UNIT 22 ENVIRONMENTAL QUALITY MANAGEMENT

Structure

22.1 INTRODUCTION

You have already learnt about types, sources and effects of air, water and land pollution in Units 10, 11 and 12 respectively. You have also learnt about the state of degradation of physical resources in Unit 21. In this unit, we shall discuss the various aspects of environmental quality management.

Also in most of the cases, it is technically not possible to completely eliminate the generation of pollutants; it can at best be minimised. Then the question arises—to what extent can the environment tolerate the pollutants? Various countries, including India, have set up standards which specify the limits of emission of various pollutants, viz, the maximum concentrations of pollutants that are permitted in specified media (e.g., air or water). The standards are based on : (primary) estimates of maxima which, with an allowance for safety, present no hazard to public welfare. They may take the form of emission standards, or relate to the content of products (e.g., additives or pesticide residues) in food, or phosphates in detergents. As per the pollution control acts, enacted from time to time, all the manufacturers have to adhere to these standards. Having set the standards, we now have to address ourselves to the following questions :

- What control measures are needed to bring down the immission levels to the standards set?
- What are the various issues involved in achieving the desired environmental quality? and
- At what cost could that be achieved?

We shall discuss these questions in this unit.

22.1.1 Objectives

After reading this unit you will be able to :

- account for the problem of air, water and land pollution
- list the standards for air and water pollution
- broadly suggest the various types of air and water pollution control equipment and techniques
- assess the cost of industrial pollution
- rationalise social forestry as a means of land reclamation, and
- suggest other methods of reclamation of degraded lands.

22.2 MANAGEMENT OF AIR QUALITY

The management of air quality comprises the following aspects :

a) Establishment of emission standards and ambient air quality standards

b) Measurement and control of pollution from various sources

c) Monitoring of ambient air quality to ensure that the level of pollutants is always maintained within safe limits

d) Planning of developmental activity so that the incremental pollution does not affect air quality adversely and that it remains within the permissible limits.

22.2.1 Air Quality Standards

Air quality standards are prescribed by Central Pollution Control Board. There are three types of standards :

i) Emission standards, which limit the emission of pollutants from a source; stock emission standards are the maximum tolerable level of a pollutant that are permitted to escape the chimney of an industry or the stack of a thermal power plant.

ii) Immission standards, which specify the ambient air quality, i.e., the amounts of various pollutants which are tolerable in space surrounding the source of generation. Immission standards are the maximum levels of a pollutant which can be tolerated in the air mass of the surrounding areas of the industry/factory or a thermal power plant. These are also called as ambient air standards.

iii) A third category of standards can be defined separately, for the sake of convenience; the vehicular emission standards. These standards have been prescribed only recently. Vehicular emission standards are the maximum tolerable limits of the levels of various pollutants that are allowed to escape the exhaust duct of an automobile.

i) Emission Standards

Various emission standards have been prescribed for different industries. The maximum permissible level of dust in the form of suspended particular matter (SPM) is 150 mg/Nm^3 (read as milligram per normal cubic metre). Dust comes from stacks of thermal power plants, iron and steel sintering plants, fertiliser manufacturing units, small industry boilers and stone quarrying activities. Other industrial units such as metal refineries, brick kilns and synthetic fibre plants belch out other pollutants in the form of acid mist consisting of droplets of dissolved gases suspended in air. These droplets consist mainly of aqueous solution of varying proportions of gases like SO_2, oxides of nitrogen (NO_x), CS_2, CO_2 and H_2S. The total permissible level of acid mist in the stack exhaust should not exceed 50 mg/Nm^3. Some of the stack emission standards are given in Table 22.1.

Table 22.1 : Stack Emission Standards

Typical Emission standards for industries are as follows :

Industry		Protected Area	Other Area
Cement Plant	< 200 TPD SPM	250	400 mg/Nm^3
	> 200 TPD SPM	150	250 mg/Nm^3
Thermal Power Plants	> 200 MW SPM	150	150 mg/Nm^3
	< 200 MW SPM	150	600 (350) mg/Nm^3
	< 50 MW SPM	1000	2000 mg/Nm^3
(last two categories are under revision)			
Iron and Steel Plant			
Sintering Plant		150	150 mg/Nm^3
Steel Melting, Normal		150	150 mg/Nm^3
Steel Melting, Oxygenated		400	400 mg/Nm^3
Fertiliser, Urea Manufacture		50	50 mg/Nm^3
Nitric acid NO_x		3 kg NO_x per tonne acid product	

Sulfuric acid SCSA SO_2 10 kg per tonne conc acid product		
Sulfuric acid SCSA Acid Mist 50		50 mg/Nm³
Sulfuric acid SCSA SO_2 4 kg per tonne conc acid product		
Sulfuric acid DCDA Acid Mist 50		50 mg/Nm³
Furnace		150 mg/Nm³
Synthetic fibre plant H_2S 60 kg/t of fibre		
Synthetic fibre plant CS_2 30 kg/t of fibre		
Small Industrial Boilers		
Coal fired		
> 15T/hr steam generation	150	150 mg/Nm³
2-15T/hr steam generation	1200	1200 mg/Nm³
< 2-T/hr steam generation	1500	1500 mg/Nm³
Oil fired SO_2 as per formula for stack height		
	H = 14 Q	
where H : stack height and Q = SO_2 emission in kg/hr		
Calcium carbide SPM	150	15 mg/Nm³

ii) The Immission Standards

The gaseous pollutants released from the stacks of various industries are ultimately deposited in the air surrounding these units, that is, in the ambient air. Obviously, regardless of how much of pollutants are released from the stack, there is a limit to the amount of individual pollutants that can be allowed to accumulate in the zone surrounding a factory, kiln or unit. The ambient air quality or immission air standards define the maximum permissible level/concentration of individual pollutants which can be allowed to prevail in the surrounding air. Some of the ambient air Standards are given in Table 22.2.

Table 22.2 : Ambient Air quality Standards in mg/Nm³

	SPM	SO_2	CO	NO_x
Industrial areas	500	120	5000	120
Residential areas	200	80	2000	30
Sensitive areas*	120	30	1000	30

* Areas near the hospitals, health resorts, parks and entertainment ground

iii) Vehicular Emission Standards

Automobile emissions of all types are thought to contribute 60 per cent of total air pollutants in western countries. The gases and solid particles coming from automobile exhaust pipes consist mainly of carbon monoxide, lead compounds and oxides of nitrogen (NO_x), as well as unburnt hydrocarbons. The maximum permissible levels of dust laden with these pollutants for various kinds of engines are shown in Table 22.3.

Table 22.3 : Vehicular Emission Standards

Recently standards have also been proposed for Automobiles. The proposed standards in mg/Nm³ SPM are :

Diesel Engines			
At Factory	60		
On Road	70		
Petrol Engines			
Carbon Monoxide % :			
	Two Wheelers		
	< 50 CC	> 50 CC	4 Wheelers
At Factory	5.0	4.5	3.5
On Road	5.0	4.5	4.0
Lead in Petrol			
Average	200 ppm		
Maximum	450 ppm		
Target (1992)	150 ppm		

22.2.2 Air Quality Measurement

Air quality measurements can be made either at source (in the chimney) or in air around. Recent technical advances now enable remote measurements to be made at large heights above the ground. Measurements at the source are relatively easy to make, have better repeatability and require less time. However, they need more

sophisticated instruments. Ambient air quality measurements on the other hand, require simpler instruments but are time consuming and exhaustive.

i) Measurements of Stack Emissions

The dust measurements are carried out by stack sampling. The collection of representative gaseous and particulate samples of air flowing through a stack gas is drawn through a thimble, for filtering, at a constant rate under **isokinetic conditions**. The total volume drawn is measured and the dust collected in the thimble is also measured by weight difference. The dust concentration is expressed in mg/Nm^3 (volume at 25 C and 760 mm/wc).

The following three precautions must be observed during stack sampling :

- There must be sufficient number of samples,
- The long axis of the sampling probe should be parallel to and not facing the air flow direction, and
- The samples must be taken under isokinetic conditions.

Isokinetic sampling is a technique for collecting airborne suspended particulate matter, in which the sample collector is so designed that the air stream entering it has a velocity equal to that of the air passing around and outside the collector. Now, let us see what we mean by isokinetic conditions.

Isokinetic implies the velocity of gas drawn in the collector probe (v_p) should be the same as velocity of the gas (v_g) around the collector probe. If the velocity V_p is lower than V_g (Fig. 22.1b), then the collected portion will contain excessive proportion of coarse particulates whereas the fine particles following the streamlines would pass outside the probe. Thus, if the dust is richer in fine particles, the sample will show lesser than actual dust concentration. The reverse is true in case V_p is greater than V_g (Fig. 22.1c). In simple terms, an isokinetic sampling device has a collection efficiency of unity (1) for all sizes of particles in the sampled air.

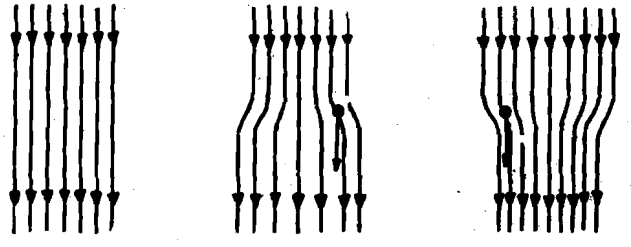

Fig. 22.1 (a, b and c) : The principle of isokinetic sampling of particulate matter.

The gaseous pollutants are usually measured by passing the stack gas through an appropriate absorbing medium for absorbing the pollutant and then identifying it by analytical methods. Standard methods of analysis and measurements have been prescribed by Central Pollution Control Board of India and the Environment Protection Agency of USA.

ii) Measurement of Ambient Air Quality

In principle, the measurement of ambient air quality is also similar to the measurement of stack air, the basic difference being that due to far lower concentration of the pollutant, compared to that in stack, the sample volume is usually very high. High volume samplers are, therefore, used. Since ambient air quality is dependent, to a very large extent, on the climatic conditions, it is important that various metereological parameters like wind velocity, wind direction, etc., be also recorded simultaneously. Ambient air quality measurements are carried out over periods ranging from 8 to 24 hours. The period of sampling for stack emission measurements depends on the concentration of the pollutants and is usually less than an hour.

22.2.3 Air Quality Control

A. Industrial

The control of air quality implies limiting the emission of pollutant. The conventional approach is usually called 'end of the pipe approach' which takes forgranted the emissions coming out from the source and a suitable equipment is then designed and installed to meet the pollutant emission standards. However, a more rational approach would be : to prevent generation of pollutants first and then control whatever is technically or economically not preventable.

The control systems for industrial emissions depend on the type of pollutants. The most common types of control systems for suspended particulate matter (SPM) are :

- Cyclones
- Electrostatic Precipitators
- Bag Filters
- Scrubbers

i) Cyclones/Multiclones

These are the most conventional types of control system. These work on the principle of dust separation by centrifugal force. The dirty gas enters tangentially in the cyclone and swirls in it. The dust particles get thrown on the periphery and clean gas escapes from the centre of the cyclone. Cyclone usually works at a dust separation efficiency of 70-75 per cent. The efficiency drops down sharply as the particle size goes below 10 microns. Use of cyclone is not suggestible for moisture laden gas.

ii) Electrostatic Precipitators (ESP)

The ESPs are now widely used for separation of dust in large industries like thermal power stations, cement industries, etc. They work on the principle of charging the dust by application of high voltage electricity to settle the particles down. The ESPs are simple in operation and most cost effective in larger sizes. They work with efficiency in the range of 99 per cent or even higher.

iii) Bag Filters

Of late, tremendous developments have taken place in the field of bag filters. As the name implies these consist of filter bags through which dust laden gas is passed. The dust gets filtered and clean air escapes. Bags are periodically shaken to remove the dust collected. Different types of filter bag materials are available to suit various types of dust. The common bag materials are cotton, polyester, glasswool, teflon, polyamide and of late, ceramic fibre. Therefore, these filters are used by ceramic, cotton, insulation and textile industries.

iv) Scrubbers

Another method of separation of dust is by using scrubbers which also are the only equipment for separation of gaseous pollutants. A scrubber is an apparatus used in air sampling or cleaning, in which air is passed through a space containing wet packing material or spray. The gaseous pollutants are removed principally by scrubbing. The process consists of absorbing the gaseous pollutant in appropriate liquids to bring the pollutants from gaseous phase to liquid/solid phase. The liquid is used to remove dust particles and soluble gases from the air stream. Various types of scrubbers are available. To name a few, spray type scrubbers, ventury scrubbers, impingment scrubbers, etc. Scrubbers can also be used for removal of particulate matter; their efficiency ranges from 80 to 98 per cent. The principal disadvantages is that the gaseous pollutant gets converted into liquid/solid phase and have to be further treated before disposal. Scrubber operation is generally a costly affair as it consumes a large quantity of water and power.

B. Motor Vehicles

The major emissions from motor vehicles are :

a) Carbon monoxide
b) Unburnt hydrocarbons (soot), and
c) Nitrogen Oxides

Apart from these, lead is also emitted in case the petrol consists of lead based anti-knocking agents such as TEL (Tetra ethyl lead). The control of vehicular emissions is usually carried out in the following ways :

a) Use of good quality petrol to minimise emissions.

b) Better tuning of carburettor and maintenance of engine, specially for better combustion which by itself brings down emissions of carbon monoxide, hydrocarbons and smoke to minimum limits.

c) Installation of catalytic convertor in the vehicles to convert nitrogen oxide into nitrogen. In the absence of any standards in our country, control measures have been recently enforced. These are, however, mandatory in Japan, West Germany and USA.

22.2.4 Economics of Air Quality Control

The entire world has one continuous atmosphere. Obviously, therefore, air pollutants are not limited to local area but cross national and even continental boundaries. The examples of dust from Sahara desert reaching West Germany and the sulphur dioxide emissions in UK causing acid rain in Scandinavia are well known. Air pollutants, therefore, cause damage not only to the local inhabitants but also to those living in far-flung areas.

Immediate threat from air pollutants is in the form of health hazard to local population—dust causing respiratory diseases and gaseous pollutants causing several other diseases. The long-term effect is even more harmful. The breaking up of ozone layer by gaseous pollutants like chlorofluorocarbons would cause an increase in incidence of ultra-violet radiation from the sun which is a well known cancer-causing agent. The green house effect caused by carbon dioxide and other gaseous pollutants, as you have read in Section 10.5.2, reduce the amount of heat radiated from the earth, thereby increasing the earth's temperature. The sulphur dioxide comes back to earth in the form of acid rain, see Section 10.6, which damages vast terrains of fertile land and renders soil acidic and barren. It should be obvious that it is always more economical to control air pollution than to suffer from it and then identify ways and means to cure its ill-effects.

At the unit level, dust pollution control through cyclone samplers would cost anywhere from a few thousand to a few lakh rupees depending upon volume of gases to be handled. Investment-wise, scrubbers are also cheap but require a higher operating cost due to high water and power consumption. Bag filters with indigenously available bags are not very expensive (a few lakh rupees) but for industries requiring imported bags, cost can be much higher. Further, since the life of a filter bag is not more than 3 to 4 years, the recurring costs in terms of bag replacement could be considerable. Large filter bag installations may cost from several lakhs to few crores of rupees. ESPs are used mostly for large installations and obviously are more expensive (cost ranges in several crores). However, operation and maintenance costs are not very high.

The experience of developed countries like Japan and West Germany has shown that on a national basis the investment made towards air pollution control is paid back several times. It is important for us to take cue from their experience and adopt these measures in our country as well.

SAQ 1

1) Compare the terms given in Column A with their definitions given in Column B :

Column A	Column B
a) Scrubber	a) The maximum levels of a pollutant which can be tolerated in the air mass of the surrounding areas of the industry/factory or a thermal power plant.
b) Standard	b) A device used to clean air by passing it through a wet packing material.
c) Stack Emission Standards	c) The maximum tolerable limits to the levels of pollutants that are allowed to escape the exhaust duct of an automobile.
d) Vehicular Emission Standards	d) The maximum tolerable levels of a pollutant that are permitted to escape the chimney of an industry or the stack of a thermal power plant.
e) Immission Standards	e) The maximum limits or concentrations of pollutants permitted in specific media, based on the estimates of maximum levels which do not present any hazard to public welfare.

f) Electrostatic Precipitator	f) A device consisting of filter bag through which dust laden air is passed. The dust gets filtered and clean air escapes.
g) Bag Filter	g) A device used to remove dust from air by passing high voltage electricity which charges the dust particles and settles them down.

II) Are the following statements True or False?

i) Cyclone is an excellent device for arresting fine particles. ☐

ii) Electrostatic precipitator consumes large electric power for operation. ☐

iii) Bag filters are the cheapest dust collection devices. ☐

iv) Scrubbers can be used for removal of both particulates and gaseous pollutants. ☐

v) Pollution from furnace oil-fired boilers is more than that from natural gas-fired boilers. ☐

22.3 MANAGEMENT OF WATER QUALITY

Water quality management involves multi-disciplinary approach, in which the required water quality is related to municipal, industrial, agricultural and recreational requirements. In many cases a cost-benefit ratio must be established between the benefit derived from a certain water quality and the cost of achieving that quality. Figure 22.2 shows various components to be considered while developing an effective water quality management programme. Such a programme is designed to establish the most economic long-term solution for achieving the desired water quality. We will now discuss its major components, viz.

i) Water quality standards
ii) Water quality measurement
iii) Water quality control

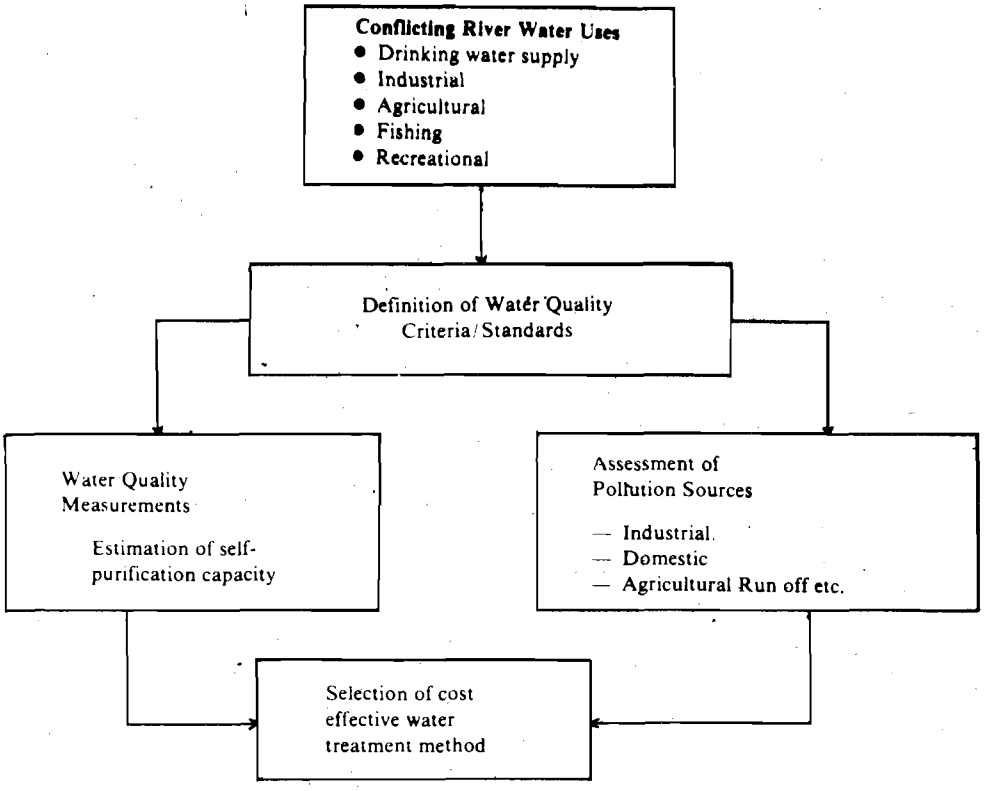

Fig. 22.2 : Development of a Water Quality Management Programme.

SAQ 2

Which of the following can be described as pure water?

1) Rain water
2) Water having a pH value of 7.

3) Water free of suspended solids
4) Soft water
5) None of the above

22.3.1 Water Quality Standards

Water quality standards are based either on stream standards or on effluent standards.

Stream standards are normally based on the beneficial uses of the water whic fixes the threshold value of specific pollutants permissible in the receiving wat our country the general criteria for stream water quality, required for various beneficial uses have been specified by the Central Pollution Control Board (CPC) in 1979. For this purpose the CPCB has classified fresh water bodies into the following broad categories :

a) Drinking water source without conventional treatment but after disinfection.
b) Organised outdoor bathing.
c) Drinking water source with conventional treatment followed by disinfection.
d) Propagation of wildlife, fisheries, and
e) Irrigation, industrial cooling and controlled waste disposal.

The waters of category A should conform to the following standards, such water should have a minimum of 6 mg/l dissolved oxygen and a maximum of 2 mg/l of biological oxygen demand. They should not have more than 50 *E. coli* per 100 ml and the pH value should be between 6.5-8.5, viz., the water should neither be sour nor bitter.

The waters of category B are useful for outdoor bathing and swimming and should conform to slightly less strict criteria for quality. The waters of category C can be used for laundrying. These waters can be made worth drinking by giving a conventional treatment followed by disinfection. The waters of category D are used for propagation of wildlife and maintenance of fisheries. The last category comprises of waters (E) which are not fit for any of the above purposes. These waters have very high BOD and large number of coliform bacteria. These can, however, be used for irrigation and industrial activities provided the electrical conductivity is not more than 2,250 micro mhos per ml.

The Central Board has prescribed the primary quality criteria in respect of eight basic parameters for each of this category, as given in Table 22.4.

Table 22.4 : Primary Water Quality Criteria for various uses of fresh waters, as laid down by the CPCB*

	Purpose	Drinking	Bathing	Laundrying	Fisheries	Irrigation, Industries
S. No.	Characteristics/ Parameters	A	B	C	D	E
1.	Dissolved Oxygen mg/l, minimum	6	5	4	4	—
2.	Biochemical Oxygen demand (BOD), mg/l, maximum	2	3	3	—	—
3.	Total coliform organisms** MPN/100 ml. maximum	50	500	5000	—	—
4.	pH value	6.5-8.5	6.5-8.5	6-9	6.5-8.5	6.5-8.5
5.	Electrical conductivity micromhos per ml maximum	—	—	—	—	2,250

* CPCB—Central Pollution Control Board.

* Coli count means the number of bacteria of the species *E. coli* present in unit volume of water. This is taken as an index of number of other pathogens present in the water, because *E. coli* is almost invariably discharged with human fecal matter. It is not a pathogen itself, but waters in which number of pathogens is high, the number of coliforms, is usually found to be high. A low coli count is thus indicative of low number of pathogens in water sample. It is measured in numbers per hundred ml of water sample.

There should be no visible discharge of domestic and industrial wastes into Class A waters. In case of Classes B and C the discharges shall be so regulated/treated as to ensure maintenance of the stream standards. Although stream standards are the most realistic and directly based on the beneficial uses, they are difficult to administer and control in an expanding industrial and urban area.

Effluent Standards are based on the maximum concentration of a pollutant (mg/l) of maximum pollution load (kg/day) discharged into a receiving water. These standards in turn can be related to a stream classification as discussed above. In our country, under the Water Pollution Control Act enacted in 1974, effluent standards, based on the maximum concentration of a pollutant (mg/l), have been prescribed. Depending upon the receiving media, such as open stream or sewer or land, appropriate disposal standards have been evolved. The water pollution control act is primarily a state subject. The respective state pollution control boards are empowered to promulgate their own standards, but within the upper limits, prescribed by the CPCB.

22.3.2 Water Quality Measurement

Quantitative and qualitative measurements are essential to understand and control the processes affecting the fresh surface water pollution. Depending upon the objectives, the water quality measurement programmes are divided into :

Monitoring : Continuous, standardised measurement—to define the characteristics of the water resources, the nature of existing inputs and their potential pollutants.

Survey : Series of intensive programmes of finite duration, designed to carry out measurements in detail, ideal for a specific purpose and to determine the self-purification capacity of the receiving media under the conditions of the survey.

Surveillance : For practical reasons related to both economic and human resources, continuous specific observations and measurements are carried out for specific pollution control or management purposes.

We would like you to spend sometime studying Fig. 22.2. You will find that the above three programmes are important for an analysis of the dispersion of pollutants and self-purification processes occurring in rivers, lakes and reservoirs, and have the following aims :

a) to provide a basic set of data for the purpose of developing scientific knowledge, including water quality modelling;

b) to protect a body of water from pollution, and to ensure the quality of water for different uses (drinking water supply, watering of livestock, bathing, fish culture, and irrigation etc.)

Parameters to be Measured

Water quality measurements are usually complex and expensive. Hence, it is important to be clear about the objective and the actual use of the collected data. Detailed discussions on parameters to be measured are outside the scope of this unit. However, a list of common parameters related to water sources, water uses and sources of pollution given in Table 22.4, can be used as a guideline, while planning a water quality measurement programme.

In addition to chemical and other forms of analysis, the physical behaviour of the water body needs to be considered while deciding the location of sampling points and the frequency of sampling. In many rivers of our country, several hydrological data measurement stations (gauging stations) have been established long before water quality measurement programmes were begun. For gauging purposes a measuring station may be located close to the confluence, or in the middle of a large river cross-section. However, for water quality measurements, the same points are unlikely to be the best location, because of incomplete mixing, and expected non-homogeneous distribution of pollutants in receiving waters used for establishing its characteristics.

22.3.3 Ganga Action Plan

So far we have discussed, in general, the major components of a sound water quality management programme. Let us now discuss, in specific details, how various issues/factors have been taken into account while planning the first-ever major river cleaning project of our country.

Ganga, the holiest of the rivers of India, has served as the cradle of Indian civilisation. Several major pilgrim centres have flourished on its banks for centuries and millions of people come to bathe in the river during various religious festivals. The Ganga in its 2525 km stretch passes along 27 big cities, each with a population more than 100,000 and 73 small towns, each with less than 100,000 population. Most of these cities and towns are either only partially sewered or do not have any sewage system at all. Hence, every day about 1 million m^3 of waste water, flows through open drains (nalahs), directly into the river, without any treatment. In addition, the Ganga basin is extensively cultivated and about 47 per cent of the total irrigated area of the country is located in the Ganga Basin. Three fourths of annual rainfall in the Ganga Basin, occurs only in the four month period from June to September. Hence, during the lean season, in the upstream, more than 80-90 per cent of river flow is diverted by two major canals for irrigation purposes. Over a period of time, all these activities have resulted in severe pollution, particularly in certain specific stretches of the river, where BOD levels of 10-15 mg/l are often observed.

In 1984, the Central Pollution Control Board, completed a comprehensive pollution inventory study on identification and quantification of all major pollution sources. Based on the results of this study and recognising the importance and need for preserving the Ganga river water quality, Government of India launched the **Ganga Action Plan** in the year 1985.

Immediate reduction of pollution load and establishment of self sustaining waste water treatment plants are the two major objectives of the first phase of the Action Plan. Accordingly, following components have been identified :

- Renovation of existing trunk sewers
- Construction of interceptors to divert the sewage flow
- Renovation of existing sewage pumping stations and construction of new sewage pumping stations and sewage treatment plants, with emphasis on resource recovery, e.g., energy recovery, to operate the treatment plants, and use of treated waste water for irrigation.
- Low cost sanitation programmes
- Construction of electric crematoria
- River front facilities and related improvements.

In the first phase, 262 different schemes, within the overall framework of the components listed above, have been taken up for the 27 big cities, since they alone contribute to more than 70 per cent of the pollution load. Total cost of these 262 schemes has been estimated as Rs. 2,600 million rupees.

In addition, an inventory of industrial units discharging waste water into the river was carried out. As a result, 68 units were identified as gross polluters, who discharge more than 1000 kilo-litres of waste water per day. All these units were directed to construct waste water treatment plants and to comply with the water pollution control act.

The overall objective of the Ganga Action Plan is to achieve the bathing water quality standard of D.O. (dissolved oxygen) of 5 mg/l, minimum, and BOD of 3 mg/l, maximum, over the stretch of his river. In order to assess the impact of Ganga Action Plan, regular water quality monitoring is carried out at 27 different locations, starting from Rishikesh to Ulberia. In these locations, 42 different physico-chemical parameters are being monitored once in a month.

SAQ 3

Indicate if the following statements are true or false :

i) In a water quality measurement programme, it is necessary to consider the physical behaviour of the water body.

ii) Hydrological data measurement stations or the gauging station locations are also the best locations for water quality measurements.

iii) The results obtained from a well designed water quality measurement programme do not have any uncertainties arising from analytical errors, sampling location, sampling frequency, etc.

22.4 MANAGEMENT OF LAND

You recall from Unit 6 that from the beginning of civilisation, food, fodder and fuel needs have been met by use of land. As the years pass, the pressures on human population and of grazing animals increase, as also the demands for natural resources. These pressures and demands destroy the vegetative cover of the land. This results in fast erosion of soil and loss of nutrients from the soil, converting large tracts of land into wastelands. It may seem unbelievable but the fact is that more than 40 per cent of India's land is degraded and is useless for all agricultural purposes. India is basically an agricultural country. But half of the agricultural land area in our country is degraded. Its productivity is lower than what it should be. Use of such land for growing agricultural crops becomes uneconomical. So these lands are left fallow. This results in wastage of a non-renewable resource. The total agricultural land area available in our country is 143 million hectares, out of which some 80 million hectares is degraded agricultural area. The maximum degraded area is in Madhya Pradesh, about 0.2 million hectares.

Degraded land may be of different types. It may be degraded in the form of gullied or ravinous land, it may be salt-affected land, it may be degraded due to mining or industrial activities or it may be degraded land area on account of steep slope. Our country has several types of degraded land about which you have already read in Unit 12.

Once the soil cover is lost in the process of soil erosion, it cannot be replaced. It requires a very long time for the natural processes of soil formation to recover the fertility, running into years, decades and sometimes centuries. For example, one inch or 2.5 cm. of top soil is formed in 100 to 2,500 years.

Fertile soil supports the demand for food, fodder, timber, forage, natural fibre production, etc. As the demand for these essential items grows, the need for fertile soil increases. But the tragedy is that a very large area of land has become unusable, only because of improper use. So, proper planning for use of land is essential. In addition, pollution of soil and land have to be curbed. Also, we have to improve the quality of the existing available land through reclamation. When pollutants are discharged on land, some of them may get decomposed, through the activity of living organisms present in the soil; into harmless products. Some of the pollutants are also decomposed automatically as they are not stable. For example, organic wastes do not cause great concern as these substances do not remain in soil for long. Micro-organisms present in soil can decompose these materials into simpler harmless compounds. But many a pollutants remain as such in the soil for longer durations. So, if the soil is used for raising crops, these pollutants may affect the growth of the plants, and the pollutants may also enter the plants and become a part of the food chain.

22.4.1 Methods to Improve Land Quality

It is essential to improve land quality to grow more and to meet the increasing demands for food and other essential agricultural items, large-scale use of chemical fertilisers is not advisable. Chemical fertilisers can improve soil and land quality, but, these are costly. Also, excessive use of chemical fertilisers causes eutrophication of water bodies as a result the run off. Other alternative will have to be looked for. The best alternative is to utilise natural resources for land improvement.

Organic Farming

Organic fertilisers in the form of biomass and waste products cannot only provide nutrients to soil but also enrich humus content. Biomass is used as fuel in the form of dung cakes, dry leaves, agricultural residues and the like. If these are utilised to improve soil quality, the benefits may be much more. Use of raw dung as fertiliser is not advisable, because if dung is raw, it attracts white ants which ultimately eat away the roots of vegetation growing in the area. Composted dung does not attract white ants and consists of nutrients in readily available form. As another version of composting the cowdung, it can be first used for generating biogas like "Gobar-gas" and then the decomposed product can be used as fertiliser. So, not only will the energy demand be met in a cleaner way but also the fertiliser value will be properly used.

Another way of improving land quality is to grow those plant species which add nutrients to soil. Generally, plants extract nutrients from soil. But there are certain species of plants mainly belonging to the leguminous group which fix nitrogen from atmosphere and add it to soil. These species can grow on very poor soil and in turn, they improve the soil. So, if we have a land area which is poor in nitrogen, we may grow leguminous plants such as pea, lathyrus, dhaincha, chandani, etc. for a few seasons on the land. Care should be taken to allow maximum amount of biomass from these plants to mix with the soil. Within a short time, the soil may improve to such an extent that other crops can be grown successfully there. You must have read about green manuring given in Section 8.4.1.

Mixed Cropping

A modification of this technique can be made. Leguminous crops may be grown alternately with other crops on the land. This is called "crop rotation". So, nutrients are absorbed by one crop while the other crop makes good the loss. Slowly, the land quality improves. Another modification is "mixed cropping". Here non-leguminous and leguminous crops are grown together in the same area in a mixed pattern. So, one crop derives nutrients from the soil while the other adds.

Use of Halophytes

Unscientific irrigation may also lead to degradation in land quality. Excessive irrigation (as you have read in Section 8.4.3) leads very often to salinisation or alkalinisation of soil. The irrigation water evaporates leaving the dissolved salts behind. In our country, very large areas are affected by salinity and alkalinity. Together, these are called salt-affected soils. Once, the soils become salt-affected, they are rendered almost useless for agriculture as crops do not grow there successfully. These areas are generally left fallow. But these soils can be reclaimed mainly by growing special types of plants' (halophytes) which are tolerant to salinity or alkalinity. When these plants grow there, the soil condition becomes better and finally other species can also be grown. They provide cover on otherwise infertile soils because, they survive better, improve the soil faster and also provide hay for the livestock.

Aerial Seeding

For large scale improvement of degraded land, the Government has created a separate programme called "National Mission on Wastelands Development" under the Ministry of Environment and Forests. This mission provides funds for training people, raising seedlings, carrying out plantation and afforestation to bring degraded land into use and grow fuelwood, fodder, forage, etc., if they cannot be used for grain production. As a result the pressure on natural forests, grasslands, and grazing grounds may be reduced. It also checks soil erosion and further degradation of land. For difficult sites, aerial seeding practices are also adopted. Packets containing seeds along with a little fertiliser are sprayed just before rains from aircrafts and they are left to grow undisturbed. Slowly, the degraded land is transformed into productive area. A good example is afforded by hills near Islamabad, Pakistan.

Land Use Planning

It is essential to plan beforehand how land is to be used. For example, cities, highways, roads and dams should be built on degraded land areas. These requirements should be met with minimum possible disturbance to agriculture and forestry. Cities should not be permitted to grow beyond an optimum limit. Industries may be established utilising land which is otherwise useless. Agricultural production should be increased by adopting better crop management measures and technological innovations and not by bringing more areas under agriculture through forest clearance. Fallow land in the proximity of cities and towns may be costlier than these. So, the tendency is that people go for those lands for uses other than agriculture. This must be stopped.

Land use should also take into account land capability : the quality of land and the economic use to which it can be put. For example, if we use a poor quality land for agricultural purposes, the cost involved will be high and production will be low. But the same land may be suitable for growing some tree or grasses or shrub species which may be used as fuel, fodder or fibre. This type of practice should be adopted. This would generate more benefits and also reduce pressure on other land areas. Even in the case of agriculture, proper planning is essential. Mixed cropping or rotation

cropping practices should be adopted. Irrigation must be scientifically planned. Excessive irrigation should be avoided and proper avenues for drainage be kept, otherwise the land may become salt affected. Those land areas where nothing can grow may be earmarked for buildings, roads, factories, etc.

22.4.2 Measures to Curb Land Pollution

Pollution of land has to be curbed. You have read in Unit 13 that if land is polluted through (say) improper waste disposal, it will not only hamper the growth of plants and crops but may also lead to other problems. Ground water may become polluted when the pollutants percolate down the layers of soil along with runoff water. Also, as pointed out earlier, the pollutants may enter into crops and from there into food chain. Similarly, air pollutants emitted in to air finally settle down and most of these fall on land to pollute soil. For example, you might have seen that land near a thermal power station or a large factory equipments become polluted by pollutants discharged from the chimneys into air if it does not have adequate pollution control equipments. From the air, the pollutants, especially TEL (Tetra ethyl lead) as a group are very dangerous air pollution agents settle down with rains. Most of them find way to soil. If a chemical has long life and cannot easily be decomposed, it can create severe problems. You must have read in Unit 11 about the problems created by DDT, a very common pesticide. Heavy metals are also generally toxic and they are not decomposed. So, they enter the food chain and create problems for organisms at higher trophic levels which may include man. You have read about problems caused by TEL lead. It can damage brain, cause cancer and lead to still birth etc., as you have seen in Unit 18. Lead is also used very commonly as an additive in petrol. When petrol is used in our cars, scooters, etc., lead is discharged into air (see Section 10.2.2). From there, it settles on soil and enters the food chain.

You have read in Unit 12 that pollution of soil may be caused by different agents such as :

a) Pesticides
b) Heavy metals
c) Inorganic salts of metals and other elements
d) Radioactive substances.

Among these, radioactive substances are of limited importance as these are not used at many places and there is a strong control on manufacture, sale and use of radioactive materials. Accidentally, however, these substances may sometimes get into the environment.

A large number of these chemicals are toxic too. When these chemicals mix with soil, they create problems. Hence, it is essential to curb land pollution. This is possible if adequate pollution control measures are adopted at every level. For example, solid wastes and liquid wastes are properly treated before these are disposed (see Sections 13.4.2, 21.4.4 and 22.3.2). Sludge treatment takes care of the pollutants present in these wastes.

So, an allround control on pollution is essential to curb land pollution. For this the Government has passed several legislations such as Water Prevention and Control of Pollution Act, 1974, Air Prevention and Control Pollution Act, 1981. Later, these Acts were amended to make them more effective. Ministry of Environment & Forests, Government of India. Central Pollution Control Board, and State Pollution Control Boards, have been given powers to control pollution of all types including pollution of land. But it is essential that all of us should make effort to keep our land free from pollution.

SAQ 4

I) Indicate whether the following statements are true or false :

a) Increase in human population puts more pressure on land.

b) Presently, in our country soil erosion is not a major problem.

c) Pollutants present in soil do not affect growth of plants.

d) Improper use of land converts fertile land into unusable land.

e) Largest area of degraded land is in Madhya Pradesh.

II) List five different categories of degraded land.

22.4.3 Management of Forests

As a result of deforestation, further erosion of soil takes place, water availability becomes low, rains become erratic, floods become a common phenomenon, and soil nutrients are lost. All this leads to decrease in agricultural production. Similarly, when cities grow, they generally do so at the cost of agricultural land or forest land. Also, industries, highways, dams, etc. occupy large areas of agricultural land or forest land. Clearance of forest areas has also caused threat to wildlife.

Forests not only provide food and shelter for different kinds of wild animals, birds, insects, micro-organisms but they also play an important role in maintaining stability of climate and bringing rains, etc. In addition, various species of plants and animals which come under wildlife contain innumerable genes which have already proved their usefulness or are likely to prove their usefulness.

Our country has already paid a heavy price for lack of proper management of these resources. Many species of wildlife might have become extinct due to the loss of forest cover. It was, therefore, decided in the Seventh Five Year Plan that highest priority should be given to restore forest cover. Aim should be to bring 33 per cent of the land area of the country under healthy forest cover.

i) Forest harvest and Management

Until very recently, our capacity to interfere with natural ecosystems was quite limited. Natural regeneration could take care of these interferences. Recent scientific and technological developments have given human beings the capability to make changes on a very large scale; for example, in the 19th century, cutting of a big tree needed several man-days. Today, one person can cut a lot of trees within a day using modern machines. This is the reason why it is much more important for all of us to know how to manage forests scientifically. Efforts should be made to ensure survival of a forest with mixed age and size of plants. The complex vegetation structure has to be maintained. If there are patches of forests separated from each other, corridors of forests should be maintained between different patches, to give these patches a continuity. When logging is being done, we must avoid the technique called 'clear-cut'. In this technique all the trees are cut so that the land is clear. New trees are then planted, fertilised and maintained. When the trees reach maturity, they are again cut and the process is repeated. This technique is more economical but it creates problems of soil erosion. This is the reason why clearcut forests are always under the threat of soil erosion. The other alternative available is that only selected mature trees are cut at intervals. The rest continue to grow there. So, the land and soil is never left bare. No doubt, the cost of this operation is high but it is technically more sound.

Another point is that forests should always have mixed types of trees and plants. Pure stands, i.e. of only one species is never advisable. The reason is that if there is any problem for the only species, whole forest may be destroyed. In addition, mixed types of forest provide food, shelter, etc. to animals in a much better way. Also, soil cover will be better as all round the year, some of the species will be shedding leaves while others will be green. Forest management also includes the controlling of forest fires.

ii) Social Forestry

One of the management practices is to allow afforestation, and social forestry is one such approach. The idea behind social forestry is to create forests with the help of society for meeting the demands of the society. Social forestry is a term used to denote tree-raising programmes to supply firewood, fodder, small timber and minor forest produce to rural populations. Social forestry programmes have mainly three components : a) farm forestry, encouraging farmers to plant trees on their own farms by distributing free or subsidised seedlings, b) woodlots, planted by the forest departments for the needs of the community, especially along roadside, canal banks and other such public lands, and c) community woodlots, planted by the communities themselves on otherwise useless lands, to be shared equally between them. The idea of social forestry is to grow forests on any available land which is not being used for other purposes. So, the needs which are met through natural forests may be fulfilled by these forests resulting in reduced pressure on the natural forests. This can save natural forests from degradation while allowing barren lands to be utilised purposefully.

Social forestry programmes have been launched by several states. Since 1976, social forestry programmes have been taken up in Bastar, Madhya Pradesh. Derelict patches

of forests near villages are being rehabilitated by planting fruit and other economically valuable species. In 1983, a new approach to social forestry was taken up in Bastar, as well as in other parts of MP. Under the Hitagrahi scheme, the 60 comparatively poor families of a village were selected, and each given a hectare of derelict land for growing fruit trees. The forest department provides saplings, fencing and any other required materials. Thus, the incentive given to the landless farmers by the forest department has brought about tremendous increase in social forestry. It is generally thought that wood is the fuel of the poor. Use of biomass, i.e., material obtained from living beings whether plants or animals, will reduce pressure on the supply and availability of fossil fuels such as coal, gas, kerosene, and other petroleum products. So, for our country it is essential that we use more and more biomass as fuel. Already, in the rural sector 94.5 per cent of cooking is done using fuels based on biomass. Even in urban sector, more than 58 per cent of cooking is done by burning biomass. It is estimated that firewood demand per year for our country will be about 300 million tonnes in near future as we cannot provide coal, kerosene or petroleum gas to such a large population. You have read in Unit 21 smokeless 'chulhas' are used for utilising the heat from biomass in an efficient manner.

If things are left as such, natural forests will be cut to produce wood for fuel. This will lead to a further decrease in forest area. Here, social forestry can help in a big way. In every village, town and city large areas of land are degraded where growing agricultural crops is not economical. These areas, however, can easily support selected species of trees and shrubs which provide fuel. In the social forestry programme fast growing species of trees, shrubs and herbs are planted on the degraded land areas using community labour and resources. When trees and other plants grow, these are harvested for use as fuel, fodder, forage, etc., so that biomass becomes available very close to where people need these items. All this comes from the land which was otherwise useless. So, people not only save natural forests but also derive benefits without spending much. When forests grow near the village or town, one additional advantage is that people do not have to spend much time in collecting the products. Similarly, animals do not have to be taken to distant forests for grazing. They can graze in the community forests growing near the village or town.

Social forestry will also provide other benefits which conventional forests give. For example, erosion of soil and desertification will be checked. Retention of water through percolation into soil will be favoured. Carbon-dioxide and other gases and particulate pollutants present in the air will be absorbed and reduced by these trees and plants just as in natural forests. These forests can also be utilised for conserving biological diversity by growing those species which are otherwise threatened. Social forestry will provide job opportunities to people who are interested in working in these forests. Indirectly, it will check the present trend of migration from rural areas to cities in search of employment.

SAQ 5

1) Fill in the blanks with appropriate words and compare your answers with those given at the end of this Unit :

   a) The idea of social forestry is to meet the demands of the .....

   b) Social forestry relieves pressure of demand from ..... forests.

   c) In rural areas about 75 per cent of cooking is done by burning fuels based on .....

   d) Presently, ... destruction is the main reason for extinction of species.

   e) Loss of species may lead to loss of ..... genes.

22.5 SUMMARY

In this unit we have learnt that :

- Atmospheric pollution has assumed alarming proportions in our country. The Government has already enacted several laws and formulated standards of emissions for various industries.
- The measurement of air quality requires sophisticated instruments. Standard analytical methods have been prescribed by Central Pollution Control Board and also by Environment Protection Agency, USA.

- Atmospheric pollution takes place chiefly because of particulates, gases and mist fumes. Various types of control devices are available to limit these emissions within the prescribed limits. The important and well-known control systems are cyclones, bag filters, electrostatic precipitators and scrubbers.
- Air pollution control is expensive but essential. The best approach is to first take steps to prevent it to the extent possible, and then control the residual pollution.
- Water quality management requires a multi-disciplinary approach involving : i) water quality measurements, ii) water quality standards, and iii) water quality control.
- Water quality measurements are normally complex and expensive. Hence, one should be very clear about the objective and the actual use of the collected data. It is also important to recognise the existence of uncertainties introduced by the analytical errors, sampling methodology, sampling frequency, etc.
- Water quality standards are based either on stream standards or on effluent standards. Although stream standards are the most realistic and directly based on the beneficial uses, they are difficult to administer and control.
- Land pollution is becoming a major problem as we progress in our industrial development. Once the soil becomes polluted, it can cause harm to plants growing on the soil and later, it can affect the entire ecosystem. So, land pollution has to be checked.
- Forest is a very important resource. To reduce pressure from the natural forests, we should adopt social forestry on lands which are otherwise useless.
- Wildlife should also be considered a resource. Policies on environmental management should not be guided by immediate gains only.

22.6 TERMINAL QUESTIONS

1) Compare and contrast stack emission standards and the immission standards.

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2) What is isokinetic sampling?

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3) You find large areas of land which are unused. How can you put them to useful purposes?

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4) "Forest management is an integral part of our ecosystem management." Discuss.

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5) What is the difference between stream standard and effluent standard?

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22.7 ANSWERS

Answers to SAQ

1) i)

a)	b)
b)	e)
c)	d)
d)	c)
e)	a)
f)	g)
g)	f)

ii)

I)	False
II)	False
III)	False
IV)	True
V)	True

2) None of the item describe pure water. Rain water contains a substantial amount of dissolved and suspended substances, many of them resulting from air pollution. The neutral pH value indicates only that the effective concentration of hydrogen and hydroxide ions are equivalent. Softwater does not mean pure water since it may have dissolved or suspended impurities that do not display the characteristics of hardness.

3) i) True ii) False iii) False.

4) I) a) True b) False c) False d) True d) True.
II) Any five from Unit 12 may be listed.

5) I a) community b) natural c) biomass d) habitat e) useful.

Answers to Terminal Questions

1) Stack emission standards limit the emission of pollutants from a source whereas the immission standards prescribe the maximum levels of a pollutant which can be tolerated in the ambient air. Measurement of pollutants at the source is easy, the results obtained are repeatable, and require less time, whereas pollutants found in ambient air are in far lower concentration, and their levels very greatly under the simultaneous effect of a large number of meteorological parameters.

2) A technique for collecting air borne particulate matter, in which the sample collector probe is so designed that the airstream entering the probe has a velocity equal to that of the air passing around and outside the collector. So that, the device collects all sizes of particulates with equal efficiency.

3) These areas have become useless on account of improper land use. Growing of crops on these is lands is uneconomical and therefore, they are abandoned. We can grow successfully certain species of trees, shrubs, herbs etc. on them. This will provide not only cover to land but will also yield products which we normally obtain from forests. So, the natural forests will be relieved of pressure.

4) Forests are essential for proper ecological balance. They control climate, rain, balance of oxygen in atmosphere, they help in checking soil erosion, etc. If forests are not managed properly, they will be lost and its effect will be adverse on the entire ecosystem.

5) Stream standards are based on the beneficial uses of the water which in turn fix the thrust hold value for specific pollutants in the receiving water. Effluent standards are based on the maximum concentration of a pollutant (mg/l) or maximum pollution load (kg/d) discharged into the receiving water. These standards can be related to the beneficial uses of the receiving water.