells, is abundant in nature but availability of the special grade silicon for making solar cells is limited. The entire process of manufacture is still very expensive, silver used for interconnection of the cells in the panel further adds to the cost. In spite of the high cost and low efficiency, solar cells are used for many scientific and technological applications. Artificial satellites and space probes like Mars orbiters use solar cells as the main source of energy. Radio or wireless transmission systems or TV relay stations in remote locations use solar cell panels. Traffic signals, calculators and many toys are fitted with solar cells. The solar cell panels are mounted on specially designed inclined roof tops so that more solar energy is incident over it. The domestic use of solar cells is, however, limited due to its high cost.

14.3.2 Energy from the Sea

Tidal Energy

Due to the gravitational pull of mainly the moon on the spinning earth, the level of water in the sea rises and falls. If you live near the sea or ever travel to some place near the sea, try and observe how the sea-level changes during the day. This phenomenon is called high and low tides and the difference in sea-levels gives us tidal energy. Tidal energy is harnessed by constructing a dam across a narrow opening to the sea. A turbine fixed at the opening of the dam converts tidal energy to electricity. As you can guess, the locations where such dams can be built are limited.

Wave Energy

Similarly, the kinetic energy possessed by huge waves near the sea-shore can be trapped in a similar manner to generate electricity. The waves are generated by strong winds blowing across the sea. Wave energy would be a viable proposition only where waves are very strong. A wide variety of devices have been developed to trap wave energy for rotation of turbine and production of electricity.

Ocean Thermal Energy

The water at the surface of the sea or ocean is heated by the Sun while the water in deeper sections is relatively cold. This difference in temperature is exploited to obtain energy in ocean-thermal-energy conversion plants. These plants can operate if the temperature difference between the water at the surface and water at depths up to 2 km is 293 K (20°C) or more. The warm surface-water is used to boil a volatile liquid like ammonia. The vapours of the liquid are then used to run the turbine of generator. The cold water from the depth of the ocean is pumped up and condense vapour again to liquid.

The energy potential from the sea (tidal energy, wave energy and ocean thermal energy) is quite large, but efficient commercial exploitation is difficult.

14.3.3 Geothermal Energy

Due to geological changes, molten rocks formed in the deeper hot regions of earth's crust are pushed upward and trapped in certain regions called 'hot spots'. When underground water comes in contact with the hot spot, steam is generated. Sometimes hot water from that region finds outlets at the surface. Such outlets are known as hot springs. The steam trapped in rocks is routed through a pipe to a turbine and used to generate electricity. The cost of production would not be much, but there are very few commercially viable sites where such energy can be exploited. There are number of power plants based on geothermal energy operational in New Zealand and United States of America.

14.3.4 Nuclear Energy

How is nuclear energy generated? In a process called nuclear fission, the nucleus of a heavy atom (such as uranium, plutonium or thorium), when bombarded with low-energy neutrons, can be split apart into lighter nuclei. When this is done, a tremendous amount of energy is released if the mass of the original nucleus is just a little more than the sum of the masses of the individual products. The fission of an atom of uranium, for example, produces 10 million times the energy produced by the combustion of an atom of carbon from coal. In a nuclear reactor designed for electric power generation, such nuclear 'fuel' can be part of a self-sustaining fission chain reaction that releases energy at a controlled rate. The released energy can be used to produce steam and further generate electricity.

Do You Know?

In a nuclear fission, the difference in mass, Δm , between the original nucleus and the product nuclei gets converted to energy E at a rate governed by the famous equation,

$$E = \Delta m c^2$$

first derived by Albert Einstein in 1905, where c is the speed of light in vacuum. In nuclear science, energy is often expressed in units of electron volts (eV): $1 \text{ eV} = 1.602 \times 10^{-19}$ joules. It is easy to check from the above equation that 1 atomic mass unit (u) is equivalent to about 931 mega electron volts (MeV) of energy.

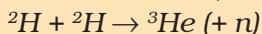
Nuclear power reactors located at Tarapur (Maharashtra), Rana Pratap Sagar (Rajasthan), Kalpakkam (Tamil Nadu), Narora (UP), Kakrapar (Gujarat) and Kaiga (Karnataka) have the installed capacity of less than 3% of the total electricity generation capacity of our country. However, many industrialised countries are meeting more than 30% of their electrical power needs from nuclear reactors.

The major hazard of nuclear power generation is the storage and disposal of spent or used fuels – the uranium still decaying into harmful subatomic particles (radiations). Improper nuclear-waste storage and disposal result in environmental contamination. Further, there is a risk of accidental leakage of nuclear radiation. The high cost of installation of a nuclear power plant, high risk of environmental contamination and limited availability of uranium makes large-scale use of nuclear energy prohibitive.

Nuclear energy was first used for destructive purposes before nuclear power stations were designed. The fundamental physics of the fission chain reaction in a nuclear weapon is similar to the physics of a controlled nuclear reactor, but the two types of device are engineered quite differently.

Nuclear fusion

Currently all commercial nuclear reactors are based on nuclear fission. But there is another possibility of nuclear energy generation by a safer process called nuclear fusion. Fusion means joining lighter nuclei to make a heavier nucleus, most commonly hydrogen or hydrogen isotopes to create helium, such as



It releases a tremendous amount of energy, according to the Einstein equation, as the mass of the product is little less than the sum of the masses of the original individual nuclei.

Such nuclear fusion reactions are the source of energy in the Sun and other stars. It takes considerable energy to force the nuclei to fuse. The conditions needed for this process are extreme – millions of degrees of temperature and millions of pascals of pressure.

The hydrogen bomb is based on thermonuclear fusion reaction. A nuclear bomb based on the fission of uranium or plutonium is placed at the core of the hydrogen bomb. This nuclear bomb is embedded in a substance which contains deuterium and lithium. When the nuclear bomb (based on fission) is detonated, the temperature of this substance is raised to 10^7 K in a few microseconds. The high temperature generates sufficient energy for the light nuclei to fuse and a devastating amount of energy is released.

Activity 14.7

- Discuss in class the question of what is the ultimate source of energy for bio-mass, wind and ocean thermal energy.
- Is geothermal energy and nuclear energy different in this respect? Why?
- Where would you place hydro electricity and wave energy?

QUESTIONS

1. What kind of mirror – concave, convex or plain – would be best suited for use in a solar cooker? Why?
2. What are the limitations of the energy that can be obtained from the oceans?
3. What is geothermal energy?
4. What are the advantages of nuclear energy?



14.4 ENVIRONMENTAL CONSEQUENCES

We have studied various sources of energy in the previous sections. Exploiting any source of energy disturbs the environment in some way or the other. In any given situation, the source we would choose depends on factors such as the ease of extracting energy from that source, the economics of extracting energy from the source, the efficiency of the technology available and the environmental damage that will be caused by using that source. Though we talk of ‘clean’ fuels like CNG, it would be more exact to say that a particular source is cleaner than the other. We have already seen that burning fossil fuels causes air pollution. In some cases, the actual operation of a device like the solar cell may be pollution-free, but the assembly of the device would have caused some environmental damage. Research continues in these areas to produce longer lasting devices that will cause less damage throughout their life.

Activity 14.8

- Gather information about various energy sources and how each one affects the environment.
- Debate the merits and demerits of each source and select the best source of energy on this basis.

QUESTIONS

1. Can any source of energy be pollution-free? Why or why not?
2. Hydrogen has been used as a rocket fuel. Would you consider it a cleaner fuel than CNG? Why or why not?



14.5 HOW LONG WILL AN ENERGY SOURCE LAST US?

We saw earlier that we cannot depend on the fossil fuels for much longer. Such sources that will get depleted some day are said to be exhaustible sources or non-renewable sources of energy. On the other hand, if we manage bio-mass by replacing the trees we cut down for fire-wood, we can be assured of a constant supply of energy at a particular rate. Such energy sources that can be regenerated are called renewable sources of energy.

Renewable energy is available in our natural environment, in the form of some continuing or repetitive currents of energy, or is stored in such large underground reservoirs that the rate of depletion of the reservoir because of extraction of usable energy is practically negligible.

Activity 14.9

- Debate the following two issues in class.
 - (a) The estimated coal reserves are said to be enough to last us for another two hundred years. Do you think we need to worry about coal getting depleted in this case? Why or why not?
 - (b) It is estimated that the Sun will last for another five billion years. Do we have to worry about solar energy getting exhausted? Why or why not?
- On the basis of the debate, decide which energy sources can be considered (i) exhaustible, (ii) inexhaustible, (iii) renewable and (iv) non-renewable. Give your reasons for each choice.

Q U E S T I O N S

1. Name two energy sources that you would consider to be renewable. Give reasons for your choices.
2. Give the names of two energy sources that you would consider to be exhaustible. Give reasons for your choices.



What you have learnt

- Our energy requirements increase with our standard of living.
- In order to fulfil our energy requirements, we try to improve the efficiency of energy usage and also try and exploit new sources of energy.
- We also need to look for new sources of energy because the conventional sources of energy like fossil fuels are in danger of getting exhausted soon.
- The energy source we select would depend on factors like the ease and cost of extracting energy from the source, the efficiency of the technology available for using that source of energy and the environmental impact of using that source.
- Many of the sources ultimately derive their energy from the Sun.

E X E R C I S E S

1. A solar water heater cannot be used to get hot water on
 - (a) a sunny day.
 - (b) a cloudy day.
 - (c) a hot day.
 - (d) a windy day.

CHAPTER 15

Our Environment



We have heard the word ‘environment’ often being used on the television, in newspapers and by people around us. Our elders tell us that the ‘environment’ is not what it used to be earlier; others say that we should work in a healthy ‘environment’; and global summits involving the developed and developing countries are regularly held to discuss ‘environmental’ issues. In this chapter, we shall be studying how various factors in the environment interact with each other and how we impact the environment. In Class IX, we saw how different materials are cycled in the environment in separate biogeochemical cycles. In these cycles, essential nutrients like nitrogen, carbon, oxygen and water are changed from one form to another. We shall now see how human activities affect these cycles.

15.1 WHAT HAPPENS WHEN WE ADD OUR WASTE TO THE ENVIRONMENT?

In our daily activities, we generate a lot of material that are thrown away. What are some of these waste materials? What happens after we throw them away? Let us perform an activity to find answers to these questions.

Activity 15.1

- Collect waste material from your homes. This could include all the waste generated during a day, like kitchen waste (spoilt food, vegetable peels, used tea leaves, milk packets and empty cartons), waste paper, empty medicine bottles/strips/bubble packs, old and torn clothes and broken footwear.
- Bury this material in a pit in the school garden or if there is no space available, you can collect the material in an old bucket/flower pot and cover with at least 15 cm of soil.
- Keep this material moist and observe at 15-day intervals.
- What are the materials that remain unchanged over long periods of time?
- What are the materials which change their form and structure over time?
- Of these materials that are changed, which ones change the fastest?

We have seen in the chapter on 'Life Processes' that the food we eat is digested by various enzymes in our body. Have you ever wondered why the same enzyme does not break-down everything we eat? Enzymes are specific in their action, specific enzymes are needed for the break-down of a particular substance. That is why we will not get any energy if we try to eat coal! Because of this, many human-made materials like plastics will not be broken down by the action of bacteria or other saprophytes. These materials will be acted upon by physical processes like heat and pressure, but under the ambient conditions found in our environment, these persist for a long time.

Substances that are broken down by biological processes are said to be biodegradable. How many of the substances you buried were biodegradable? Substances that are not broken down in this manner are said to be non-biodegradable. These substances may be inert and simply persist in the environment for a long time or may harm the various members of the eco-system.

Activity 15.2

- Use the library or internet to find out more about biodegradable and non-biodegradable substances.
- How long are various non-biodegradable substances expected to last in our environment?
- These days, new types of plastics which are said to be biodegradable are available. Find out more about such materials and whether they do or do not harm the environment.

Q U E S T I O N S

1. Why are some substances biodegradable and some non-biodegradable?
2. Give any two ways in which biodegradable substances would affect the environment.
3. Give any two ways in which non-biodegradable substances would affect the environment.



15.2 ECO-SYSTEM — WHAT ARE ITS COMPONENTS?

All organisms such as plants, animals, microorganisms and human beings as well as the physical surroundings interact with each other and maintain a balance in nature. All the interacting organisms in an area together with the non-living constituents of the environment form an ecosystem. Thus, an ecosystem consists of biotic components comprising living organisms and abiotic components comprising physical factors like temperature, rainfall, wind, soil and minerals.

For example, if you visit a garden you will find different plants, such as grasses, trees; flower bearing plants like rose, jasmine, sunflower;

and animals like frogs, insects and birds. All these living organisms interact with each other and their growth, reproduction and other activities are affected by the abiotic components of ecosystem. So a garden is an ecosystem. Other types of ecosystems are forests, ponds and lakes. These are natural ecosystems while gardens and crop-fields are human-made (artificial) ecosystems.

Activity 15.3

- You might have seen an aquarium. Let us try to design one.
- What are the things that we need to keep in mind when we create an aquarium? The fish would need a free space for swimming (it could be a large jar), water, oxygen and food.
- We can provide oxygen through an oxygen pump (aerator) and fish food which is available in the market.
- If we add a few aquatic plants and animals it can become a self-sustaining system. Can you think how this happens? An aquarium is an example of a human-made ecosystem.
- Can we leave the aquarium as such after we set it up? Why does it have to be cleaned once in a while? Do we have to clean ponds or lakes in the same manner? Why or why not?

We have seen in earlier classes that organisms can be grouped as producers, consumers and decomposers according to the manner in which they obtain their sustenance from the environment. Let us recall what we have learnt through the self sustaining ecosystem created by us above. Which organisms can make organic compounds like sugar and starch from inorganic substances using the radiant energy of the Sun in the presence of chlorophyll? All green plants and certain blue-green algae which can produce food by photosynthesis come under this category and are called the producers.

Organisms depend on the producers either directly or indirectly for their sustenance? These organisms which consume the food produced, either directly from producers or indirectly by feeding on other consumers are the consumers. Consumers can be classed variously as herbivores, carnivores, omnivores and parasites. Can you give examples for each of these categories of consumers?

- Imagine the situation where you do not clean the aquarium and some fish and plants have died. Have you ever thought what happens when an organism dies? The microorganisms, comprising bacteria and fungi, break-down the dead remains and waste products of organisms. These microorganisms are the decomposers as they break-down the complex organic substances into simple inorganic substances that go into the soil and are used up once more by the plants. What will happen to the garbage, and dead animals and plants in their absence? Will the natural replenishment of the soil take place, even if decomposers are not there?

Activity 15.4

- While creating an aquarium did you take care not to put an aquatic animal which would eat others? What would have happened otherwise?
- Make groups and discuss how each of the above groups of organisms are dependent on each other.
- Write the aquatic organisms in order of who eats whom and form a chain of at least three steps. → →
- Would you consider any one group of organisms to be of primary importance? Why or why not?

15.2.1 Food Chains and Webs

In Activity 15.4 we have formed a series of organisms feeding on one another. This series or organisms taking part at various biotic levels form a food chain (Fig. 15.1).

Each step or level of the food chain forms a trophic level. The autotrophs or the producers are at the first trophic level. They fix up the solar energy and make it available for heterotrophs or the consumers. The herbivores or the primary consumers come at the second, small carnivores or the secondary consumers at the third and larger carnivores or the tertiary consumers form the fourth trophic level (Fig. 15.2).

We know that the food we eat acts as a fuel to provide us energy to do work. Thus the interactions among various components of the environment involves flow of energy from one component of the system to another. As we have studied, the autotrophs capture the energy present in sunlight and convert it into chemical energy. This energy supports all the activities of the living world. From autotrophs, the energy goes to the heterotrophs and decomposers. However, as we saw in the previous Chapter on 'Sources of Energy', when one form of energy is changed to another, some energy is lost to the environment in forms which cannot be used again. The flow of energy between various components of the environment has been extensively studied and it has been found that –

- The green plants in a terrestrial ecosystem capture about 1% of the energy of sunlight that falls on their leaves and convert it into food energy.
- When green plants are eaten by primary consumers, a great deal of energy is lost as heat to the environment, some amount goes into digestion and in doing work and the rest goes towards growth and reproduction. An average of 10% of the food eaten is turned into its own body and made available for the next level of consumers.
- Therefore, 10% can be taken as the average value for the amount of organic matter that is present at each step and reaches the next level of consumers.

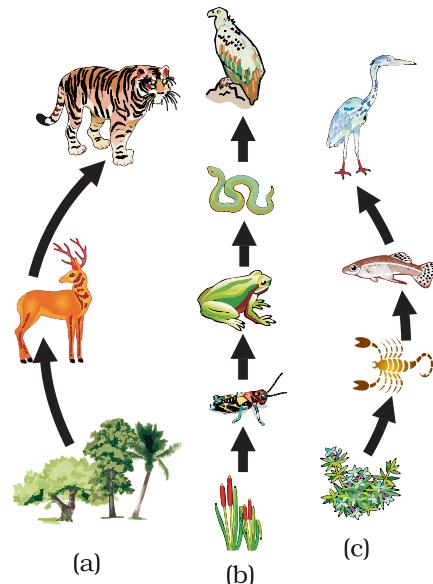


Figure 15.1
Food chain in nature
(a) in forest, (b) in grassland and (c) in a pond

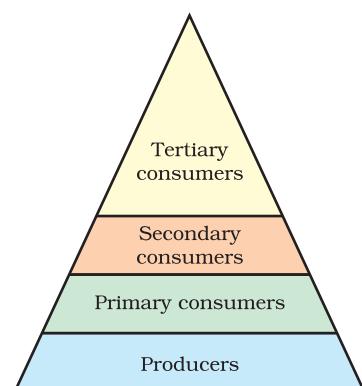


Figure 15.2
Trophic levels

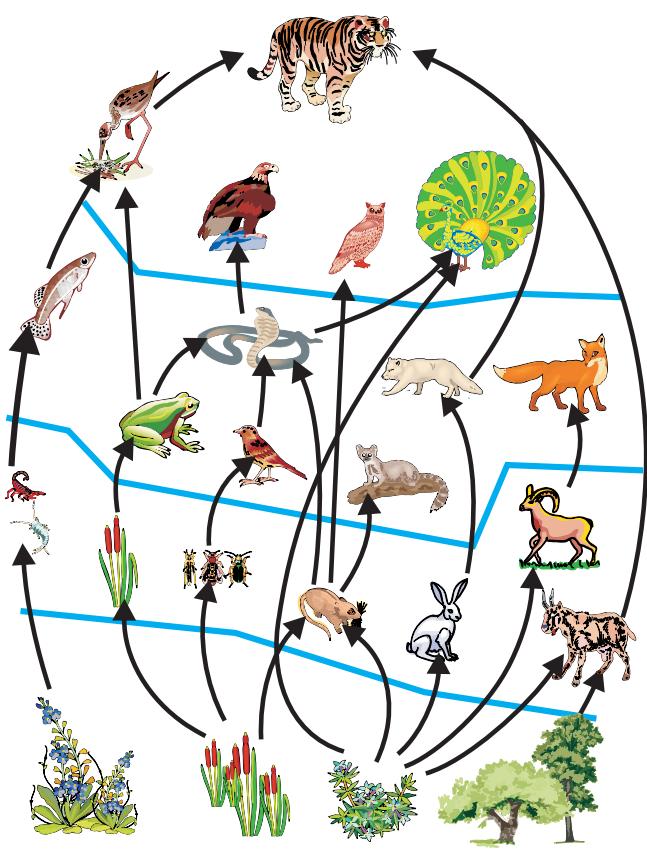


Figure 15.3
Food web, consisting of many food chains

- Since so little energy is available for the next level of consumers, food chains generally consist of only three or four steps. The loss of energy at each step is so great that very little usable energy remains after four trophic levels.
- There are generally a greater number of individuals at the lower trophic levels of an ecosystem, the greatest number is of the producers.
- The length and complexity of food chains vary greatly. Each organism is generally eaten by two or more other kinds of organisms which in turn are eaten by several other organisms. So instead of a straight line food chain, the relationship can be shown as a series of branching lines called a food web (Fig. 15.3).

From the energy flow diagram (Fig. 15.4), two things become clear. Firstly, the flow of energy is unidirectional. The energy that is captured by the autotrophs does not revert back to the solar input and the energy which passes to the herbivores does not come back to autotrophs. As it moves progressively through the various trophic levels it is no longer available to the previous level.

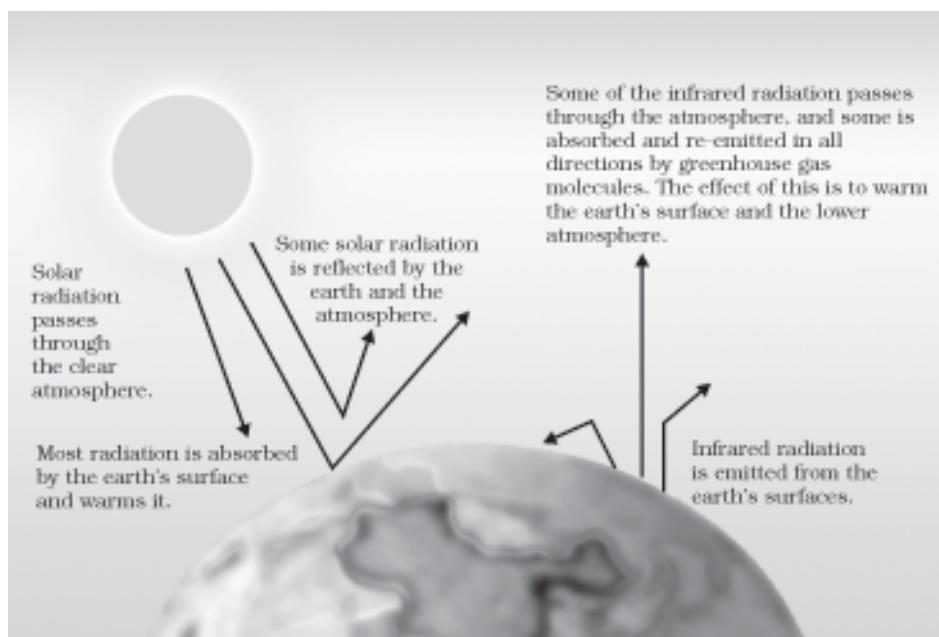


Figure 15.4 Diagram showing flow of energy in an ecosystem

Another interesting aspect of food chain is how unknowingly some harmful chemicals enter our bodies through the food chain. You have read in Class IX how water gets polluted. One of the reasons is the use of several pesticides and other chemicals to protect our crops from diseases and pests. These chemicals are either washed down into the soil or into the water bodies. From the soil, these are absorbed by the plants along with water and minerals, and from the water bodies these are taken up by aquatic plants and animals. This is one of the ways in which they enter the food chain. As these chemicals are not degradable, these get accumulated progressively at each trophic level. As human beings occupy the top level in any food chain, the maximum concentration of these chemicals get accumulated in our bodies. This phenomenon is known as biological magnification. This is the reason why our food grains such as wheat and rice, vegetables and fruits, and even meat, contain varying amounts of pesticide residues. They cannot always be removed by washing or other means.

Activity 15.5

- Newspaper reports about pesticide levels in ready-made food items are often seen these days and some states have banned these products. Debate in groups the need for such bans.
- What do you think would be the source of pesticides in these food items? Could pesticides get into our bodies from this source through other food products too?
- Discuss what methods could be applied to reduce our intake of pesticides.

Q U E S T I O N S

1. *What are trophic levels? Give an example of a food chain and state the different trophic levels in it.*
2. *What is the role of decomposers in the ecosystem?*



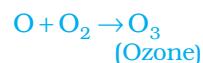
15.3 HOW DO OUR ACTIVITIES AFFECT THE ENVIRONMENT?

We are an integral part of the environment. Changes in the environment affect us and our activities change the environment around us. We have already seen in Class IX how our activities pollute the environment. In this chapter, we shall be looking at two of the environmental problems in detail, that is, depletion of the ozone layer and waste disposal.

15.3.1 Ozone Layer and How it is Getting Depleted

Ozone (O_3) is a molecule formed by three atoms of oxygen. While O_2 , which we normally refer to as oxygen, is essential for all aerobic forms of life. Ozone, is a deadly poison. However, at the higher levels of the atmosphere, ozone performs an essential function. It shields the surface of the earth from ultraviolet (UV) radiation from the Sun. This radiation is highly damaging to organisms, for example, it is known to cause skin cancer in human beings.

Ozone at the higher levels of the atmosphere is a product of UV radiation acting on oxygen (O_2) molecule. The higher energy UV radiations split apart some molecular oxygen (O_2) into free oxygen (O) atoms. These atoms then combine with the molecular oxygen to form ozone as shown—



The amount of ozone in the atmosphere began to drop sharply in the 1980s. This decrease has been linked to synthetic chemicals like chlorofluorocarbons (CFCs) which are used as refrigerants and in fire extinguishers. In 1987, the United Nations Environment Programme (UNEP) succeeded in forging an agreement to freeze CFC production at 1986 levels.

Activity 15.6

- Find out from the library, internet or newspaper reports, which chemicals are responsible for the depletion of the ozone layer.
- Find out if the regulations put in place to control the emission of these chemicals have succeeded in reducing the damage to the ozone layer. Has the size of the hole in the ozone layer changed in recent years?

15.3.2 Managing the Garbage we Produce

Visit any town or city, and we are sure to find heaps of garbage all over the place. Visit any place of tourist interest and we are sure to find the place littered with empty food wrappers. In the earlier classes we have talked about this problem of dealing with the garbage that we generate. Let us now look at the problem a bit more deeply.

Activity 15.7

- Find out what happens to the waste generated at home. Is there a system in place to collect this waste?
- Find out how the local body (panchayat, municipal corporation, resident welfare association) deals with the waste. Are there mechanisms in place to treat the biodegradable and non-biodegradable wastes separately?

Activity 15.8

- Calculate how much waste is generated at home in a day.
- How much of this waste is biodegradable?
- Calculate how much waste is generated in the classroom in a day.
- How much of this waste is biodegradable?
- Suggest ways of dealing with this waste.

Activity 15.9

- Find out how the sewage in your locality is treated. Are there mechanisms in place to ensure that local water bodies are not polluted by untreated sewage.
- Find out how the local industries in your locality treat their wastes. Are there mechanisms in place to ensure that the soil and water are not polluted by this waste?

Improvements in our life-style have resulted in greater amounts of waste material generation. Changes in attitude also have a role to play, with more and more things we use becoming disposable. Changes in packaging have resulted in much of our waste becoming non-biodegradable. What do you think will be the impact of these on our environment?

Think it over

Disposable cups in trains

If you ask your parents, they will probably remember a time when tea in trains was served in plastic glasses which had to be returned to the vendor. The introduction of disposable cups was hailed as a step forward for reasons of hygiene. No one at that time perhaps thought about the impact caused by the disposal of millions of these cups on a daily basis. Some time back, *kulhads*, that is, disposable cups made of clay, were suggested as an alternative. But a little thought showed that making these *kulhads* on a large scale would result in the loss of the fertile top-soil. Now disposable paper-cups are being used. What do you think are the advantages of disposable paper-cups over disposable plastic cups?

Activity 15.10

- Search the internet or library to find out what hazardous materials have to be dealt with while disposing of electronic items. How would these materials affect the environment?
- Find out how plastics are recycled. Does the recycling process have any impact on the environment?

QUESTIONS

1. What is ozone and how does it affect any ecosystem?
2. How can you help in reducing the problem of waste disposal? Give any two methods.



What you have learnt

- The various components of an ecosystem are interdependent.
- The producers make the energy from sunlight available to the rest of the ecosystem.
- There is a loss of energy as we go from one trophic level to the next, this limits the number of trophic levels in a food-chain.
- Human activities have an impact on the environment.
- The use of chemicals like CFCs has endangered the ozone layer. Since the ozone layer protects against the ultraviolet radiation from the Sun, this could damage the environment.
- The waste we generate may be biodegradable or non-biodegradable.
- The disposal of the waste we generate is causing serious environmental problems.

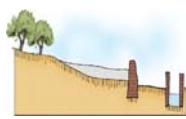
EXERCISES

1. Which of the following groups contain only biodegradable items?
 - (a) Grass, flowers and leather
 - (b) Grass, wood and plastic
 - (c) Fruit-peels, cake and lime-juice
 - (d) Cake, wood and grass
2. Which of the following constitute a food-chain?
 - (a) Grass, wheat and mango
 - (b) Grass, goat and human
 - (c) Goat, cow and elephant
 - (d) Grass, fish and goat
3. Which of the following are environment-friendly practices?
 - (a) Carrying cloth-bags to put purchases in while shopping
 - (b) Switching off unnecessary lights and fans
 - (c) Walking to school instead of getting your mother to drop you on her scooter
 - (d) All of the above

4. *What will happen if we kill all the organisms in one trophic level?*
5. *Will the impact of removing all the organisms in a trophic level be different for different trophic levels? Can the organisms of any trophic level be removed without causing any damage to the ecosystem?*
6. *What is biological magnification? Will the levels of this magnification be different at different levels of the ecosystem?*
7. *What are the problems caused by the non-biodegradable wastes that we generate?*
8. *If all the waste we generate is biodegradable, will this have no impact on the environment?*
9. *Why is damage to the ozone layer a cause for concern? What steps are being taken to limit this damage?*

CHAPTER 16

Management of Natural Resources



We learnt in Class IX, about some natural resources like soil, air and water and how various components are cycled over and over again in nature. In the previous chapter we also learnt about the pollution of these resources because of some of our activities. In this chapter, we shall look at some of our resources and how we are using them. May be we should also think about how we ought to be using our resources so as to sustain the resources and conserve our environment. We shall be looking at our natural resources like forests, wild-life, water, coal and petroleum and see what are the issues at stake in deciding how these resources are to be managed for sustainable development.

We often hear or read about environmental problems. These are often global-level problems and we feel helpless to make any changes. There are international laws and regulations, and then there are our own national laws and acts for environmental protection. There are also national and international organisations working towards protecting our environment.

Activity 16.1

- Find out about the international norms to regulate the emission of carbon dioxide.
- Have a discussion in class about how we can contribute towards meeting those norms.

Activity 16.2

- There are a number of organisations that seek to spread awareness about our environment and promote activities and attitudes that lead to the conservation of our environment and natural resources. Find out about the organisation(s) active in your neighbourhood/village/town/city.
- Find out how you can contribute towards the same cause.

Awareness about the problems caused by unthinkingly exploiting our resources has been a fairly recent phenomenon in our society. And once this awareness rises, some action is usually taken. You must have heard about the Ganga Action Plan. This multi-crore project came about in 1985 because the quality of the water in the Ganga was very poor

(see Fig. 16.1). Coliform is a group of bacteria, found in human intestines, whose presence in water indicates contamination by disease-causing microorganisms.

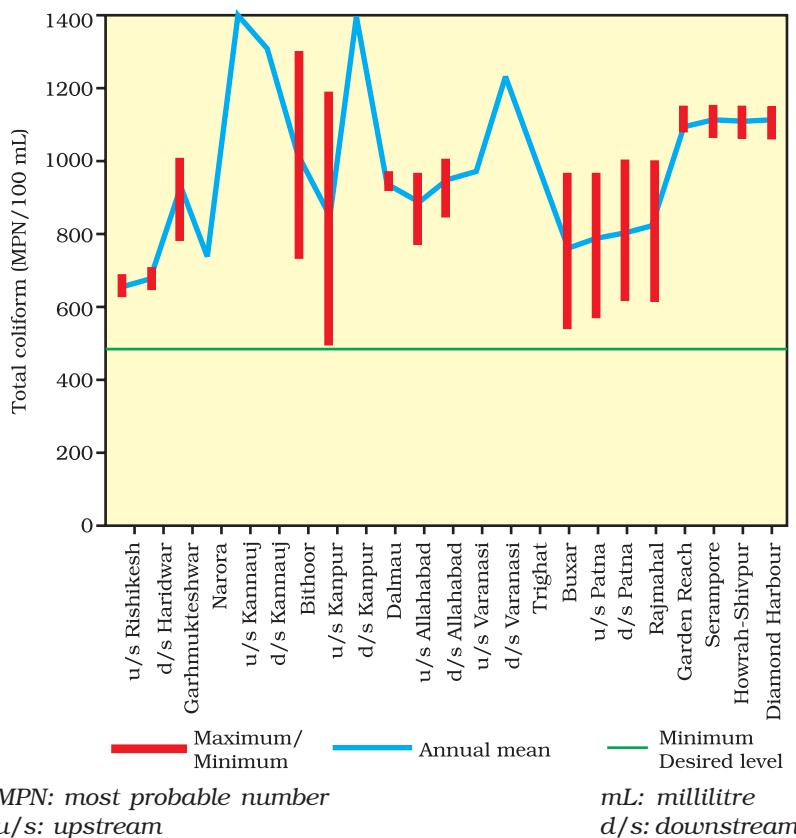


Figure 16.1 Total coliform count levels in the Ganga (1993-1994)

Source: Anon 1996, Water Quality – Status and Statistics (1993 & 1994), Central Pollution Control Board, Delhi, p.11.

Do You Know?

Pollution of the Ganga

The Ganga runs its course of over 2500 km from Gangotri in the Himalayas to Ganga Sagar in the Bay of Bengal. It is being turned into a drain by more than a hundred towns and cities in Uttar Pradesh, Bihar and West Bengal that pour their garbage and excreta into it. Largely untreated sewage is dumped into the Ganges every day. In addition, think of the pollution caused by other human activities like bathing, washing of clothes and immersion of ashes or unburnt corpses. And then, industries contribute chemical effluents to the Ganga's pollution load and the toxicity kills fish in large sections of the river.

As you can see, there are some measurable factors which are used to quantify pollution or the quality of the water that we use for various activities. Some of the pollutants are harmful even when present in very small quantities and we require sophisticated equipment to measure them. But as we learnt in Chapter 2, the pH of water is something that can easily be checked using universal indicator.

Activity 16.3

- Check the pH of the water supplied to your house using universal indicator or litmus paper.
- Also check the pH of the water in the local water body (pond, river, lake, stream).
- Can you say whether the water is polluted or not on the basis of your observations?

But we need not feel powerless or overwhelmed by the scale of the problems because there are many things we can do to make a difference. You must have come across the three R's to save the environment: Reduce, Recycle and Reuse. What do they refer to?

Reduce: This means that you use less. You save electricity by switching off unnecessary lights and fans. You save water by repairing leaky taps. You do not waste food. Can you think of other things that you can reduce the usage of?

Recycle: This means that you collect plastic, paper, glass and metal items and recycle these materials to make required things instead of synthesising or extracting fresh plastic, paper, glass or metal. In order to recycle, we first need to segregate our wastes so that the material that can be recycled is not dumped along with other wastes. Does your village/town/city have a mechanism in place for recycling these materials?

Reuse: This is actually even better than recycling because the process of recycling uses some energy. In the 'reuse' strategy, you simply use things again and again. Instead of throwing away used envelopes, you can reverse it and use it again. The plastic bottles in which you buy various food-items like jam or pickle can be used for storing things in the kitchen. What other items can we reuse?

But even while making everyday choices, we can make environment-friendly decisions. For doing this, we need to know more about how our choices affect the environment, these effects may be immediate or long-term or long-ranging. The concept of sustainable development encourages forms of growth that meet current basic human needs, while preserving the resources for the needs of future generations. Economic development is linked to environmental conservation. Thus sustainable development implies a change in all aspects of life. It depends upon the willingness of the people to change their perceptions of the socio-economic and environmental conditions around them, and the readiness of each individual to alter their present use of natural resources.

Activity 16.4

- Have you ever visited a town or village after a few years of absence? If so, have you noticed new roads and houses that have come up since you were there last? Where do you think the materials for making these roads and buildings have come from?
- Try and make a list of the materials and their probable sources.
- Discuss the list you have prepared with your classmates. Can you think of ways in which the use of these materials be reduced?

16.1 WHY DO WE NEED TO MANAGE OUR RESOURCES?

Not just roads and buildings, but all the things we use or consume – food, clothes, books, toys, furniture, tools and vehicles – are obtained from resources on this earth. The only thing we get from outside is energy which we receive from the Sun. Even this energy is processed by living organisms and various physical and chemical processes on the earth before we make use of it.

Why do we need to use our resources carefully? Because these are not unlimited and with the human population increasing at a tremendous rate due to improvement in health-care, the demand for all resources is increasing at an exponential rate. The management of natural resources requires a long-term perspective so that these will last for the generations to come and will not merely be exploited to the hilt for short term gains. This management should also ensure equitable distribution of resources so that all, and not just a handful of rich and powerful people, benefit from the development of these resources.

Another factor to be considered while we exploit these natural resources is the damage we cause to the environment while these resources are either extracted or used. For example, mining causes pollution because of the large amount of slag which is discarded for every tonne of metal extracted. Hence, sustainable natural resource management demands that we plan for the safe disposal of these wastes too.

QUESTIONS

1. What changes can you make in your habits to become more environment-friendly?
2. What would be the advantages of exploiting resources with short-term aims?
3. How would these advantages differ from the advantages of using a long-term perspective in managing our resources?
4. Why do you think there should be equitable distribution of resources? What forces would be working against an equitable distribution of our resources?



16.2 FORESTS AND WILD LIFE

Forests are 'biodiversity hot spots'. One measure of the biodiversity of an area is the number of species found there. However, the range of different life forms (bacteria, fungi, ferns, flowering plants, nematodes, insects, birds, reptiles and so on) is also important. One of the main aims of conservation is to try and preserve the biodiversity we have inherited. Experiments and field studies suggest that a loss of diversity may lead to a loss of ecological stability.

16.2.1 Stakeholders

Activity 16.5

- Make a list of forest produce that you use.
- What do you think a person living near a forest would use?
- What do you think a person living in a forest would use?
- Discuss with your classmates how these needs differ or do not differ and the reasons for the same.

We all use various forest produce. But our dependency on forest resources varies. Some of us have access to alternatives, some do not. When we consider the conservation of forests, we need to look at the stakeholders who are –

- (i) the people who live in or around forests are dependent on forest produce for various aspects of their life (see Fig. 16.2).
- (ii) the Forest Department of the Government which owns the land and controls the resources from forests.
- (iii) the industrialists – from those who use ‘tendu’ leaves to make *bidis* to the ones with paper mills – who use various forest produce, but are not dependent on the forests in any one area.
- (iv) the wild life and nature enthusiasts who want to conserve nature in its pristine form.



Figure 16.2
A view of a forest life

Let us take a look at what each of these groups needs/gets out of the forests. The local people need large quantities of firewood, small timber and thatch. Bamboo is used to make slats for huts, and baskets for collecting and storing food materials. Implements for agriculture, fishing and hunting are largely made of wood, also forests are sites for fishing and hunting. In addition to people gathering fruits, nuts and medicines from the forests, their cattle also graze in forest areas or feed on other fodder which is collected from forests.

Do you think such use of forest resources would lead to the exhaustion of these resources? Do not forget that before the British came and took over most of our forest areas, people had been living in these forests for centuries. They had developed practices to ensure that the resources were used in a sustainable manner. After the British took control of the forests (which they exploited ruthlessly for their own purposes), these people were forced to depend on much smaller areas and forest resources started becoming over-exploited to some extent. The Forest Department in independent India took over from the British but local knowledge and local needs continued to be ignored in the management practices. Thus vast tracts of forests have been converted to monocultures of pine, teak or eucalyptus. In order to plant these trees, huge areas are first cleared of all vegetation. This destroys a large amount of biodiversity in the area. Not only this, the varied needs of the

local people – leaves for fodder, herbs for medicines, fruits and nuts for food – can no longer be met from such forests. Such plantations are useful for the industries to access specific products and are an important source of revenue for the Forest Department.

Do you know how many industries are based on forest produce? A short count reveals timber, paper, lac and sports equipment.

Activity 16.6

- Find out about any two forest produce that are the basis for an industry.
- Discuss whether this industry is sustainable in the long run. Or do we need to control our consumption of these products?

Industries would consider the forest as merely a source of raw material for its factories. And huge interest-groups lobby the government for access to these raw materials at artificially low rates. Since these industries have a greater reach than the local people, they are not interested in the sustainability of the forest in one particular area. For example, after cutting down all the teak trees in one area, they will get their teak from a forest farther away. They do not have any stake in ensuring that one particular area should yield on optimal amount of some produce for all generations to come. What do you think will stop the local people in behaving in a similar manner?

Lastly, we come to the nature and wildlife enthusiasts who are in no way dependent on the forests, but who may have considerable say in their management. The conservationists were initially taken up with large animals like lions, tigers, elephants and rhinoceros. They now recognise the need to preserve biodiversity as a whole. But shouldn't we recognise people as forming part of the forest system? There have been enough instances of local people working traditionally for conservation of forests. For example, the case of the Bishnoi community in Rajasthan, for whom conservation of forest and wildlife has been a religious tenet. The Government of India has recently instituted an 'Amrita Devi Bishnoi National Award for Wildlife Conservation' in the memory of Amrita Devi Bishnoi, who in 1731 sacrificed her life along with 363 others for the protection of 'khejri' trees in Khejrali village near Jodhpur in Rajasthan.

Studies have shown that the prejudice against the traditional use of forest areas has no basis. Here is an example – the great Himalayan National Park contains, within its reserved area, alpine meadows which were grazed by sheep in summer. Nomadic shepherds drove their flock up from the valleys every summer. When this national park was formed, this practice was put to an end. Now it is seen that without the regular grazing by sheep the grass first grows very tall, and then falls over preventing fresh growth.

Management of protected areas, by keeping the local people out, by using force cannot possibly be successful in the long run. In any case, the damage caused to forests cannot be attributed to only the local people – one cannot turn a blind eye to the deforestation caused by industrial

needs or development projects like building roads or dams. The damage caused in these reserves by tourists or the arrangements made for their convenience is also to be considered.

We need to accept that human intervention has been very much a part of the forest landscape. What has to be managed in the nature and extent of this intervention. Forest resources ought to be used in a manner that is both environmentally and developmentally sound – in other words, while the environment is preserved, the benefits of the controlled exploitation go to the local people, a process in which decentralised economic growth and ecological conservation go hand in hand. The kind of economic and social development we want will ultimately determine whether the environment will be conserved or further destroyed. The environment must not be regarded as a pristine collection of plants and animals. It is a vast and complex entity that offers a range of natural resources for our use. We need to use these resources with due caution for our economic and social growth, and to meet our material aspirations.

16.2.2 Sustainable Management

We need to consider if the goals of all the above stakeholders with regard to the management of the forests are the same. Forest resources are often made available for industrial use at rates far below the market value while these are denied to the local people. The *Chipko Andolan* ('Hug the Trees Movement') was the result of a grassroots level effort to end the alienation of people from their forests. The movement originated from an incident in a remote village called Reni in Garhwal, high-up in the Himalayas during the early 1970s. There was a dispute between the local villagers and a logging contractor who had been allowed to fell trees in a forest close to the village. On a particular day, the contractor's workers appeared in the forest to cut the trees while the men folk were absent. Undeterred, the women of the village reached the forest quickly and clasped the tree trunks thus preventing the workers from felling the trees. Thus thwarted, the contractor had to withdraw.

Inherent in such a competition to control a natural resource is the conservation of a replenishable resource. Specifically the method of use was being called into question. The contractor would have felled the trees, destroying them forever. The communities traditionally lop the branches and pluck the leaves, allowing the resource to replenish over time. The *Chipko* movement quickly spread across communities and media, and forced the government, to whom the forest belongs, to rethink their priorities in the use of forest produce. Experience has taught people that the destruction of forests affected not just the availability of forest products, but also the quality of soil and the sources of water. Participation of the local people can indeed lead to the efficient management of forests.

An Example of People's Participation in the Management of Forests
In 1972, the West Bengal Forest Department recognised its failures in reviving the degraded *Sal* forests in the southwestern districts of the state. Traditional methods of surveillance and policing had led to a

'complete alienation of the people from the administration', resulting in frequent clashes between forest officials and villagers. Forest and land related conflicts in the region were also a major factor in fuelling the militant peasant movements led by the Naxalites.

Accordingly, the Department changed its strategy, making a beginning in the Arabari forest range of Midnapore district. Here, at the instance of a far-seeing forest officer, A.K. Banerjee, villagers were involved in the protection of 1,272 hectares of badly degraded sal forest. In return for help in protection, villagers were given employment in both silviculture and harvesting operations, 25 per cent of the final harvest, and allowed fuelwood and fodder collection on payment of a nominal fee. With the active and willing participation of the local community, the sal forests of Arabari underwent a remarkable recovery – by 1983, a previously worthless forest was valued Rs 12.5 crores.

Activity 16.7

- Debate the damage caused to forests by the following –
 - (a) Building rest houses for tourists in national parks.
 - (b) Grazing domestic animals in national parks.
 - (c) Tourists throwing plastic bottles/covers and other litter in national parks.

Q U E S T I O N S

1. *Why should we conserve forests and wildlife?*
2. *Suggest some approaches towards the conservation of forests.*



16.3 WATER FOR ALL

Activity 16.8

- Villages suffering from chronic water shortage surround a water theme park in Maharashtra. Debate whether this is the optimum use of the available water.

Water is a basic necessity for all terrestrial forms of life. We studied in Class IX about the importance of water as a resource, the water cycle and how human intervention pollutes water bodies. However, human intervention also changes the availability of water in various regions.

Activity 16.9

- Study the rainfall patterns in India from an atlas.
- Identify the regions where water is abundant and the regions of water scarcity.

After the above activity, would you be very surprised to learn that regions of water scarcity are closely correlated to the regions of acute poverty?

A study of rainfall patterns does not reveal the whole truth behind the water availability in various regions in India. Rains in India are largely due to the monsoons. This means that most of the rain falls in a few months of the year. Despite nature's monsoon bounty, failure to sustain water availability underground has resulted largely from the loss of vegetation cover, diversion for high water demanding crops, and pollution from industrial effluents and urban wastes. Irrigation methods like dams, tanks and canals have been used in various parts of India since ancient times. These were generally local interventions managed by local people and assured that the basic minimum requirements for both agriculture and daily needs were met throughout the year. The use of this stored water was strictly regulated and the optimum cropping patterns based on the water availability were arrived at on the basis of decades/centuries of experience, the maintenance of these irrigation systems was also a local affair.

The arrival of the British changed these systems as it changed many other things. The conception of large scale projects – large dams and canals traversing large distances were first conceived and implemented by the British and carried on with no less gusto by our newly formed independent government. These mega-projects led to the neglect of the local irrigation methods, and the government also increasingly took over the administration of these systems leading to the loss of control over the local water sources by the local people.

Kulhs in Himachal Pradesh

Parts of Himachal Pradesh had evolved a local system of canal irrigation called *kulhs* over four hundred years ago. The water flowing in the streams was diverted into man-made channels which took this water to numerous villages down the hillside. The management of the water flowing in these *kulhs* was by common agreement among all the villages. Interestingly, during the planting season, water was first used by the village farthest away from the source of the *kulh*, then by villages progressively higher up. These *kulhs* were managed by two or three people who were paid by the villagers. In addition to irrigation, water from these *kulhs* also percolated into the soil and fed springs at various points. After the *kulhs* were taken over by the Irrigation Department, most of them became defunct and there is no amicable sharing of water as before.

16.3.1 Dams

Why do we seek to build dams? Large dams can ensure the storage of adequate water not just for irrigation, but also for generating electricity, as discussed in the previous chapter. Canal systems leading from these dams can transfer large amounts of water great distances. For example, the Indira Gandhi Canal has brought greenery to considerable areas of Rajasthan. However, mismanagement of the water has largely led to the benefits being cornered by a few people. There is no equitable distribution

of water, thus people close to the source grow water intensive crops like sugarcane and rice while people farther downstream do not get any water. The woes of these people who have been promised benefits which never arrived are added to the discontentment among the people who have been displaced by the building of the dam and its canal network.

In the previous chapter, we mentioned the reasons for opposition to the construction of large dams, such as the Tehri Dam on the river Ganga. You must have read about the protests by the *Narmada Bachao Andolan* ('Save the Narmada Movement') about raising the height of the Sardar Sarovar Dam on the river Narmada. Criticisms about large dams address three problems in particular –

- (i) Social problems because they displace large number of peasants and tribals without adequate compensation or rehabilitation,
- (ii) Economic problems because they swallow up huge amounts of public money without the generation of proportionate benefits,
- (iii) Environmental problems because they contribute enormously to deforestation and the loss of biological diversity.

The people who have been displaced by various development projects are largely poor tribals who do not get any benefits from these projects and are alienated from their lands and forests without adequate compensation. The oustees of the Tawa Dam built in the 1970s are still fighting for the benefits they were promised.

16.3.2 Water Harvesting

Watershed management emphasises scientific soil and water conservation in order to increase the biomass production. The aim is to develop primary resources of land and water, to produce secondary resources of plants and animals for use in a manner which will not cause ecological imbalance. Watershed management not only increases the production and income of the watershed community, but also mitigates droughts and floods and increases the life of the downstream dam and reservoirs. Various organisations have been working on rejuvenating ancient systems of water harvesting as an alternative to the 'mega-projects' like dams. These communities have used hundreds of indigenous water saving methods to capture every trickle of water that had fallen on their land; dug small pits and lakes, put in place simple watershed systems, built small earthen dams, constructed dykes, sand and limestone reservoirs, set up rooftop water-collecting units. This has recharged groundwater levels and even brought rivers back to life.

Water harvesting is an age-old concept in India. *Khadins*, tanks and *nadis* in Rajasthan, *bandharas* and *tals* in Maharashtra, *bundhis* in Madhya Pradesh and Uttar Pradesh, *ahars* and *pynes* in Bihar, *kulhs* in Himachal Pradesh, ponds in the Kandi belt of Jammu region, and *eris* (tanks) in Tamil Nadu, *surangams* in Kerala, and *kattas* in Karnataka are some of the ancient water harvesting, including water conveyance, structures still in use today (see Fig. 16.3 for an example). Water harvesting techniques are highly locale specific and the benefits are also localised. Giving people control over their local water resources ensures that mismanagement and over-exploitation of these resources is reduced/removed.

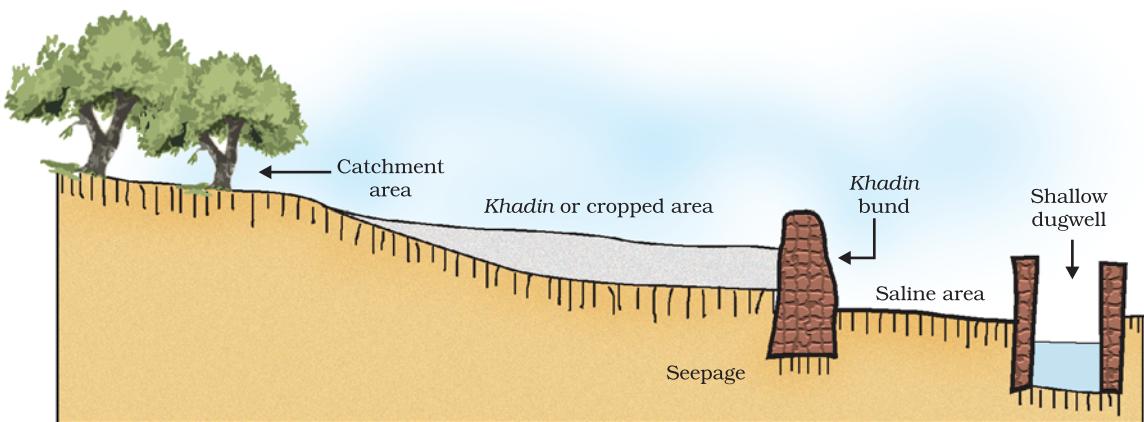


Figure 16.3 Traditional water harvesting system — an ideal setting of the khadin system

In largely level terrain, the water harvesting structures are mainly crescent shaped earthen embankments or low, straight concrete-and-rubble “check dams” built across seasonally flooded gullies. Monsoon rains fill ponds behind the structures. Only the largest structures hold water year round; most dry up six months or less after the monsoons. Their main purpose, however, is not to hold surface water but to recharge the ground water beneath. The advantages of water stored in the ground are many. It does not evaporate, but spreads out to recharge wells and provides moisture for vegetation over a wide area. In addition, it does not provide breeding grounds for mosquitoes like stagnant water collected in ponds or artificial lakes. The ground-water is also relatively protected from contamination by human and animal waste.

Q U E S T I O N S

- Find out about the traditional systems of water harvesting/management in your region.
- Compare the above system with the probable systems in hilly/mountainous areas or plains or plateau regions.
- Find out the source of water in your region/locality. Is water from this source available to all people living in that area?



16.4 COAL AND PETROLEUM

We have seen some of the issues involved in the conservation and sustainable use of resources like forests, wild-life and water. These can meet our needs perpetually if we were to use them in a sustainable manner. Now we come to yet another important resource – fossil fuels, that is, coal and petroleum, which are important sources of energy for us. Since the industrial revolution, we have been using increasing amounts of energy to meet our basic needs and for the manufacture of a

large number of goods upon which our lives depend. These energy needs have been largely met by the reserves of coal and petroleum.

The management of these energy sources involves slightly different perspectives from those resources discussed earlier. Coal and petroleum were formed from the degradation of bio-mass millions of years ago and hence these are resources that will be exhausted in the future no matter how carefully we use them. And then we would need to look for alternative sources of energy. Various estimates as to how long these resources will last us exist and one is that at present rates of usage, our known petroleum resources will last us for about forty years and the coal resources will last for another two hundred years.

But looking to other sources of energy is not the only consideration when we look at the consumption of coal and petroleum. Since coal and petroleum have been formed from bio-mass, in addition to carbon, these contain hydrogen, nitrogen and sulphur. When these are burnt, the products are carbon dioxide, water, oxides of nitrogen and oxides of sulphur. When combustion takes place in insufficient air (oxygen), then carbon monoxide is formed instead of carbon dioxide. Of these products, the oxides of sulphur and nitrogen and carbon monoxide are poisonous at high concentrations and carbon dioxide is a green-house gas. Another way of looking at coal and petroleum is that they are huge reservoirs of carbon and if all of this carbon is converted to carbon dioxide, then the amount of carbon dioxide in the atmosphere is going to increase leading to intense global warming. Thus, we need to use these resources judiciously.

Activity 16.10

- Coal is used in thermal power stations and petroleum products like petrol and diesel are used in means of transport like motor vehicles, ships and aeroplanes. We cannot really imagine life without a number of electrical appliances and constant use of transportation. So can you think of ways in which our consumption of coal and petroleum products be reduced?

Some simple choices can make a difference in our energy consumption patterns. Think over the relative advantages, disadvantages and environment-friendliness of the following –

- (i) Taking a bus, using your personal vehicle or walking/cycling.
- (ii) Using bulbs or fluorescent tubes in your homes.
- (iii) Using the lift or taking the stairs.
- (iv) Wearing an extra sweater or using a heating device (heater or 'sigri') on cold days.

The management of coal and petroleum also addresses the efficiency of our machines. Fuel is most commonly used in internal combustion engines for transportation and recent research in this field concentrates on ensuring complete combustion in these engines in order to increase efficiency and also reduce air pollution.

Activity 16.11

- You must have heard of the Euro I and Euro II norms for emission from vehicles. Find out how these norms work towards reducing air pollution.

16.5 AN OVERVIEW OF NATURAL RESOURCE MANAGEMENT

Sustainable management of natural resources is a difficult task. In addressing this issue, we need to keep an open mind with regard to the interests of various stakeholders. We need to accept that people will act with their own best interests as the priority. But the realisation that such selfish goals will lead to misery for a large number of people and a total destruction of our environment is slowly growing. Going beyond laws, rules and regulations, we need to tailor our requirements, individually and collectively, so that the benefits of development reach everyone now and for all generations to come.

What you have learnt

- Our resources like forests, wild life, water, coal and petroleum need to be used in a sustainable manner.
- We can reduce pressure on the environment by sincerely applying the maxim of 'Reduce, Reuse and Recycle' in our lives.
- Management of forest resources has to take into account the interests of various stakeholders.
- The harnessing of water resources by building dams has social, economic and environmental implications. Alternatives to large dams exist. These are locale-specific and may be developed so as to give local people control over their local resources.
- The fossil fuels, coal and petroleum, will ultimately be exhausted. Because of this and because their combustion pollutes our environment, we need to use these resources judiciously.

EXERCISES

- What changes would you suggest in your home in order to be environment-friendly?
- Can you suggest some changes in your school which would make it environment-friendly?
- We saw in this chapter that there are four main stakeholders when it comes to forests and wildlife. Which among these should have the authority to decide the management of forest produce? Why do you think so?

4. How can you as an individual contribute or make a difference to the management of (a) forests and wildlife, (b) water resources and (c) coal and petroleum?
5. What can you as an individual do to reduce your consumption of the various natural resources?
6. List five things you have done over the last one week to –
 - (a) conserve our natural resources.
 - (b) increase the pressure on our natural resources.
7. On the basis of the issues raised in this chapter, what changes would you incorporate in your life-style in a move towards a sustainable use of our resources?