



Class Xth NEW NCERT
Chapter-3



1068CH03

WATER RESOURCES

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Hey Pinky, did you see those awesome T.V. reports on floods in Assam? My God! What havoc they have created it has destroyed and swept away everything in its path.

Yes, Chintu, I did. Isn't it strange that water can give life and take life as well. What would we do without water? We need water to drink, cook our food, wash our clothes and wash ourselves as well. My father was telling me that in his factory they need a lot of water for a number of things. Did you know that they even need water for cooling the machines?

In fact, the factory runs on the power supplied by the hydel power plant. Now, I can understand why through the ages we humans have chosen to live near water courses along the rivers and other water sources like springs, lakes, ponds and oases.

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

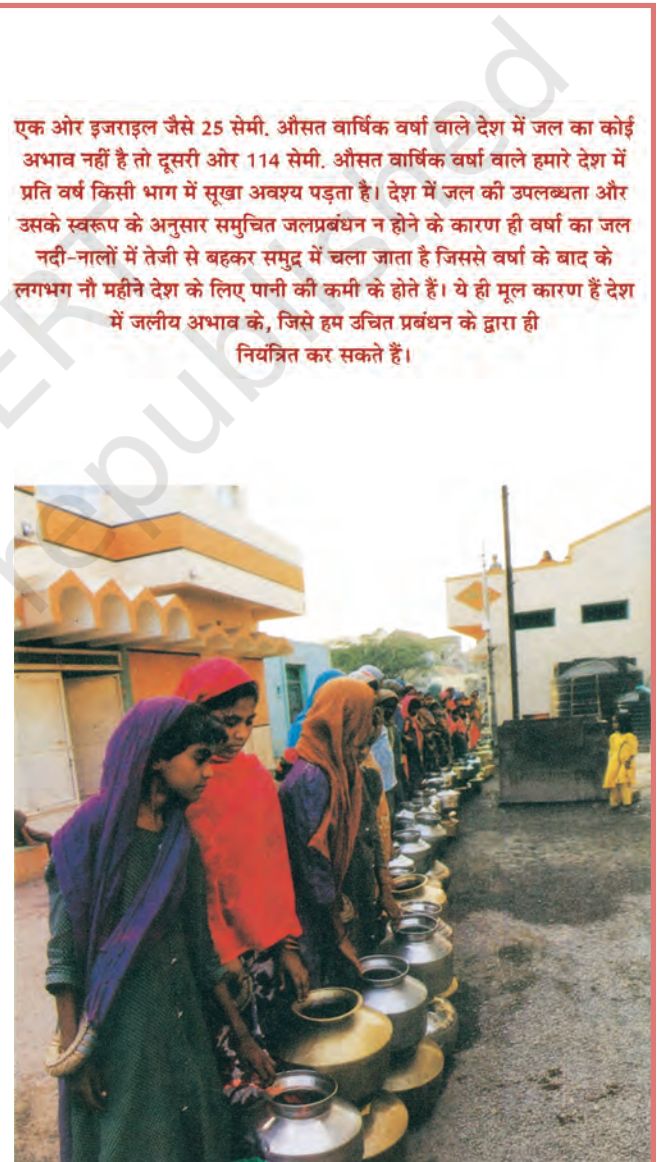
consequent greater demands for water, and unequal access to it. A large population requires more water not only for domestic use but also to produce more food. Hence, to facilitate higher food-grain production, water resources are being over-exploited to expand irrigated areas for dry-season agriculture. 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



Water, Water Everywhere, Not a Drop to Drink: After a heavy downpour, a boy collects drinking water in Kolkata. Life in the city and its adjacent districts was paralysed as incessant overnight rain, meaning a record 180 mm, flooded vast area and disrupted traffic.



A Kashmiri earthquake survivor carries water in the snow in a devastated village.



एक ओर इजराइल जैसे 25 सेमी. औसत वार्षिक वर्षा वाले देश में जल का कोई अभाव नहीं है तो दूसरी ओर 114 सेमी. औसत वार्षिक वर्षा वाले हमारे देश में प्रति वर्ष किसी भाग में सूखा अवश्य पड़ता है। देश में जल की उपलब्धता और उसके स्वरूप के अनुसार समुचित जलप्रबंधन न होने के कारण ही वर्षा का जल नदी-नालों में तेजी से बहकर समुद्र में चला जाता है जिससे वर्षा के बाद के लगभग नौ महीने देश के लिए पानी की कमी के होते हैं। ये ही मूल कारण हैं देश में जलीय अभाव के, जिसे हम उचित प्रबंधन के द्वारा ही नियंत्रित कर सकते हैं।

Fig. 3.1: Water Scarcity



own wells and tube-wells in their farms for irrigation to increase their produce. But have you ever wondered what this could result in? That it may lead to falling groundwater levels, adversely affecting water availability and food security of the people.

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. 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.

Do you know?

Atal Bhujal Yojana (Atal Jal) is being implemented in 8220 water stressed Gram Panchayats of 229 administrative blocks/talukas in 80 districts of seven states, viz. Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh. The selected States account for about 37 per cent of the total number of water—stressed (over-exploited, critical and semi-critical) blocks in India. One of the key aspects of Atal Jal is to bring in behavioural changes in the community, from the prevailing attitude of consumption to conservation and smart water management.

Source: Annual Report, Ministry of Jal Shakti, Government of India 2022–23

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. Government of India has accorded highest priority to improve the quality of life and enhance ease of living of people especially those living in rural areas by announcing the Jal Jeevan Mission (JJM). The Goal of JJM is to enable every rural household get assured supply of potable piped water at a service level of 55 litres per capita per day regularly on long-term basis by ensuring functionality of the tap water connections. (Source: Economic Survey 2020–21, p.357)

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. Over exploitation 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., Sringerapur 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.
- In the 11th Century, Bhopal Lake, one of the largest artificial lakes of its time was built.
- In the 13th–14th Century, the tank in Hauz Khas, Delhi was constructed by Allauddin Khilji (Khalji) for supplying water to Siri Fort area.

Source: *Dying Wisdom, CSE, 1997.*



Fig. 3.2: Hirakud Dam

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

A **dam** is a barrier across flowing water that obstructs, directs or retards the flow, often creating a reservoir, lake or impoundment. “Dam” refers to the reservoir rather than the structure. Most dams have a section called a spillway or weir over which or through which it is intended that water will flow either intermittently or continuously. Dams are classified according to structure, intended purpose or height. Based on structure and the materials used, dams are classified as timber dams, embankment dams or masonry dams, with several subtypes. According to the height, dams can be categorised as large dams and major dams or alternatively as low dams, medium height dams and high dams.

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.

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. Sardar Sarovar Project will provide irrigation facilities to 18.45 lakh hectare of land, covering 3112 villages in 15 districts of Gujarat. It will also irrigate 2,46,000 hectare of land in the strategic desert districts of Barmer and Jalore in Rajasthan and 37,500 hectare in the tribal hilly tract of Maharashtra through lift. About 75 per cent of the command area in Gujarat is drought prone while entire command in Rajasthan is drought prone. Assured water supply will soon make this area drought proof.

Source: Sardar Sarovar Narmada Nigam Ltd.
<https://www.sardarsarovardam.org/>

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.

Activity

Collect information about floods occurred in different parts of the country due to heavy rainfall in recent times.

These 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.

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.

Pradhan Mantri Krishi Sinchayee Yojana has been started which ensures access to some means to protective irrigation for all agricultural farms in the country, thus bringing much desired rural prosperity. Some of the broad objectives of this programme are to enhance the physical access of water on the farm and expand cultivable area under assured irrigation (*har khet ko pani*), improve on-farm water use efficiency to reduce wastage and increase availability both in duration and extent, irrigation and other water saving technologies (*per drop more crop*) and introduce sustainable water conservation practices, etc.

Do you know?

Do you know that the Krishna-Godavari dispute is due to the objections raised by Karnataka and Andhra Pradesh governments? It is regarding the diversion of more water at Koyna by the Maharashtra government for a multipurpose project. This would reduce downstream flow in their states with adverse consequences for agriculture and industry.

Activity

Make a list of inter-state water disputes.





India: Major Rivers and Dams



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 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


FLOODS

Basic Safety Precautions To Be Taken :

- Listen to radio/TV for the latest weather bulletins and flood warnings. Pass on the information to others.
- Make a family emergency kit which should include; a portable radio/transistor, torch, spare batteries, a first aid box along with essential medicines, ORS, dry food items, drinking water, matchboxes, candles and other essential items.
- Keep hurricane lamp, ropes, rubber tubes, umbrella and bamboo stick in your house. These could be useful.
- Keep your cash, jewellery, valuables, important documents etc. in a safe place.
- If there is a flood, move along with your family members and cattle to safe areas like relief camps, evacuation centres, elevated grounds where you can take shelter.
- Turn off power and gas connections before leaving your house.

During floods

- Don't enter into flood waters; it could be dangerous.
- Don't allow children to play in or near flood waters.
- Stay away from sewerage line, gutters, drains, culverts etc.
- Be careful of snakes; snakebites are common during floods.
- Stay away from electric poles and fallen power-lines to avoid electrocution.
- Don't use wet electrical appliances - get them checked before use.
- Eat freshly cooked and dry food. Always keep your food covered.
- Use boiled and filtered drinking water.
- Keep all drains, gutters near your house clean.
- Stagnation of water can breed vector/water-borne diseases. In case of sickness, seek medical assistance.
- Use bleaching powder and lime to disinfect the surroundings.



THE RIDE OF HIS LIFE

Heavy rain drowns Kolkata

Durga Puja Preparations Go Awry As Met Predicts Downpour For Next 2 Days

THREE NEWS NETWORKS

Kolkata: With two days of incessant rain - and more forecast for the next 48 hours - Kolkata came to a complete halt on Friday. The city has so far recorded 224.6 mm rainfall.

Three people died of electrocution in the southern fringes of the city and three of a family were killed in a road collapse in North 24 Parganas district. Elsewhere in the state, 22 people died and nearly 70,000 houses were damaged. Bengalite make up on Friday to the chanting of Mahanaras - the auspicious occasion observed seven days prior to the start of Durga Puja - began even as rains lashed the city.

Deaths were noted at Chhatrapati, Ashoka, Jyoti, Bala, Ganga, Laxmi, Anand, Street, Chitra and Manjushree. People had to wade through waist-deep water in many areas. Above Bhowanipore, Laxmi, which houses barracks and 500 quarters of Kolkata Police, was flooded. It had been cut off since tea stops, but Friday's deluge and an accompanying tide in the Hooghly river left it completely unmanageable.

Trains services were disrupted in both Eastern and South Eastern Railway's Howrah and Howrah divisions with tracks submerged under water in many places. Six trains, including Jammu Tawi Express and Howrah-Patna passenger train, were cancelled, while 11 trains, including Patna Express, Howrah-Jaipur, Shalimar-Howrah, Howrah-Durgam Cheruvu, Howrah-Durgam Cheruvu and Howrah-Durgam Cheruvu, were cancelled. Howrah-Durgam Cheruvu and Howrah-Durgam Cheruvu were cancelled. Howrah-Durgam Cheruvu and Howrah-Durgam Cheruvu were cancelled.

SANKEY SQUARE: A bus is stuck in a waterlogged street in Kolkata on Friday.

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Collect information about flood prone areas of the country

WATER RESOURCES

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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.



(a) Recharge through Hand Pump



(b) Recharge through Abandoned Dugwell

- Rooftop rainwater is collected using a PVC pipe
- Filtered using sand and bricks
- Underground pipe takes water to sump for immediate usage
- Excess water from the sump is taken to the well
- Water from the well recharges the underground
- Take water from the well (later)

Fig 3.3: Rooftop Rainwater Harvesting

Are you a water harvester?

This monsoon, join us in counting the raindrops



Fig. 3.4

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, 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



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

Fig 3.5: Traditional method of rainwater harvesting



Interesting Fact

Rooftop rainwater harvesting is the most common practice in Shillong, Meghalaya. It is interesting because Cherapunjee and Mawsynram situated at a distance of 55 km. from Shillong receive the highest rainfall in the world, yet the state capital Shillong faces acute shortage of water. Nearly every household in the city has a rooftop rainwater harvesting structure. Nearly 15-25 per cent of the total water requirement of the household comes from rooftop water harvesting.

Activity

Find out other rainwater harvesting systems existing in and around your locality.

room cool.

Today, in western Rajasthan, sadly the practice of rooftop rainwater harvesting is on the decline as plenty of water is available due to the perennial Indira Gandhi Canal, though some houses still maintain the tankas since they do not like the taste of tap water. 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 household's 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.



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*.

Fig. 3.6

Interesting Fact

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.

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.*

Fig 3.7

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) 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.





Class XIIth NEW NCERT
Chapter-4



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WATER RESOURCES



Do you think that what exists today will continue to be so, or the future is going to be different in some respects? It can be said with some certainty that the societies will witness demographic transition, geographical shift of population, technological advancement, degradation of environment and water scarcity. Water scarcity is possibly to pose the greatest challenge on account of its increased demand coupled with shrinking supplies due to over utilisation and pollution. Water is a cyclic resource with abundant supplies on the globe. Approximately, 71 per cent of the earth's surface is covered with it but freshwater constitutes only about 3 per cent of the total water. In fact, a very small proportion of freshwater is effectively available for human use. The availability of freshwater varies over space and time. The tensions and disputes on sharing and control of this scarce resource are becoming contested issues among communities, regions, and states. The assessment, efficient use and conservation of water, therefore, become necessary to ensure development. In this chapter, we shall discuss water resources in India, its geographical distribution, sectoral utilisation, and methods of its conservation and management.

Water Resources of India

India accounts for about 2.45 per cent of the world's surface area, 4 per cent of the world's water resources and more than 17 per cent of the world's population. The total water available from precipitation in the country in a year is about 4,000 cubic km. The availability from surface water and replenishable groundwater is 1,869 cubic km. Out of this, only 60 per cent can be put to beneficial uses. Thus, the total utilisable water resource in the country is only 1,122 cubic km.

Surface Water Resources

There are four major sources of surface water. These are rivers, lakes, ponds and tanks. In the country, there are about 10,360 rivers and their tributaries longer than 1.6 km each. The mean annual flow in all the river basins

in India is estimated to be 1,869 cubic km. However, due to topographical, hydrological and other constraints, only about 690 cubic km (32 per cent) of the available surface water can be utilised. Water flow in a river depends on size of its catchment area or river basin and rainfall within its catchment area. You have studied in your Class XI textbook “*India : Physical Environment*” that precipitation in India has very high spatial variation, and it is mainly concentrated in Monsoon season. You also have studied in the textbook that some of the rivers in the country like the Ganga, the Brahmaputra, and the Indus have huge catchment areas. Given that precipitation is relatively high in the catchment areas of the Ganga, the Brahmaputra and the Barak rivers, these rivers, although account for only about one-third of the total area in the country, have 60 per cent of the total surface water resources. Much of the annual water flow in south Indian rivers like the Godavari, the Krishna, and the Kaveri has been harnessed, but it is yet to be done in the Brahmaputra and the Ganga basins.

Groundwater Resources

The total replenishable groundwater resources in the country are about 432 cubic km. The level of groundwater utilisation is relatively high in the river basins lying in north-western region and parts of south India.

The groundwater utilisation is very high in the states of Punjab, Haryana, Rajasthan, and Tamil Nadu. However, there are States like Chhattisgarh, Odisha, Kerala, etc., which utilise only a small proportion of their groundwater potentials. States like Gujarat, Uttar Pradesh, Bihar, Tripura and Maharashtra are utilising their groundwater resources at a moderate rate. If the present trend continues, the demands for water would need the supplies. And such situation, will be detrimental to development, and can cause social upheaval and disruptions.

Lagoons and Backwaters

India has a vast coastline and the coast is very indented in some states. Due to this, a number

of lagoons and lakes have formed. The States like Kerala, Odisha and West Bengal have vast surface water resources in these lagoons and lakes. Although, water is generally brackish in these water bodies, it is used for fishing and irrigating certain varieties of paddy crops, coconut, etc.

Water Demand and Utilisation

India has traditionally been an agrarian economy, and about two-third of its population have been dependent on agriculture. Hence, development of irrigation to increase agricultural production has been assigned a very high priority in the Five Year Plans, and multipurpose river valleys projects, like the Bhakra-Nangal, Hirakud, Damodar Valley, Nagarjuna Sagar, Indira Gandhi Canal Project, etc., have been taken up. In fact, India’s water demand at present is dominated by irrigational needs.

Agriculture accounts for most of the surface and groundwater utilisation, it accounts for 89 per cent of the surface water and 92 per cent of the groundwater utilisation. While the share of industrial sector is limited to 2 per cent of the surface water utilisation and 5 per cent of the ground-water, the share of domestic sector is higher (9 per cent) in surface water utilisation as compared to groundwater. The share of agricultural sector in total water utilisation is much higher than other sectors. However, in future, with development, the shares of industrial and domestic sectors in the country are likely to increase.

Demand of Water for Irrigation

In agriculture, water is mainly used for irrigation. Irrigation is needed because of spatio-temporal variability in rainfall in the country. The large tracts of the country are deficient in rainfall and are drought prone. North-western India and Deccan plateau constitute such areas. Winter and summer seasons are more or less dry in most part of the country. Hence, it is difficult to practise agriculture without assured





Fig. 4.1 : India – River Basins

irrigation during dry seasons. Even in the areas of ample rainfall like West Bengal and Bihar, breaks in monsoon or its failure creates dry spells detrimental for agriculture. Water need of certain crops also makes irrigation necessary. For instance, water requirement of rice, sugarcane, jute, etc. is very high which can be met only through irrigation.

Provision of irrigation makes multiple cropping possible. It has also been found that irrigated lands have higher agricultural productivity than unirrigated land. Further, the high yielding varieties of crops need regular moisture supply, which is made possible only by a developed irrigation systems. In fact, this is why that green revolution strategy of agriculture development in the country has largely been successful in Punjab, Haryana and western Uttar Pradesh.

In Punjab, Haryana and western Uttar Pradesh, more than 85 per cent of their net sown area is under irrigation. Wheat and rice are grown mainly with the help of irrigation in these states. Of the total net irrigated area 76.1 per cent in Punjab and 51.3 per cent in Haryana are irrigated through wells and tubewells. This shows that these states utilise large proportion of their groundwater potential which has resulted in groundwater depletion in these states.

The over-use of groundwater resources has led to decline in groundwater table in these states. In fact, over withdrawals in some states, like Rajasthan and Maharashtra, has increased fluoride concentration in groundwater, and this practice has led to increase in concentration of arsenic in parts of West Bengal and Bihar.

Activity

Intensive irrigation in Punjab, Haryana and western Uttar Pradesh is increasing salinity in the soil and depletion of groundwater irrigation. Discuss its likely impacts on agriculture.

DO YOU KNOW ?

Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)

Pradhan Mantri Krishi Sinchayee Yojana has been launched by the Central Government during 2015-16 with an overarching vision to ensure access to some means of protective irrigation for all agricultural farms in the country, thus bringing much desired rural prosperity. Some of the broad objectives of the this programmes are to:

- Enhance the physical access of water on the farm and expand cultivable area under assured irrigation (*Harkhet ko pani*)
- Promote integration of water source, distribution and its efficient use, to make best use of water through appropriate technologies and practices.
- Improve on-farm water use efficiency to reduce wastage and increase availability both in duration and extent; irrigation and other water saving technologies (*Per drope more crop*)
- Introduce sustainable water conservation practices
- Ensure the integrated development of rain-fed areas using the waters held approach towards soil and water conservation, regeneration of ground water, providing livelihood options, etc.

Emerging Water Problems

The per capita availability of water is dwindling day-by-day due to increase in population. The available water resources are also getting polluted with industrial, agricultural and domestic effluents, and this, in turn, is further limiting the availability of usable water resources.

Deterioration of Water Quality

Water quality refers to purity of water, or water without unwanted foreign substances. Water

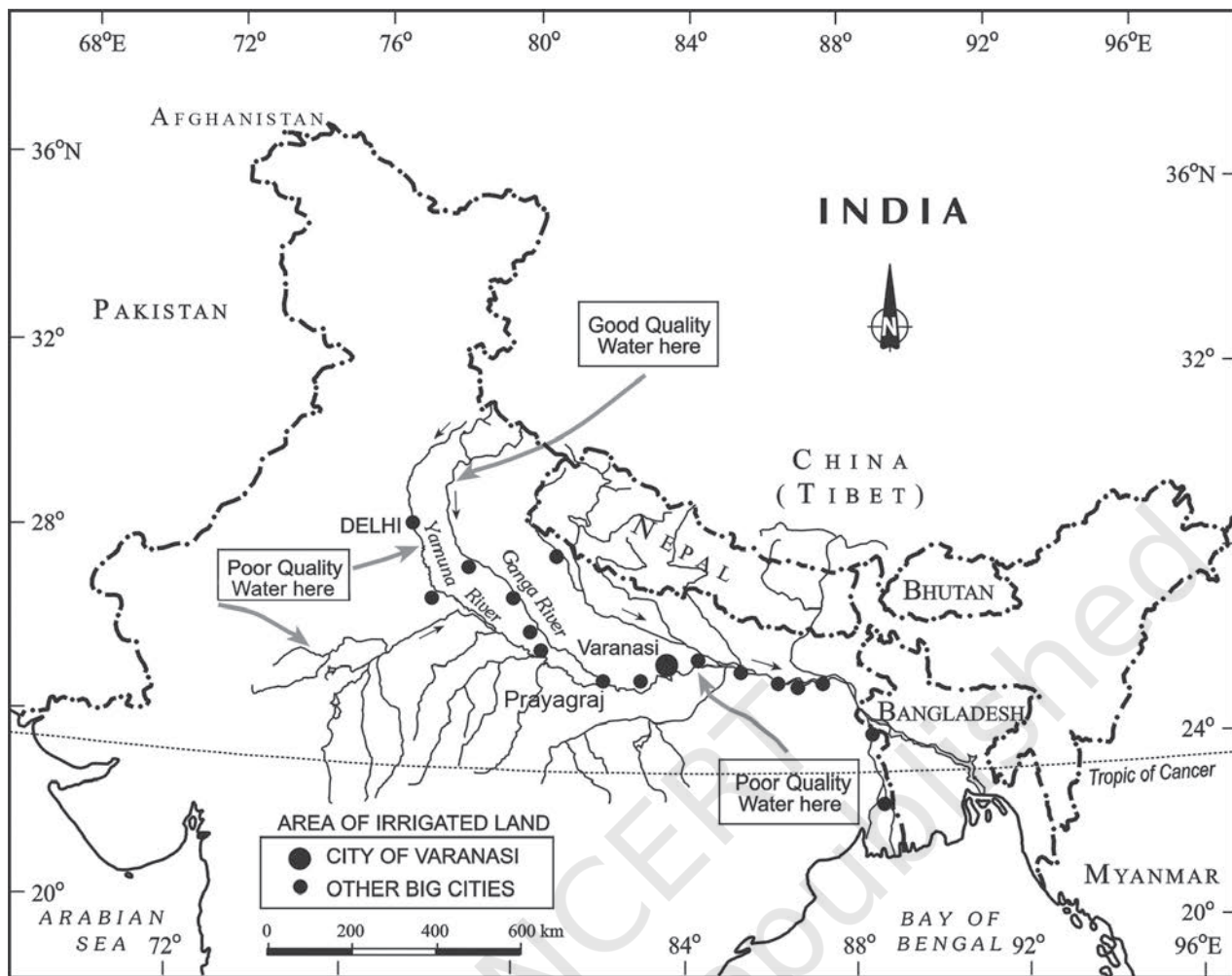


Fig. 4.2 : The Ganga and its Tributaries and Towns Located on them

gets polluted by foreign matters, such as micro-organisms, chemicals, industrial and other wastes. Such matters deteriorate the quality of water and render it unfit for human use. When toxic substances enter lakes, streams, rivers, ocean and other water bodies, they get dissolved or lie suspended in water. This results in pollution of water, whereby quality of water deteriorates affecting aquatic systems. Sometimes, these pollutants also seep down and pollute groundwater.

Activity

Find out which are the major towns/cities located on the bank of the Ganga and its tributaries and major industries they have.

Water Conservation and Management

Since there is a declining availability of freshwater and increasing demand, the need has arisen to conserve and effectively manage this precious life giving resource for sustainable development. Given that water availability from sea/ocean, due to high cost of desalinisation, is considered negligible, India has to take quick steps and make effective policies and laws, and adopt effective measures for its conservation. Besides developing water-saving technologies and methods, attempts are also to be made to prevent the pollution. There is need to encourage watershed development, rainwater harvesting, water recycling and reuse, and



conjunctive use of water for sustaining water supply in long run.

Prevention of Water Pollution

Available water resources are degrading rapidly. The major rivers of the country generally retain better water quality in less densely populated upper stretches in hilly areas. In plains, river water is used intensively for irrigation, drinking, domestic and industrial purposes. The drains carrying agricultural (fertilizers and insecticides), domestic (solid and liquid wastes), and industrial effluents join the rivers. The concentration of pollutants in rivers, especially remains very high during the summer season when flow of water is low.

The Central Pollution Control Board (CPCB) in collaboration with State Pollution Control Boards has been monitoring water quality of

national aquatic resources at 507 stations. The data obtained from these stations show that organic and bacterial contamination continues to be the main source of pollution in rivers. The Yamuna river is the most polluted river in the country between Delhi and Etawah. Other severely polluted rivers are: the Sabarmati at Ahmedabad, the Gomti at Lucknow, the Kali, the Adyar, the Cooum (entire stretches), the Vaigai at Madurai and the Musi of Hyderabad and the Ganga at Kanpur and Varanasi. Groundwater pollution has occurred due to high concentrations of heavy/toxic metals, fluoride and nitrates at different parts of the country.

The legislative provisions such as the Water (Prevention and Control of Pollution) Act 1974, and Environment Protection Act 1986 have not been implemented effectively. The result is that in 1997, 251 polluting industries were located along the rivers and lakes. The Water

Rivers of conflict...but also of peace

Water has been known for centuries to be a major cause of tension and conflict—within countries, as well as among nations. Yet while its propensity to strain relations frequently makes headlines, the other side of the coin—water as an agent of cooperation—rarely gets sufficient attention.

With more than the 260 water basins in the world transcending national borders, it is hardly surprising that the situation is widely seen as being fodder for hostility.

Nevertheless, research has shown much more historical evidence of water as a catalyst for cooperation rather than a trigger of conflict. There are more than

There have been more than 500 conflicts over water in the past century, but it's also an agent of cooperation



ALL WELLS? There are more than 3,800 declarations or conventions on water, including 286 treaties

3,800 unilateral, bilateral or multilateral declarations or conventions on water. 286 are treaties, with 61 referring to over 200 international river basins.

There are examples of workable agreements on water reached even by states that were in conflict over other matters. Like India and Pakistan, Israel and Jordan. Another example is that of the Northern Aral Sea, shared by Kazakhstan and Uzbekistan. It is being consensually restored after its surface had shrunk to less than half its original size as a result of a massive diversion of water under the Soviet Union, which has drained the two rivers feeding it and destroyed the surrounding environment.

Rich countries poor in supply of water: WWF

Geneva: Rich countries have to make drastic changes to policies if they are to avoid the water crisis that is facing poorer nations, environmental organisation WWF said on Wednesday. In a survey of the situation across the industrialised world, it said many cities were already losing the battle to maintain water supplies as governments talked about conservation but failed to implement their pledges.



WILL IT LAST?

has been very difficult. In Europe, the report said, countries around the Atlantic are suffering from recurring droughts, while in the Mediterranean region water resources were being depleted by the boom in tourism and irrigated agriculture. In Australia, already the driest continent, salinity had become a major threat to a large proportion of key farming areas, while in the US wide areas were using substantially more water than could be replenished.

Even in Japan with its high rainfall, contamination of water supplies had become a serious issue.

Climate change? Barmer grapples with floods

AND THEY SAY IT'S A DESERT



In the Times of Adversity: A woman carries her child to safety in the flooded Kadia village of Rajasthan's Barmer district

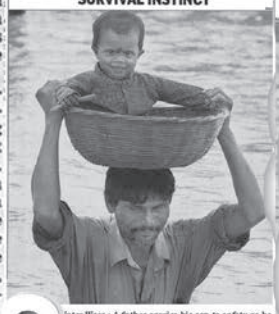


A-prone Barmer?

place in Barmer. 500 people in the region died of falsciparium malaria. The state government's health department is yet to wake up to the situation.

Ironically, this is the same region where the much-touted Indira Canal cuts a greening swathe across the desert, but brings its own share of woes. The waters that were to bloom the desert, have also led to a change in eco-system of the desert. Large parts of it have turned marshy and in some places, soil salinity has changed, leading to problems like water-logging, say experts.

such support from all walks of



Water Woes: A father carries his son to safety as he wades through floodwater, after a three-day spell of rain in Dhanata village, near Bilqurt

Discuss the issues highlighted in the news items.



Cess Act, 1977, meant to reduce pollution has also made marginal impacts. There is a strong need to generate public awareness about importance of water and impacts of water pollution. The public awareness and action can be very effective in reducing the pollutants from agricultural activities, domestic and industrial discharges.

Recycle and Reuse of Water

Another way through which we can improve fresh water availability is by recycle and reuse. Use of water of lesser quality such as reclaimed wastewater would be an attractive option for industries for cooling and fire fighting to reduce their water cost. Similarly, in urban areas water after bathing and washing utensils can be used for gardening. Water used for washing vehicle can also be used for gardening. This would conserve better quality of water for drinking purposes. Currently, recycling of water is practised on a limited scale. However, there is enormous scope for replenishing water through recycling.

Activity

Observe the quantity of water used at your home in various activities and enlist the ways in which the water can be reused and recycled in various activities.

Class teachers should organise a discussion on recycle and reuse of water.

Watershed Management

Watershed management basically refers to efficient management and conservation of surface and groundwater resources. It involves prevention of runoff and storage and recharge of groundwater through various methods like percolation tanks, recharge wells, etc. However, in broad sense watershed management includes conservation, regeneration and judicious use of all resources – natural (like land, water, plants and animals) and human within a watershed. Watershed management aims at bringing about balance between natural resources on the one

hand and society on the other. The success of watershed development largely depends upon community participation.

The Central and State Governments have initiated many watershed development and management programmes in the country. Some of these are being implemented by non-governmental organisations also. **Haryali** is a watershed development project sponsored by the Central Government which aims at enabling the rural population to conserve water for drinking, irrigation, fisheries and afforestation. The Project is being executed by Gram Panchayats with people's participation.

DO YOU KNOW ?

Atal Bhujal Yojana (Atal Jal) is being implemented in 8220 water stressed Gram Panchayats of 229 administrative blocks/talukas in 80 districts of seven states, viz. Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh. The selected States account for about 37 per cent of the total number of water-stressed (over-exploited, critical and semi-critical) blocks in India. One of the key aspects of ATAL JAL is to bring in behavioural changes in the community, from the prevailing attitude of consumption to conservation and smart water management. (Source: *Annual Report, Ministry of Jal Shakti, Govt. of India, 2022-23*)

Neeru-Meeru (Water and You) programme (in Andhra Pradesh) and **Arvary Pani Sansad** (in Alwar, Rajasthan) have taken up constructions of various water-harvesting structures such as percolation tanks, dug out ponds (**Johad**), check dams, etc., through people's participation. Tamil Nadu has made water harvesting structures in the houses compulsory. No building can be constructed without making structures for water harvesting.

Watershed development projects in some areas have been successful in



Watershed Development in Ralegan Siddhi, Ahmadnagar, Maharashtra: A Case Study

Ralegan Siddhi is a small village in the district of Ahmadnagar, Maharashtra. It has become an example for watershed development throughout the country.

In 1975, this village was caught in a web of poverty and illicit liquor trade. The transformation took place when a retired army personnel, settled down in the village and took up the task of watershed development. He convinced villagers about the importance of family planning and voluntary labour; preventing open grazing, felling trees, and liquor prohibition.

Voluntary labour was necessary to ensure minimum dependence on the government for financial aids. "It socialised the costs of the projects," explained the activist. Even those who were working outside the village contributed to the development by committing a month's salary every year.

Work began with the percolation tank constructed in the village. In 1975, the tank could not hold water. The embankment wall leaked. People voluntarily repaired the embankment. The seven wells below it swelled with water in summer for the first time in the living memory of the people. The people reposed their faith in him and his visions.

A youth group called Tarun Mandal was formed. The group worked to ban the dowry system, caste discrimination and untouchability. Liquor distilling units were removed and prohibition imposed. Open grazing was completely banned with a new emphasis on stall-feeding. The cultivation of water-intensive crops like sugarcane was banned. Crops such as pulses, oilseeds and certain cash crops with low water requirements were encouraged.

All elections to local bodies began to be held on the basis of consensus. "It made the community leaders complete representatives of the people." A system of Nyay Panchayats (informal courts) were also set up. Since then, no case has been referred to the police.

A Rs.22 lakh school building was constructed using only the resources of the village. No donations were taken. Money, if needed, was borrowed and paid back. The villagers took pride in this self-reliance. A new system of sharing labour grew out of this infusion of pride and voluntary spirit. People volunteered to help each other



Ralegan Siddhi before mitigation approach



Ralegan Siddhi after mitigation approach

in agricultural operation. Landless labourers also gained employment. Today the village plans to buy land for them in adjoining villages.

At present, water is adequate; agriculture is flourishing, though the use of fertilisers and pesticides is very high. The prosperity also brings the question of ability of the present generation to carry on the work after the leader of the movement who declared that, "The process of Ralegan's evolution to an ideal village will not stop. With changing times, people tend to evolve new ways. In future, Ralegan might present a different model to the country."

What a mitigation approach can do? A success story.



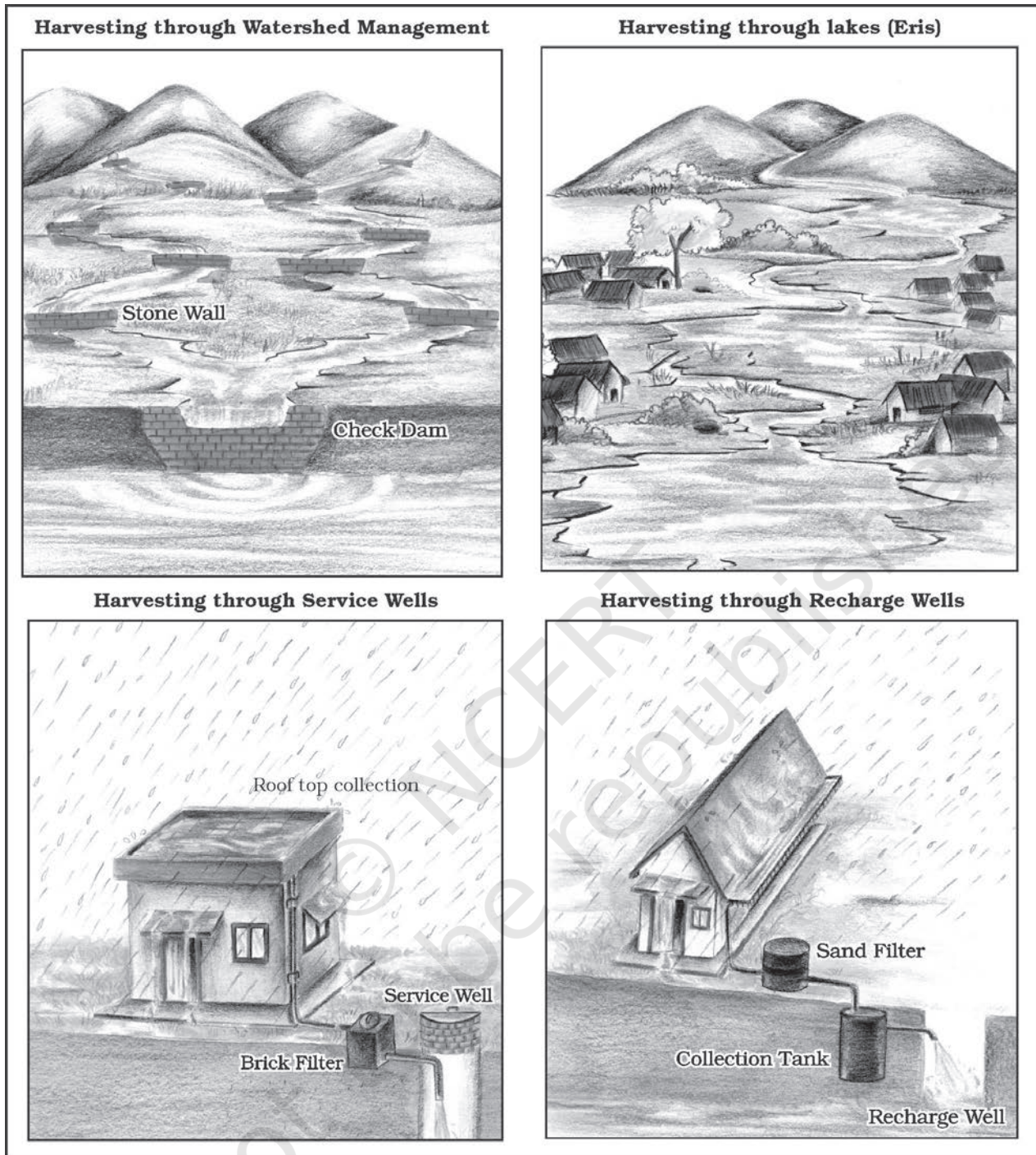


Fig. 4.3 : Various Methods of Rainwater Harvesting

rejuvenating environment and economy. However, there are only a few success stories. In majority of cases, the programme is still in its nascent stage. There is a need to generate awareness regarding benefits of

watershed development and management among people in the country, and through this integrated water resource management approach water availability can be ensured on sustainable basis.



Rainwater Harvesting

Rainwater harvesting is a method to capture and store rainwater for various uses. It is also used to recharge groundwater aquifers. It is a low cost and eco-friendly technique for preserving every drop of water by guiding the rain water to borewell, pits and wells. Rainwater harvesting increases water availability, checks the declining groundwater table, improves the quality of groundwater through dilution of contaminants, like fluoride and nitrates, prevents soil erosion, and flooding and arrests salt water intrusion in coastal areas if used to recharge aquifers.

Rainwater harvesting has been practised through various methods by different communities in the country for a long time. Traditional rainwater harvesting in rural areas is done by using surface storage bodies, like lakes, ponds, irrigation tanks, etc. In Rajasthan, rainwater harvesting structures locally known as **Kund** or **Tanka** (a covered underground tank) are constructed near or in the house or village to store harvested rainwater (see Fig. 4.3 to understand various ways of rainwater harvesting).

There is a wide scope to use rainwater harvesting technique to conserve precious water resource. It can be done by harvesting rainwater on rooftops and open spaces. Harvesting rainwater also decreases the community dependence on groundwater for domestic use. Besides bridging the demand-supply gap, it can also save energy to pump groundwater as recharge leads to rise in groundwater table. These days rainwater harvesting is being taken up on massive scale in many states in the country. Urban areas can specially benefit from rainwater harvesting as water demand has already outstripped supply in most of the cities and towns.

Apart from the above mentioned factors, the issue desalinisation of water particularly in coastal areas and brackish water in arid and semi-arid areas, transfer of water from water surplus areas to water deficit areas through inter-linking of rivers can be important remedies for solving water problem in India (read more about inter linking of rivers). However, the most important issue from the point of view of individual users, household and communities is pricing of water.

Highlights of India's National Water Policy 2012

The objective of the National Water Policy, 2012 is to assess the existing situation and to propose a framework for a plan of action with a unified national perspective. In order to achieve the objective of the Policy, a number of recommendations have been made therein for conservation, development and improved management of water resources of the country.

Some of the salient features of national water policy 2012 are:

- Emphasis on the need for a national water framework law, comprehensive legislation for optimum development of inter-State rivers and river valleys.
- Water, after meeting the pre-emptive needs for safe drinking water and sanitation, achieving food security, supporting poor people dependent on agriculture for their livelihood and high priority allocation for minimum eco-system needs, be treated as economic good so as to promote its conservation and efficient use.
- Adaptation strategies in view of climate change for designing and management of water resources structures and review of acceptability criteria has been emphasized.
- A system to evolve benchmarks for water uses for different purposes, i.e., water footprints, and water auditing be developed to ensure efficient use of water.
- Removal of large disparity in stipulations for water supply in urban areas and in rural areas has been recommended.
- Water resources projects and services should be managed with community participation.

Source: Press Information Bureau, Govt. of India, Ministry of Water Resources.

Jal Kranti Abhiyan (2015-16)

Water is a recyclable resource but its availability is limited and the gap between supply and demand will be widening over time. Climate change at the global scale will be creating water stress conditions in many regions of the world. India has a unique situation of high population growth and rapid economic development with high water demand. The *Jal Kranti Abhiyan* launched by the Government of India in 2015–16 with an aim to ensure water security through per capita availability of water in the country. People in different regions of India had practised the traditional knowledge of water conservation and management to ensure water availability.

The *Jal Kranti Abhiyan* aims at involving local bodies, NGOs and citizens, at large, in creating awareness regarding its objectives. The following activities have been proposed under the *Jal Kranti Abhiyan*:

1. Selection of one water stressed village in each 672 districts of the country to create a 'Jal Gram'.
2. Identification of model command area of about 1000 hectares in different parts of the country, for example, UP, Haryana (North), Karnataka, Telangana, Tamil Nadu (South), Rajasthan, Gujarat (West), Odisha (East), Meghalaya (North-East).
3. Abatement of pollution:
 - Water conservation and artificial recharge.
 - Reducing groundwater pollution.
 - Construction of Arsenic-free wells in selected areas of the country.
4. Creating mass awareness through social media, radio, TV, print media, poster and essay writing competitions in schools.

Jal Kranti Abhiyan is designed to provide livelihood and food security through water security.



EXERCISES

1. Choose the right answers of the following from the given options.
 - (i) Which one of the following types describes water as a resource?

(a) Abiotic resource	(c) Biotic Resource
(b) Non-renewable Resources	(d) Non-cyclic Resource
 - (ii) Which one of the following south Indian states has the highest groundwater utilisation (in per cent) of its total ground water potential?

(a) Tamil Nadu	(c) Andhra Pradesh
(b) Karnataka	(d) Kerala



(iii) The highest proportion of the total water used in the country is in which one of the following sectors?

- (a) Irrigation (c) Domestic use
(b) Industries (d) None of the above

2. Answer the following questions in about 30 words.

- (i) It is said that the water resources in India have been depleting very fast. Discuss the factors responsible for depletion of water resources?
(ii) What factors are responsible for the highest groundwater development in the states of Punjab, Haryana, and Tamil Nadu?
(iii) Why the share of agricultural sector in total water used in the country is expected to decline?
(iv) What can be possible impacts of consumption of contaminated/unclean water on the people?

3. Answer the following questions in about 150 words.

- (i) Discuss the availability of water resources in the country and factors that determine its spatial distribution?
(ii) The depleting water resources may lead to social conflicts and disputes. Elaborate it with suitable examples?
(iii) What is watershed management? Do you think it can play an important role in sustainable development?

