You already know that three-fourth of the earth's surface is covered with water, but only a small proportion of it accounts for freshwater that can be put to use. This freshwater is mainly obtained from surface run off and ground water that is continually being renewed and recharged through the hydrological cycle. All water moves within the hydrological cycle ensuring that water is a renewable resource.

You might wonder that if three-fourth of the world is covered with water and water is a renewable resource, then how is it that countries and regions around the globe suffer from water scarcity? Why is it predicted that by 2025, nearly two billion people will live in absolute water scarcity?

**Water Scarcity and the Need for Water Conservation and Management**

Given the abundance and renewability of water, it is difficult to imagine that we may suffer from water scarcity. The moment we speak of water shortages, we immediately associate it with regions having low rainfall or those that are drought prone. We instantaneously visualise the deserts of Rajasthan and women balancing many ‘matkas’ (earthen pots) used for collecting and storing water and travelling long distances to get water. True, the availability of water resources varies over space and time, mainly due to the variations in seasonal and annual precipitation, but water scarcity in
most cases is caused by over-exploitation, excessive use and unequal access to water among different social groups.

Where is then water scarcity likely to occur? As you have read in the hydrological cycle, freshwater can be obtained directly from precipitation, surface run off and groundwater.

Is it possible that an area or region may have ample water resources but is still facing water scarcity? Many of our cities are such examples. Thus, water scarcity may be an outcome of large and growing population and consequent greater demands for water, and unequal access to it. A large population requires more water not only for domestic use but also to produce more food. Hence, to facilitate higher food-grain production, water resources are being over-exploited to expand irrigated areas for dry-season agriculture. Irrigated agriculture is the largest consumer of water. Now it is needed to revolutionise the agriculture through developing drought resistant crops and dry farming techniques. You may have seen in many television advertisements that most farmers have their
You may have already realised that the need of the hour is to conserve and manage our water resources, to safeguard ourselves from health hazards, to ensure food security, continuation of our livelihoods and productive activities and also to prevent degradation of our natural ecosystems. Overexploitation and mismanagement of water resources will impoverish this resource and cause ecological crisis that may have profound impact on our lives.

Post-independent India witnessed intensive industrialisation and urbanisation, creating vast opportunities for us. Today, large industrial houses are as commonplace as the industrial units of many MNCs (Multinational Corporations). The ever-increasing number of industries has made matters worse by exerting pressure on existing freshwater resources. Industries, apart from being heavy users of water, also require power to run them. Much of this energy comes from hydroelectric power. Today, in India hydroelectric power contributes approximately 22 per cent of the total electricity produced. Moreover, multiplying urban centres with large and dense populations and urban lifestyles have not only added to water and energy requirements but have further aggravated the problem. If you look into the housing societies or colonies in the cities, you would find that most of these have their own groundwater pumping devices to meet their water needs. Not surprisingly, we find that fragile water resources are being over-exploited and have caused their depletion in several of these cities.

So far we have focused on the quantitative aspects of water scarcity. Now, let us consider another situation where water is sufficiently available to meet the needs of the people, but, the area still suffers from water scarcity. This scarcity may be due to bad quality of water. Lately, there has been a growing concern that even if there is ample water to meet the needs of the people, much of it may be polluted by domestic and industrial wastes, chemicals, pesticides and fertilisers used in agriculture, thus, making it hazardous for human use.

India’s rivers, especially the smaller ones, have all turned into toxic streams. And even the big ones like the Ganga and Yamuna are far from being pure. The assault on India’s rivers – from population growth, agricultural modernisation, urbanisation and industrialisation – is enormous and growing by the day….. This entire life stands threatened.


You may have already realised that the need of the hour is to conserve and manage our water resources, to safeguard ourselves from health hazards, to ensure food security, continuation of our livelihoods and productive activities and also to prevent degradation of our natural ecosystems. Overexploitation and mismanagement of water resources will impoverish this resource and cause ecological crisis that may have profound impact on our lives.

Activity
From your everyday experiences, write a short proposal on how you can conserve water.

Multi-purpose River Projects and Integrated Water Resources Management
But, how do we conserve and manage water? Archaeological and historical records show that from ancient times we have been constructing sophisticated hydraulic structures like dams built of stone rubble, reservoirs or lakes, embankments and canals for irrigation. Not surprisingly, we have continued this tradition in modern India by building dams in most of our river basins.

Hydraulic Structures in Ancient India
• In the first century B.C., Sringaverapura near Allahabad had sophisticated water harvesting system channelling the flood water of the river Ganga.
• During the time of Chandragupta Maurya, dams, lakes and irrigation systems were extensively built.
• Evidences of sophisticated irrigation works have also been found in Kalinga, (Odisha), Nagarjunakonda (Andhra Pradesh), Bennur (Karnataka), Kolhapur (Maharashtra), etc.
What are dams and how do they help us in conserving and managing water? Dams were traditionally built to impound rivers and rainwater that could be used later to irrigate agricultural fields. Today, dams are built not just for irrigation but for electricity generation, water supply for domestic and industrial uses, flood control, recreation, inland navigation and fish breeding. Hence, dams are now referred to as multi-purpose projects where the many uses of the impounded water are integrated with one another. For example, in the Sutluj-Beas river basin, the Bhakra-Nangal project water is being used both for hydel power production and irrigation. Similarly, the Hirakud project in the Mahanadi basin integrates conservation of water with flood control.

Multi-purpose projects, launched after Independence with their integrated water resources management approach, were thought of as the vehicle that would lead the nation to development and progress, overcoming the handicap of its colonial past. Jawaharlal Nehru proudly proclaimed the dams as the ‘temples of modern India’; the reason being that it would integrate development of agriculture and the village economy with rapid industrialisation and growth of the urban economy.

**Activity**

Find out more about any one traditional method of building dams and irrigation works.

We have sown the crops in Asar
We will bring Bhadu in Bhadra
Floods have swollen the Damodar
The sailing boats cannot sail
Oh! Damodar, we fall at your feet
Reduce the floods a little
Bhadu will come a year later
Let the boats sail on your surface
(This popular Bhadu song in the Damodar valley region narrates the troubles faced by people owing to the flooding of Damodar river known as the river of sorrow.)

In recent years, multi-purpose projects and large dams have come under great scrutiny and opposition for a variety of reasons. Regulating and damming of rivers affect their natural flow causing poor sediment flow and excessive sedimentation at the bottom of the reservoir, resulting in rockier stream.
beds and poorer habitats for the rivers’ aquatic life. Dams also fragment rivers making it difficult for aquatic fauna to migrate, especially for spawning. The reservoirs that are created on the floodplains also submerge the existing vegetation and soil leading to its decomposition over a period of time.

Multi-purpose projects and large dams have also been the cause of many new environmental movements like the ‘Narmada Bachao Andolan’ and the ‘Tehri Dam Andolan’ etc. Resistance to these projects has primarily been due to the large-scale displacement of local communities. Local people often had to give up their land, livelihood and their meagre access and control over resources for the greater good of the nation. So, if the local people are not benefiting from such projects then who is benefited? Perhaps, the landowners and large farmers, industrialists and few urban centres. Take the case of the landless in a village – does he really gain from such a project?

Irrigation has also changed the cropping pattern of many regions with farmers shifting to water intensive and commercial crops. This has great ecological consequences like salinisation of the soil. At the same time, it has transformed the social landscape i.e. increasing the social gap between the richer landowners and the landless poor. As we can see, the dams did create conflicts between people wanting different uses and benefits from the same water resources. In Gujarat, the Sabarmati-basin farmers were agitated and almost caused a riot over the higher priority given to water supply in urban areas, particularly during droughts. Inter-state water disputes are also becoming common with regard to sharing the costs and benefits of the multi-purpose project.

Narmada Bachao Andolan or Save Narmada Movement is a Non Governmental Organisation (NGO) that mobilised tribal people, farmers, environmentalists and human rights activists against the Sardar Sarovar Dam being built across the Narmada river in Gujarat. It originally focused on the environmental issues related to trees that would be submerged under the dam water. Recently it has re-focused the aim to enable poor citizens, especially the oustees (displaced people) to get full rehabilitation facilities from the government.

People felt that their suffering would not be in vain... accepted the trauma of displacement believing in the promise of irrigated fields and plentiful harvests. So, often the survivors of Rihand told us that they accepted their sufferings as sacrifice for the sake of their nation. But now, after thirty bitter years of being adrift, their livelihood having even being more precarious, they keep asking: “Are we the only ones chosen to make sacrifices for the nation?”

**Source:** S. Sharma, quoted in *In the Belly of the River. Tribal conflicts over development in Narmada valley*, A. Baviskar, 1995.

**Do you know?**

Sardar Sarovar Dam has been built over the Narmada River in Gujarat. This is one of the largest water resource projects of India covering four states—Maharashtra, Madhya Pradesh, Gujarat and Rajasthan. The Sardar Sarovar project would meet the requirement of water in drought-prone and desert areas of Gujarat (9,490 villages and 173 towns) and Rajasthan (124 villages).

**Source:** [http://www.sardarsarovardam.org/project.aspx](http://www.sardarsarovardam.org/project.aspx)

**Activity**

Make a list of inter-state water disputes.
India: Major Rivers and Dams

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Most of the objections to the projects arose due to their failure to achieve the purposes for which they were built. Ironically, the dams that were constructed to control floods have triggered floods due to sedimentation in the reservoir. Moreover, the big dams have mostly been unsuccessful in controlling floods at the time of excessive rainfall. You may have seen or read how the release of water from dams during heavy rains aggravated the flood situation in Maharashtra and Gujarat in 2006. The floods have not only devastated life and property but also caused extensive soil erosion. Sedimentation also meant that the flood plains were deprived of silt, a natural fertiliser, further adding on to the problem of land degradation. It was also observed that the multi-purpose projects induced earthquakes, caused water-borne diseases and pests and pollution resulting from excessive use of water.

Rainwater Harvesting

Many thought that given the disadvantages and rising resistance against the multi-purpose projects, water harvesting system was a viable alternative, both socio-economically and environmentally. In ancient India, along with the sophisticated hydraulic structures, there existed an extraordinary tradition of water-harvesting system. People had in-depth knowledge of rainfall regimes and soil types and developed wide ranging techniques to harvest rainwater, groundwater, river water and flood water in keeping with the local ecological conditions and their water needs. In hill and mountainous regions, people built diversion channels like the ‘guls’ or ‘kuls’ of the Western Himalayas for agriculture. ‘Rooftop rainwater harvesting’ was commonly practised to store drinking water, particularly in Rajasthan. In the flood plains of Bengal, people developed inundation channels to collect information about flood prone areas of the country.
irrigate their fields. In arid and semi-arid regions, agricultural fields were converted into rain-fed storage structures that allowed the water to stand and moisten the soil like the ‘khadins’ in Jaisalmer and ‘Johads’ in other parts of Rajasthan.

In the semi-arid and arid regions of Rajasthan, particularly in Bikaner, Phalodi and Barmer, almost all the houses traditionally had underground tanks or tankas for storing drinking water. The tanks could be as large as a big room; one household in Phalodi had a tank that was 6.1 metres deep, 4.27 metres long and 2.44 metres wide. The tankas were part of the well-developed rooftop rainwater harvesting system and were built inside the main house or the courtyard. They were connected to the sloping roofs of the houses through a pipe. Rain falling on the rooftops would travel down the pipe and was stored in these underground ‘tankas’. The first spell of rain was usually not collected as this would clean the roofs and the pipes. The rainwater from the subsequent showers was then collected.

The rainwater can be stored in the tankas till the next rainfall making it an extremely reliable source of drinking water when all other sources are dried up.
Fig 3.5: Traditional method of rainwater harvesting

A kul leads to a circular village tank, as the above in the Kaza village, from which water is released as and when required.

particularly in the summers. Rainwater, or palar pani, as commonly referred to in these parts, is considered the purest form of natural water. Many houses constructed underground rooms adjoining the ‘tanka’ to beat the summer heat as it would keep the room cool.

Fig 3.6: Rooftop harvesting system

Rooftop harvesting was common across the towns and villages of the Thar. Rainwater that falls on the sloping roofs of houses is taken through a pipe into an underground tanka (circular holes in the ground), built in the main house or in the courtyard. The picture above shows water being taken from a neighbour’s roof through a long pipe. Here the neighbour’s rooftop has been used for collection of rainwater. The picture shows a hole through which rainwater flows down into an underground tanka.

Fortunately, in many parts of rural and urban India, rooftop rainwater harvesting is being successfully adapted to store and conserve water. In Gendathur, a remote backward village in Mysuru, Karnataka, villagers have installed, in their households rooftop, rainwater harvesting system to meet their water needs. Nearly 200 households have installed this system and the village has earned the rare distinction of being rich in rainwater. See Fig. 3.6 for a better understanding of the rooftop rainwater harvesting system which is adapted here. Gendathur receives an annual precipitation of 1,000 mm, and with 80 per cent of collection efficiency and of about 10 fillings, every house can collect and use about 50,000 litres of water annually. From the 200 houses, the net amount of rainwater harvested annually amounts to 1,00,000 litres.

Tamil Nadu is the first state in India which has made rooftop rainwater harvesting structure compulsory to all the houses across the state. There are legal provisions to punish the defaulters.

Activity
Find out other rainwater harvesting systems existing in and around your locality.
**Bamboo Drip Irrigation System**

In Meghalaya, a 200-year-old system of tapping stream and spring water by using bamboo pipes, is prevalent. About 18-20 litres of water enters the bamboo pipe system, gets transported over hundreds of metres, and finally reduces to 20-80 drops per minute at the site of the plant.

**Picture 1:** Bamboo pipes are used to divert perennial springs on the hilltops to the lower reaches by gravity.

**Picture 2 and 3:** The channel sections, made of bamboo, divert water to the plant site where it is distributed into branches, again made and laid out with different forms of bamboo pipes. The flow of water into the pipes is controlled by manipulating the pipe positions.

**Picture 4:** If the pipes pass a road, they are taken high above the land.

**Picture 5 and 6** Reduced channel sections and diversion units are used at the last stage of water application. The last channel section enables water to be dropped near the roots of the plant.

**Activity**

1. Collect information on how industries are polluting our water resources.
2. Enact with your classmates a scene of water dispute in your locality.
1. Multiple choice questions.
   (i) Based on the information given below classify each of the situations as ‘suffering from water scarcity’ or ‘not suffering from water scarcity’.
   (a) Region with high annual rainfall.
   (b) Region having high annual rainfall and large population.
   (c) Region having high annual rainfall but water is highly polluted.
   (d) Region having low rainfall and low population.

   (ii) Which one of the following statements is not an argument in favour of multi-purpose river projects?
   (a) Multi-purpose projects bring water to those areas which suffer from water scarcity.
   (b) Multi-purpose projects by regulating water flow helps to control floods.
   (c) Multi-purpose projects lead to large scale displacements and loss of livelihood.
   (d) Multi-purpose projects generate electricity for our industries and our homes.

   (iii) Here are some false statements. Identify the mistakes and rewrite them correctly.
   (a) Multiplying urban centres with large and dense populations and urban lifestyles have helped in proper utilisation of water resources.
   (b) Regulating and damming of rivers does not affect the river’s natural flow and its sediment flow.
   (c) In Gujarat, the Sabarmati basin farmers were not agitated when higher priority was given to water supply in urban areas, particularly during droughts.
   (d) Today in Rajasthan, the practice of rooftop rainwater water harvesting has gained popularity despite high water availability due to the Indira Gandhi Canal.

2. Answer the following questions in about 30 words.
   (i) Explain how water becomes a renewable resource.
   (ii) What is water scarcity and what are its main causes?
   (iii) Compare the advantages and disadvantages of multi-purpose river projects.

3. Answer the following questions in about 120 words.
   (i) Discuss how rainwater harvesting in semi-arid regions of Rajasthan is carried out.
   (ii) Describe how modern adaptations of traditional rainwater harvesting methods are being carried out to conserve and store water.