29

FRESH WATER RESOURCES

You have already learnt about the importance of fresh water without which there would be no life on earth. In this lesson you will learn about fresh water resources, its use and the significance of maintaining the quality of fresh water.

OBJECTIVES

After completing this lesson you will be able to:

- *describe the distribution of fresh water resources;*
- *describe the ways by which water is collected, processed and distributed for household consumption;*
- *describe the common methods of purifying fresh water for domestic uses (potable water), in view of the consequences of drinking raw water;*
- *explain the concept of water quality;*
- *describe the manner in which water is used for domestic, industrial and agricultural purposes;*
- *describe the importance of water as raw material and consequences of using it as dumping medium for effluents (domestic and industrial).*

29.1 DISTRIBUTION OF FRESH WATER

The fresh water which is so essential for life is only a small portion about 2.7 % of the total water available on this earth. Nearly all of this fresh water is locked in the masses of ice caps, glaciers and clouds. The remaining small fraction of fresh water has accumulated over centuries in the lakes and underground sources. Surprisingly it is the salt water of the oceans that is the ultimate source of fresh water on this earth. About 85% of the rain water falls on directly into the sea and never reaches the land. A small remainder of the total global precipitation on that falls on the land fills up the lakes and wells, and keeps the river flowing. Thus, the fresh water is available to mankind is a scarce and precious commodity.

Water covers about three quarters of the earth's surface. The total amount of water has been estimated to be more than 1400 mkm^3, enough to cover the entire earth with a layer of water of 300 meter depth. About 97.3% of this water is in the oceans. Of the 2.7% that is fresh, 2.14% lies frozen in the polar regions. Thus, all the water in the lakes and rivers, all the moisture in the atmosphere, soil, vegetation and all the water underground amounts to about 0.5% of the total. Of this 0.5% (that is liquid fresh water), more than 98% is in the form of ground water, half of which may lie more than 1000 meters below the surface and thus only 0.1% is in the rivers.

Table 29.1: *World water distribution*

Location	Volume $10^{12}m^3$	% of Total
Reservoirs		
• Oceans and seas	1370	94
• Lake/ponds/reservoirs	125	0.01
• Swamps and marshes	1.25	0.0001
• Rivers (average instantaneous volume)	67	0.005
• Soil moisture	8350	0.38
• Ground water (below 2200 ft)	–	0.30
• Ice caps and glaciers	29,200	2.05
• Atmospheric water	37,800	2.75
Atmosphere (water vapour)	13	0.001
Oceans	1,320,000	97.25
Grand total	1,360,000	100

Source: Schmitz (1996)

29.2 WATER RESOURCE DISTRIBUTION IN INDIA

The annual rainfall over India is 1170 mm. It is more than any where else in the world for a country of comparable size. From **precipitation** alone, India receives 4000 billion cubic meters (BCM), including snow fall. Of this ¾ part occurs only during the monsoon. A good part of it is lost through the process of evaporation and plant transpiration, leaving only half of it on the land for us to use. After allowing for evapotranspiration losses the country's surface flow is estimated as 1880 BCM. Due to topographical, hydrological and other constraints, it is assessed that only about 700 BCM of surface water can be put to beneficial use. The annual replenishable ground water resources are assessed to be about 600 BCM of which the annual usable resources are estimated at 420 BCM. Since independence, the country has been planning to best utilize this water by prolonging its stay on land by using engineering innovations such as dams and barrages.

Table 29.2: Estimated distributed of water resources of India

Compartment	Quantity, billion cubic meter (BCM)
Total precipitation	4000
• Immediate evaporation	700
• Percolation in soil	2150
-Soil moisture	1650
-Ground water	500
• Surface water	1150

There are three main sources of fresh water in our country. These are: rivers, lakes and ground water. A brief description of these sources of water is provided below:

(i) **Rivers**

The rivers are characterized by unidirectional current with a relatively high, average flow ranging from 0.1 to 1 m/s. The river flow is highly variable with time depending on climatic situation and the drainage pattern. In general, thorough and continuous vertical mixing is achieved in rivers due to prevailing currents and turbulence.

(ii) **Lakes**

The lakes are characterized by low average current velocity of 0.001 to 0.01 m/s (surface value). Current within lakes are multidirectional. Many lakes have alternating period of stratification and vertical mixing; periodicity of which is regulated by the climatic conditions and depth of the lake.

(iii) **Ground water**

The ground water are characterized by a rather steady flow pattern in terms of direction and velocity. The average flow velocities commonly found in aquifers (groundwater reservoirs) range from 10^{-10} to 10^{-3} m/s and are largely governed by the porosity and the permeability of the geological material. As a consequence, mixing is rather poor and, depending on local hydro- geological features, the groundwater dynamics can be highly diverse.

INTEXT QUESTIONS 29.1

1. What fraction of total water available on earth is fresh water?

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2. Water covers about three quarters of the earth's surface but how much of it is fresh water?

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3. Name the three resources of fresh water.

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29.3 WATER COLLECTION

Water is collected and distributed for various uses, domestic and industrial purposes and for irrigation. The domestic water is mostly used for drinking, bathing, washing, cleaning and flushing the toilets. Since domestic water is used for drinking, it requires high purity. The major sources of drinking water are **rivers, lakes** and **groundwater**. Drinking water or potable water is either directly collected from sources as in most of our rural areas or supplied by different agencies like municipal authorities or public health departments. The surface water generally requires treatment before supply for drinking as they are often found contaminated. Ground water, on the other hand, is usually free of microbes and suspended solids because of natural filtration as the water moves through soil, though it often contains relatively high concentrations of dissolved minerals from its direct contact with soil and rock. (Recall from Lesson 28).

The large cities and towns and villages where ground water is not fit for drinking, the **surface water** is used for drinking. Those cities and towns located along the rivers and lakes directly draw water from them and supply for domestic use after treatment. Those cities located away from any surface water sources transport it though canals or pipelines. Large cities like Delhi draws water from multiple sources like Bhakra reservoir, Upper Ganga Canal, Western Yamuna Canal and Yamuna river. The raw water is probably treated before supply for domestic use.

29.4 WATER TREATMENT

Water in river or lakes has to be treated or purified before it is supplied for human consumption. Groundwater, too, often needs treatment to render it potable. The primary objective of water treatment is to protect the health of the community. Potable water must be free of harmful microorganisms and chemicals. The water should be crystal clear, with almost no turbidity, and it should be free of objectionable colour, odour, and taste. For domestic supplies, water should not be corrosive, nor should it deposit troublesome amounts of scale and stains on plumbing fixtures. Industrial requirements may be even more stringent; many industries provide special treatment in their own premises.

The type and extent of treatment required to obtain potable water depends on the quality of the source. Surface water usually needs more extensive treatment than does ground water, because most streams, rivers and lakes are polluted to varying extent. Even in areas far away from human settlements, surface water contains suspended silt, organic material, decaying vegetation, and microbes from animal wastes.

29.4.1 Methods of water treatment

Water is treated by a variety of physical and chemical methods. Treatment of surface water begins with intake screens to prevent fish and debris from entering the treatment plant and damaging pumps and other components. Conventional treatment of water primarily involves clarification and disinfections. Clarification removes most of the turbidity, making water crystal clear. Disinfection, usually the final step in the treatment of drinking water, destroys pathogenic microbes. In addition, to clarification and disinfection, the processes of softening, aeration, carbon adsorption, and defluridation may be used for certain public water sources. Desalination processes i.e. removal of excess salt from water are used in areas where fresh water supplies are not readily available or the ground water is saline.

(a) **Clarification or sedimentation**

Impuries in water are either dissolved or suspended. The suspended material reduces clarity, and the easiest way to remove it is to let suspended particles settle.

• **Coagulation and flocculation**

Suspended particles cannot be removed completely by plain settling. Large, heavy particles settle out readily, but smaller and lighter particles do not settle easily. Such particles are called colloidal particles. To remove such smaller particles, alum is added. Alum causes flocculation. Flocculation is a process through which all the finer insoluble particles form large particles called **flocs**. These flocs then can easily settle and thus are removed from water. Aluminium sulphate (alum) is the most common coagulant used for water purification. Other chemicals, such as ferric sulphate or sodium aluminate, may also be used. The flocculation tank has wooden paddle-type mixers that slowly rotate on a horizontal motor-driven shaft. After flocculation the flocs are allowed to settle in a settling tank. From here the supernatant is passed through sand filters. Microstrainers are used mainly to remove algae from surface water supplies before conventional **gravity-flow filtration**.

• **Filtration**

Even after coagulation and flocculation, sedimentation does not remove enough suspended impurities from water to make it crystal clear. Filtration is a physical process that removes these impurities from water by percolating it downward through a layer or bed of porous, granular material such as sand. Suspended particles become trapped within the pore spaces of the filter media, which also remove harmful protozoa and natural colour. Most surface water supplies require filtration after the coagulation and sedimentation steps.

When clogged by particles removed from water, the filter bed must be cleaned by backwashing. In the backwash process, the direction of flow through the filter is reversed. Clean water is forced upward through the media, expanding the filter bed slightly and carrying away the impurities in wash troughs. The backwash water is distributed uniformly across the filter bottom by an under drain system of perforated pipes or porous tile blocks.

Because of its reliability, the **rapid filter** is the most common type of filter used to treat public water supplies. However, other types of filters may be used, including pressure filters, diatomaceous earth filters, and microstrainers. As pressure filter has a granular media bed, but, instead of being open at the top like gravity-flow rapid filter, it is enclosed in a cylindrical steel tank. Water is pumped through the filter under pressure. In diatomaceous earth filters a natural powder like material composed of the shells of microscopic organisms called diatoms is used as a filter media. The powder is supported in a thin layer on a metal screen or fabric, and water is pumped through the layer. Pressure filters and diatomaceous earth filters are used most often for industrial applications or for public swimming pools.

Microstrainers consist of a finely stainless steel wire cloth mounted on a revolving drum that is partially submerged in the water. Water enters through an open end of the drum and flows out through the screen, leaving suspended solids behind. Captured solids are washed into a hopper when they are carried up out of the water by the rotating drum. Microstrainers are used mainly to remove algae from surface water supplies before conventional gravity-flow filtration.

(b) **Disinfection**

Disinfection destroys pathogenic bacteria and is essential to prevent the spread of water borne disease. Typically the final process in drinking water treatment, it is accomplished by applying either chlorine, ozone or ultraviolet radiation to clarified water.

• Chlorination

The addition of chlorine or chlorine compounds to drinking water is called **chlorination**. Chlorine compounds may be applied in liquid and solid forms-for instance, liquid sodium hypochlorite or calcium in tablet or granular form, however, the direct application of gaseous chlorine from pressurized steel containers is usually the most economical methods for disinfecting large volumes of water.

Taste or odour problems are avoided with proper dosages of chlorine at the treatment plant, and a residual concentration can be maintained throughout the distribution system to ensure a safe level at the points of use. Chlorine can combine with certain naturally occurring organic compounds in water to produce chloroform and other potentially harmful by-products. The risk of this is very small, however, when chlorine is applied after coagulation, sedimentation, and filtration.

• Ozone

Ozone gas may also be used for disinfection of drinking water. However, since ozone is unstable, it cannot be stored and must be produced on-site, making the process more expensive than chlorination. Ozone has the advantage of not causing taste or odour problems. It also leaves no residue in the disinfected water. The lack of an ozone residue, however, makes it difficult to monitor its continued effectiveness as water flows through the distribution system.

29.4.2 Traditional methods of water treatment

In ancient times there was appreciation and regard for the importance of water purity. Sanskrit writings from as early as 2000 BC tell how to purify foul water by boiling and filtering. But it was not until the middle of the 19^{th} century that a direct link between polluted water and disease (Cholera) was proved. And it was not until the end of that same century that the German bacteriologist Robert Koch proved the germ theory of disease, establishing a scientific basis for the treatment and disinfection of drinking water.

Water treatment is the alteration of a water source in order to achieve a quality that meets specified goals. The end of the 19^{th} century and the beginning of the 20^{th} century, the main goal was elimination of deadly water borne diseases. The treatment of public drinking water to remove pathogenic, or disease-causing, microorganisms began about that time. Treatment methods included sand filtration as well as use of chlorine for disinfection.

In developing countries, water borne disease is still the main water quality concern. In industrialized nations, however, concern has shifted to the chronic health effects related to chemical contamination. For example, trace amounts of certain synthetic organic substances in drinking water are suspected of causing cancer in humans. The added goal of reducing such health risks is seen in the continually increasing number of factors included in drinking water standards.

29.4.3 Other methods of water purification

Sometimes natural contaminants like fluorides, iron or arsenic are present in water. These impurities are harmful to human health. There are methods to remove these impurities.

- **Removal of fluoride**

Fluoride is generally present in all natural water. Its concentration up to certain level is not harmful. Beyond that level, the bones start disintegrating. This disease is called **fluorosis**. We have fluoride problem in many parts of our country. Bureau of Indian Standards prescribes 1.0 mg/l as desirable and 1.5 mg/l as maximum permissible limit for drinking water. Any water containing high level of fluoride needs to be treated for removal of fluoride in order to make it safe. The simple treatment technique which can be adopted at house hold level is described below:

- **Domestic defluoridation**

Defluoridation at domestic level can be carried out in a container (bucket) of about 60 litre capacity. The bucket should have a tap 3-4 cm above the bottom for withdrawal of treated water after treatment. The water for treatment is taken in the container, is mixed within adequate amount of aluminum sulphate (alum) solution, lime or sodium carbonate and bleaching powder depending upon its alkalinity (concentration of bicarbonates and carbonates in water) and fluoride contents. Alum solution is added first and mixed well.

Lime or sodium carbonate solution is them added and water is stirred for 20 minutes, then it is allowed to settle for nearly one hour and then withdrawn through tap for consumption. The settle sludge is discarded. Normally 100 to 600 ml of alum solution is required to be added in 40 litres of water containing fluoride ranging from 2 to 9 mg/l in order to remove it to acceptable level.

• Defluorodation at community level

The community used technique for community water supply is called **Nalgonda Technique** developed by National Environmental Engineering Research Institute (NEERI), Nagpur. It has following components:

- Reactor(s)
- Sump well
- Sludge drying bed.

This is a batch method for community upto 200 population. The tank is equipped with mechanical agitator operated manually or by electric motor. Water is pumped or poured into the tank and required amount of alum, lime or sodium bicarbonate and bleaching powder is added with constant stirring. The contents are stirred slowly for ten minutes and allowed to settle for two hours. The defluridated supernatant water is withdrawn and supplied. The sludge from the bottom is discarded.

• Removal of iron

In many parts of our country we have problem of excess iron in drinking water especially in North-East regions. Iron causes bad taste and odour to the drinking water. Bureau of Indian Standards prescribes desirable limit for iron as 0.3 mg/l. Removal of iron is essential.

• At domestic level

This is the simplest unit developed by NEERI . It involves aeration of raw water over a series of coke, marble/calcite bed followed by slow sand filtration. No chemical is required for treatment. Upto 200 l/hr of water can be treated.

• At community level

The treatment is a sequential processes of aeration, reaction-cum-setting and filtration. The main part of the treatment plant is a vertical cylindrical vessel having following chambers:

1. aeration-cum-oxidation chamber
2. settling-cum-filtration chamber
3. final collection chamber for treated water

Water from the hand pump is sprinkled from the top. This will ensure contact with air for complete aeration. A major part of iron is oxidized here. Then the water is made to react with oxidizing media (lime stone). The remaining iron is oxidized in this chamber. By aeration and further oxidation the dissolved iron is converted to insoluble ferric hydroxide. The insoluble iron can thus be easily removed through filtration. Then it is passed through filter media (sand and gravel filter). The filtrate water contains iron in an acceptable range.

- **Removal of arsenic**

Arsenic is found in ground water in some parts of West Bengal. Arsenic is highly toxic in nature,. It may cause a number of skin disorders or even cancer. Bureau of Indian Standards prescribes desirable limit for arsenic as 0.05 mg/l. Removal of arsenic is essential. The treatment technology developed by Institute of Public Health and Hygiene, Kolkata is commonly used. The technology is based on oxidation, coagulation, flocculation, sedimentation and filtration. Bleaching powder and alum are used for removal of arsenic. It consists of three chambers. In the first chamber the chemicals are added. The mixture is then passed to next chamber called settling tank, where it is allowed to settle for 2 hours. The supernatant is then passed through a slow sand filter. The filtrate water generally contains arsenic in the acceptable range.

INTEXT QUESTIONS 29.2

1. Why does usable water require treatment?

2. Name the steps in water treatment.

3. What is fluorosis?

4. How is water rid of iron at the community level?

5. What harm does arsenic cause if consumed with water contaminated with it?

29.5 CONCEPT OF WATER QUALITY

Water being the best solvent available on earth, is seldom found in pure state. Water in nature is most nearly pure in its vapour state. Water may acquire impurities at the very moment of condensation. In hydrological cycle, water comes in contact with atmosphere, soil and other materials lying on land and also the minerals underground. During this contact water acquires impurities. Human activities contribute further impurities in the form of industrial and domestic wastes, agriculture chemicals and other contaminants.

The term quality therefore, must be considered relative to the proposed use of water. Thus, water quality is defined as "those physical, chemical or biological characteristics of water by which the user evaluates the acceptability of water". For example for the sake of human health, we require that water supply be pure, wholesome, and potable. Similarly for agriculture, we require that the sensitivity of different crops to dissolved minerals and other toxic materials is known. Textiles, paper, brewing, and dozens of other industries using water, have their specific water quality needs.

For management of water quality of a water body, one has to define the water quality requirements or water quality objectives for that water body. As mentioned above, each water use has specific water quality need, therefore, for setting water quality objectives of a water body, it is essential to identify the uses of water in that water body. In India, the Central Pollution Control Board (CPCB), an apex body in the field of water quality management, has developed a concept of "designated best use". Accordingly out of several uses a particular water body is put to, the use which is highest quality of water is called its "designated best use", and accordingly the water body is designated as A, B, C, D, E. On the basis (1) pH, (2) dissolved oxygen, mg/1 (3) BOD, (20^0C) mg/l(4) total coliform (MPN/100ml) (5) free ammonia mg/l, (6) electrical conductivity etc. The CPCB has identified 5 such "designated best uses" as given in Table 29.3.

Table 29.3: *Use based classification of surface waters in India*

Designated best use	***Quality class***
Drinking water source without conventional treatment, but with chlorination	A
Outdoor bathing (organized)	B
Drinking water source with conventional treatment	C
Propagation of wildlife and fisheries	D
Irrigation, industrial cooling and controlled waste disposal	E

The CPCB, in collaboration with the concerned State Pollution Control Boards, has classified all the water bodies including coastal waters in the country according to their "designated best uses". This classification helps the water quality managers and planners to set water quality targets and identify needs and priority for water quality restoration programmes for various water bodies in the country. The famous Ganga Action Plan and subsequently the National River Action Plan are results of such exercise.

29.6 WATER QUALITY REQUIREMENT FOR DIFFERENT USES

Inherently water is a multiple use resource. With the advent of industrialization and increasing population, the range of requirement for water has increased. The main uses of water are public supply, outdoor bathing and recreation, fisheries and wildlife propagation, irrigation and other agricultural uses, cooling in power plants, navigation and disposal of wastes. Drinking water needs highest purity of water, whereas disposal of wastes can be done in any quality of water. In recent years as the demand for water has nearly approached in magnitude the available supply, the concept of "management of the quality of water" has become very important throughout the world.

29.7 ECOLOGICAL WATER REQUIREMENTS

Maintaining ecological quality often requires significant amount of water to flow in a river. Each river has developed a well-established ecosystem in its course having different habitats and seasonality. All the biological processes are highly timed and spaced. To accomplish these processes, a minimum level of water is required. Water quantity has ecological impact in a number of ways. Flood flows flush out spawning areas, leaving clean new gravels, sand washed out of the hills. Controlling flows by dams prevents both cleaning and renewal. High flow rates sweep debris from river channels and wash down new gravels and sand needed for spawning of many fish.

In the past and even now, dilution was considered to be an acceptable "solution to pollution" and self-purifying capacity of a stream. This has been included in most of the effluent standards (Minimum National Standards, MINAS) notified under Environment (Protection) Act, 1986 by the Government of India. It is assumed that atleast ten times dilution is available in a stream where the effluent is going to be discharged. Because all deleterious material is not removed in waste water treatment, the role of dilution is very significant in protecting the health of a river. In our country, the need for fresh water is growing at a fast rate. Thus, the focus is laid on utilization of every drop of water. This has resulted in drastic reduction in flow conditions of many rivers in the country. Reduced flow followed by increased waste load have rendered many rivers almost ecologically dead. Thus, special attention is required in water resource planning.

29.8 MAJOR WATER QUALITY ISSUES OF INDIA

The major water quality issues in Indian context can be summarized as follows:

(a) **Water scarcity**

- Due to un-even distribution of rainfall in time and space and ever-increasing demand of water for agricultural, industrial and domestic activities, the water resources are over-exploited. This is resulting in shrinking or even drying up of many water bodies for considerable periods in a year.
- **Targets for conservation:** Reducing demands by optimum use, minimization of wastage, efforts to reduce the percolation and evaporation losses, conservation efforts in domestic uses, groundwater recharging, rain water harvesting, afforestation, recycling and reuse are important to combat this problem (See Lesson 28).

(b) **Pathogenic pollution**

- Water borne diseases are the most important water quality issues in India. This is mainly due to inadequate arrangements for transport and treatment of wastewaters. Thus a major portion of the wastewater generated from human settlements is not properly transported and treated before discharging into natural waters. This results in contamination of both surface and ground waters. Moreover, contribution of pathogens through diffuse sources is also quite significant. Thus, most of the surface water bodies and many ground water sources are contaminated.
- A large population of the country still uses water directly for drinking or bathing without any treatment, thus, exposed to water borne diseases. This is the single major cause for mortality due to water pollution.

(c) **Oxygen depletion**

- As indicated above a large portion of wastewater is discharged into water resources without any treatment. A major portion is from domestic sources. Such waste water contains high amount of organic matter. The industries e.g. agro-based industries also discharge effluents containing high organic matter. This organic matter when oxidized in water through microbial activities, consumes dissolved oxygen. Since water has limited availability of oxygen, if consumption exceeds the availability, oxygen depletion results and survival of aquatic life becomes difficult.
- In many water bodies massive input of organic matter set off a progressive series of chemical and biological events in the downstream water. The stretch is characterized by high bacterial population, cloudy appearance, high BOD and strong disagreeable odour-all indicating general depletion of oxygen. Masses of gaseous sludge rising from the bottom are often noticed floating near the surface of the water. During monsoon due to flood the sludge deposited in such stretches is flushed and stay in suspension, causing rise in oxygen uptake in the downstream. Due to such sudden oxygen depletion, heavy fish mortality occurs every year during first flushing after onset of monsoon.
- As per the water quality monitoring results of CPCB, a large number of rivers and some lakes are already facing such problem for a significant period in a year.

(d) **Eutrophication**

The discharge of domestic wastewater, agricultural return water or run-off water and many industrial effluents contribute nutrients like phosphates and nitrates. These nutrients promote excess growth of algae in water bodies (algal blooms). This is not desirable for balanced aquatic ecosystem (See lesson 10).

(e) **Salinity**

- There are number of cases where salinity is increasing in both surface water and groundwater. The increase in groundwater salinity is mainly due to increased irrigation activities or sea water intrusion in coastal areas. The salinity in surface water is increasing mainly due to discharges of industrial wastewater or agricultural return water.

- Salinity reduces the fitness of water for drinking or irrigation. It may also affect the ecosystem in surface water.
- Salinity is increasing in many water bodies especially groundwater due to leaching of salts build-up in agricultural areas under intense irrigation.
- A number of industrial activities discharge wastewater with high dissolved solids, cause increase in salinity of water.

(f) **Toxic pollution**

- Due to discharge of toxic effluents from many industries and increased use of chemicals in agriculture and their subsequent contribution to the water bodies, many water bodies in the country are polluted due to presence of toxic substances.
- Presence of toxic substance impairs the water quality by making it unfit for human consumption, aquatic life and irrigation.

(g) **Ecological health**

A large number of areas in our aquatic environment support rare species of aquatic and amphibious plants and animals and are, therefore, ecologically very sensitive. They need special protection.

INTEXT QUESTIONS 29.3

1. What is meant by 'water quality'?

____

2. State one example to express that concept of water quality differs with the purpose of using water.

____

3. Name any two major water quality issues of our country.

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4. What is eutrophication?

____

5. Why do certain aquatic areas require special protection?

____

29.9 WATER USE IN INDIA

The uses of water in India are divided into two categories i.e. **abstractive uses** and **in stream uses**. A brief description of these uses is given below.

(1) **Abstractive Uses**

The different abstractive uses include domestic water supply, irrigation, industrial use of water. The details are as follows:-

(a) **Domestic water supply**

The cities located along the water bodies use the water for drinking and other domestic purpose after conventional treatment. About 14 billion cubic meter (BCM) of water per annum is used for domestic water supply in India.

In India nearly 85% of the population depends on ground water as a source of water for domestic use. Some of the urban and rural population also uses surface water after conventional treatment for domestic purposes.

(b) **Irrigation**

Irrigation is the most important use of water in India. Nearly 84% of the water is used only for irrigation. The total water used for irrigation is estimated as 460 BCM per annum.

(c) **Industrial use**

A large amount of water is used for industrial purpose. As per the estimation of CPCB about 30 BCM per annum is used as cooling water in thermal power plants.

(2) **In-stream use**

The in-stream uses of water are as follows:

(a) **Hydro-power**

The total potential for hydropower (energy from water) development in India has been estimated at 84,000 MW at 60% load factor. So far a potential of about 13400 MW has already been created and three schemes with a total power potential of about 5420 MW are under construction.

(b) **Fisheries**

Indian water resources are extensively utilized for fish production through out the country. India has the distinction of being the seventh largest producer of fish in the world and second largest producer of inland fisheries after China.

(c) **Navigation**

At present the river systems are not fully utilized for navigation, but there are plans to use the several stretches of our river system for navigation. Inland waterways in public sector is managed by government owned Central Inland Water Transport Corporation (CIWTC). In addition, the private sector companies operate a major chunk of Inland Waterways Traffic (IWT) (traveling or cruising by ship, boat etc.). The inland waterways traffic constitutes only a very small part of total transport network in the country which is dominated by rail and road transport. IWT traffic is adversely affected by withdrawal of water for domestic, agricultural and industrial uses etc.

(d) **Community bathing and washing**

The entire surface water sources are being used for bathing and washing. On particular religious and cultural occasions, when millions of people take holy dip in several stretches of our riverine system e.g. "Ganga snan", "Kumbh mela" etc.

(e) **Cattle bathing and watering**

Most of the towns and villages along the surface water sources have been using them for cattle bathing and watering/washing.

(f) **Water as raw material and not dumping ground for wastes**

With the advent of industrialization and increasing populations, the ranges of requirements for water have increased. This has resulted in gradual depletion of water from its sources and degradation in its quality. Each water use, including abstraction of water and discharge of wastewater leads to specific and generally predictable impact on quality of aquatic environment. In addition, to these intentional uses, there are several human activities which have indirect and undesirable, if not devastating, effects on water quality. Examples are uncontrolled land uses, deforestation, accidental (or unauthorized) release of chemicals, discharge of untreated or partially treated wastes or leaching of noxious liquids from solid wastes deposits. Similarly, the uncontrolled and excessive use of fertilizers and pesticides has long-term effects on ground and surface water resources.

Structural interventions in the natural hydrological cycle through construction of canals and dams on rivers, diversion of water within or among basins, and the over-pumping of aquifers are resulting in serious long term environmental damage.

INTEXT QUESTIONS 29.4

1. State an abstractive use and an instream of water.

2. Of what benefit are dams and canals drawn from rivers?

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3. State two causes of long-term ecological damage to our river.

____

WHAT YOU HAVE LEARNT

- Fresh water is only a small fraction of total water available on this earth. India receives about 4000 billion cubic meter (BCM) of rainwater annually. However, usable water is estimated as 1150 BCM. So far we are able to use only about 600 BCM of water.
- Fresh water resources are mainly rivers, lakes and ground water.
- For drinking water supply surface water are treated whereas groundwater can be used directly with disinfection.
- The drinking water treatment involves coagulation, filtration followed by disinfection.
- Coagulation involves addition of alum, which helps fine suspended particles to form flocs, which can easily settle or filtered out.
- Disinfection kills the harmful germs from water, thus water becomes free from pathogens.
- The treated water is then supplied through the distribution network in the residential areas.
- For specific pollutants like fluoride, iron or arsenic specific chemical treatments are given.
- Water quality is term used to define fitness of water for a particular use. For each water use specific water quality is required. Water quality in India is regulated under Water Act, 1974.
- Water uses are ether abstractive or in stream.
- Domestic, industrial and irrigation uses are abstractive uses whereas hydro-power generation, fisheries, navigation and outdoor bathing are in stream uses.
- Pathogenic pollution is the most important form of water pollution in India
- Some water bodies are facing oxygen depletion, eutrophication and salinity or toxicity problems.
- A large number of human activities including agriculture, industrial and urban have marked impact on water quality.

TERMINAL EXERCISE

1. Describe the distribution of freshwater on earth.
2. Explain in brief the water resource distribution of India
3. How water is purified for drinking?
4. Why water is required to be purified for drinking?
5. Why ground water is safe for drinking?
6. How excess fluoride is removed from water?
7. How in stream uses affect water quality?
8. What are the main water quality issues in India?
9. How an agricultural activity affects water quality?
10. How water quality is altered due to dumping of wastes?

ANSWER TO INTEXT QUESTIONS

29.1

1. About 2.7%
2. More than 1400 million km^3
3. Lakes, rivers, ground water

29.2

1. Because water used for drinking, bathing, washing, cleaning etc. and to protect the health of the community.
2. Step of water treatment

   I. Clarification or sedimentation

   Coagulation and fluoridation

   Filtration

   II. Disinfection

   Chlorination

   Ozone
3. Fluorisis is a crippling and painful disease caused by intake of fluoride.
4. By using a sequential process of aeration, reaction-cum-setting and filtration.
5. It may cause number of skin disorders of even cancer.

29.3

1. Those physical, chemical or biological characteristics of water by which the user evaluates the acceptability of water.
2. It is based on the physical, chemical or biological quality of water, removal of toxic substances for sake of human health, we require water supply by pure wholesome and potable.
3. Water scarcity wholesome and potable. Pathogenic pollution, oxygen depletion etc. or any other.
4. Enrichment of nutrients like phosphates and nitrates. Promotes excess growth of algae in water bodies.
5. Because for protection of rare species and survival of aquatic environment.

29.4

1. (i) Domestic water supply, irrigation (any other)

   (ii) Hydropower, fisheries and navigation (any other)
2. Ample water for irrigation, production of electricity.
3. Diversions of river stream and long term environment damage, pollution.