CHAPTER 1

INTRODUCTION

1.1 THE IMPACT OF MAN ON ECOSYSTEM:

Beginning from the stage of evolution, when man gave up living on what food he found in nature, and settled down to grow his own food, he began interfering with natural system. Agriculture was man's first great challenge to the natural system. He cleared forests to grow food for himself, and built huge irrigation systems to assure a perpetual supply of water for his crops. Since the industrial revolution, man's interference with the ecosystem increased both in volume and in intensity. With the industrial revolution, our exploitation and use of minerals and natural power resources (coal and oil) has assumed alarming proportions and precipitated the environmental crisis.

The advances of technology in recent years has been dubbed as the "technological revolution". This revolution, like all revolutions, has backfired. While at one end it has accelerated the consumption of scarce materials, it has, at the other hand, thrown up a lot of unwanted wastes. These wastes are piling up, and have already become unmanageable. Some of these wastes like synthetic plastics are not bio-degradable. Therefore, they may persist for
years as a threat to the ecosystem. Latest is the nuclear age which is responsible for the contamination of radioactivity to the planet. One author has rightly said "No bird fouls its own nest, but the doubly wise man excels in this obnoxious practice."

The mankind's consciousness has been aroused quite intensely about the need for environmental protection and ecological preservation under compulsions for its survival.

1.2 ENVIRONMENT: THE LIFE SUPPORT:

The word environment is derived from an old French word 'environ' meaning 'encircle'. The environment encompasses all our surroundings, what we are linked with directly or indirectly, what our life and activities are connected with and dependent upon. In other words, the environment is our whole planet plus the thin envelope of life called the biosphere plus the outer space surrounding and influencing us. Often, however, for purposes of convenience, the notion of the environment has been simplified to mean only the biosphere and the earth crust.

The environment is the ultimate source to provide air, water and foods to the humanity for the sustenance of life. An average adult male exchanges about 15 kg of air in a day, compared to less than 1.5 kg of food and about 2.5 kg of water.
1.3 **ATMOSPHERIC POLLUTION: SOME DISASTROUS EPISODES:**

The clean and calm envelope of air surrounding us may undergo a change in its natural quality and characteristics by induction of prolonged entries of new constituents resulting into what is known as air pollution. Air pollution is the result of the discharge into the atmosphere of foreign gases, vapours, droplets and particles, or excessive amounts of normal constituents.

Air pollution is the first gift of the industrial revolution. King Edward I of England tried to clear the smoky sky over London in 1772 by banning the use of sea coal. In December 1930, a heavily industrialised area of the Meuse Valley in Belgium experienced a severe three day fog, during which hundreds of people became ill, and sixty died which is more than ten times the normal number. Shortly afterwards, during a thick nine-day fog in January 1931, 592 people in Manchester and Salford areas of England died, which is again a large jump in the death rate. In 1948, in Donora, Pennsylvania, a small mill town dominated by steel and chemical plants, a 4-day fog made almost half of the 14,000 inhabitants sick, of which twenty persons died. Ten years later, Donora residents who had been acutely ill during that episode were found to have a higher rate of sickness, and died at an earlier age than the average for all the town people. During a fog in London as far back as 1873, 268 unexpected deaths from bronchitis were reported. It was not until a great fog
blanketed London in 1952 that the sinister potential of air pollution became fully apparent. That fog lasted for four days, and 10 days after that it was learnt that the total number of deaths in Greater London during that period exceeded the average by 4000. The statistics indicated that almost all those who died unexpectedly had records of bronchitis, emphysema or heart trouble, and that people in the last category were most vulnerable. Again in Jan. 1956, 1000 extra deaths in London were blamed on an extended fog. In that year, Parliament passed a Clean Air Act, and Britain embarked on a programme to reduce the burning of soft coal.

In U.S.S.R., the picture of air quality is not very different from that in England. In the hilly cities of Armenia, for example, the established health standards for carbon monoxide are often exceeded. Similarly, Magnitogorsk, Alma Ato and Chelyabinsk, with their metallurgical industries, are frequently covered with a layer of dark blue haze. Tbilisi, the capital of the Republic of Georgia, has smog for almost six months per year. Leningrad has 40% fewer clear daylight hours than the nearby town of Pavlovsk.

Amongst the developing countries, India, in a single event, has created a world record by recording the deaths of as many as 2,500 people in an industrial disaster in Bhopal, in December 1984.
The United Nation's Conference on the Human Environment, held at Stockholm, Sweden, in June 1972 was the first comprehensive international attempt to articulate the interrelationship between the quality of environment, growing world population and world economic growth needed to sustain it. The conference recognised the need for specific national and international actions to ensure that economic growth is planned in full appreciation of the long term value of environmental protection, and natural resources conservation. The conference proclaimed, "A point has reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences".5.

1.4 CONSTITUTIONAL PROVISIONS FOR ENVIRONMENTAL PROTECTION:

In 1976, through 42 Amendment Act of Constitution of India, environmental protection was introduced as one of the Directive Principles of States in the constitution. A new provision in the constitution was introduced as follows: (a) 48 A - Protection and Improvement of Environment and Safeguarding of Forests and Wild Life. The State shall endeavour to protect and improve the environment and to safeguard forests and wild life of the country. (b) 51 A(G) Fundamental duties - It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes
rivers and wild life, and to have compassion for living creatures. (c) Other constitutional provisions - The constitutional provisions of the Seventh schedule of the constitution of India permits Union and State or both to make laws on environment. The Air Pollution Act 1961 (Prevention and Control) is one of the important Acts which has been enacted due to constitutional responsibility to protect further deterioration of nature and environment.

1.5 THE ATMOSPHERIC ENVIRONMENT: POLLUTANTS AND THEIR IMPACTS:

The principal air pollutants responsible for damage to plants are sulphur dioxide, fluoride, smoke, soot, dust and the components of photochemical smog. The pollutants may be classified according to their physical and chemical properties. They may be gaseous, e.g. nitrogen oxides and sulphur dioxide; or solid, e.g. soot, dust, etc. Interactions between two or more pollutants may increase or decrease their potential effects as individual pollutants. Sometimes chemical reactions between pollutants may influence toxicity to plants and animals. The size of particulate pollutants may influence their rate of deposition on plant leaves, and their passage through both stomata and the respiratory track of animal. Generally, the physical state of a pollutant will have a considerable effect on its dispersal and dilution in the atmosphere.
The concentration of a pollutant, and the duration of its existence at that concentration are the most important factors related to a pollutant. These two factors when combined give the time-concentration product. For air pollutants in general, Guderian et al.\textsuperscript{18} developed the concept of an irritation threshold concentration for a given species, which is the concentration that may be tolerated throughout its life without causing injury.

The airborne pollutants may enter animals through two main pathways, namely ingestion of contaminated plant material and inhalation\textsuperscript{19}. Toxic effects in animals may also show up as chemical, physiological and morphological changes in tissues and organs, but there may also be sensory effects and overt behavioural signs which are as obvious as visual symptoms of injury in plants. The concentrations of the pollutants are frequently high. In order to determine acute toxicity, the most common expression of this being the lethal dose (LD) or concentration (LC) that kills 50 or 100 per cent of the population, e.g., LD\textsubscript{50} or LC\textsubscript{100}. A time factor is sometimes included in the toxicity studies to take account of time concentration effects.\textsuperscript{20}

The nationwide emission of major air pollutants is dominated by those formed by transportation, fuel combustion, industrial processing, and solid waste disposal. Sulphur dioxide originates in the burning of coal or oil with a high sulphur content. This pollutant causes a
significant loss in crop yield, is irritating to the eyes, nose, throat and lung, and is a major cause of the reduction in atmospheric visibility. High temperature combustion processes cause nitrogen oxides to form from the nitrogen and oxygen in the air. These pollutants cause an unpleasant brown coloured haze that damages crops, and is hazardous to public health. Unburned chemicals from the combustion of organic compounds react with the air to produce smog. Automobile exhaust is the major contributor to this form of pollution. Carbon monoxide in small amounts can be deadly as it accumulates in poorly ventilated areas. Automobile exhaust is a major source of this pollutant. Zinc, lead, arsenic, beryllium and other metals in particles smaller than 10 microns or airborne emissions from automobiles, paint and spray industries and ore smelters cause chronic kidney and liver diseases and damage the blood. Ore smelting, fertilizer production, and ceramics and aluminium manufacture release gaseous and particulate fluorides. In excessive amounts, they may embrittle bones and kill vegetation.

The automobile, industrial fuels, smelters, building materials and fertilizers are the source of particulate material that is dispersed in the atmosphere. These tiny particles reduce visibility, damage property and carry poisonous material into the lungs. The size ranges of particulates of different origins have been shown in Fig. 1-1.
Smoke.

Industrial and chemical fumes

Tobacco smoke

Oil smoke

Dust causing lung damage

Paint pigments

Insecticide dust

Bacteria

Aerosols

Pollens

Sneezes

Human hair diameter

Fog

Mist

Rain

Particle size (microns)

Fig 1-1 Sizes of Airborne Pollutants
Particulates between 0.1 and 1 μ have settling velocities in still air, which are small compared with wind velocities. Particles larger than 1 μ have significant but small settling velocities. Particles above 20 μ have large settling velocities, and are removed from the air by gravity and other processes. Measurement of dust fall are commonly used to indicate the mass concentration of the settleable portion of particulate air pollution. Typical values for cities are 3.55 to 35.50 μt/km²/month, and values as high as 710 μt/km²/month have been measured in the vicinity of specially offensive sources. The concentration levels of a number of toxic metals (As, Sb, Bi, Co, Ni, Pb, Ag, Cd, Mn, Li, Rb, Be and Mo) in the suspended particulate matter in the vicinity of a cement plant have been determined during the course of this study, and the values have been shown in Table 1-3.

1.6 THE AQUATIC ENVIRONMENT: POLLUTANTS AND THEIR IMPACTS

Some nomadic tribes have been found to live on as small as five liters of water per day. However, 40 to 50 liters of water per day are required for personal and domestic hygiene if a man has to remain healthy, while still greater amounts are necessary to enable him to engage in animal husbandry and rural industry. Thus, a villager will need 100 liters or more. In an industrialised country or one in which irrigated agriculture is practised, it is not uncommon for 400 to 500 liters to be
<table>
<thead>
<tr>
<th>S.No.</th>
<th>Pollutant</th>
<th>Spm of soil (mg/kg)</th>
<th>Spm of water (mg/l)</th>
<th>Spm of air (mg/m³)</th>
<th>Details in Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>As</td>
<td>0.0013</td>
<td>5.0</td>
<td>0.67</td>
<td>5.7</td>
</tr>
<tr>
<td>2</td>
<td>Sb</td>
<td>0.0779</td>
<td>308.9</td>
<td>24</td>
<td>2.9</td>
</tr>
<tr>
<td>3</td>
<td>Bi</td>
<td>0.0052</td>
<td>20.0</td>
<td>10</td>
<td>5.7</td>
</tr>
<tr>
<td>4</td>
<td>Co</td>
<td>0.3330</td>
<td>132.2</td>
<td>18</td>
<td>4.9</td>
</tr>
<tr>
<td>5</td>
<td>Cu</td>
<td>0.0301</td>
<td>121.1</td>
<td>30</td>
<td>1.4</td>
</tr>
<tr>
<td>6</td>
<td>Pb</td>
<td>0.0121</td>
<td>0.0</td>
<td>60</td>
<td>2.4</td>
</tr>
<tr>
<td>7</td>
<td>Al</td>
<td>0.0002</td>
<td>0.9</td>
<td>-</td>
<td>1.1</td>
</tr>
<tr>
<td>8</td>
<td>Cd</td>
<td>0.0026</td>
<td>10.0</td>
<td>-</td>
<td>1.1</td>
</tr>
<tr>
<td>9</td>
<td>Ni</td>
<td>0.182</td>
<td>702.2</td>
<td>32</td>
<td>5.7</td>
</tr>
<tr>
<td>10</td>
<td>Li</td>
<td>0.007</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Rb</td>
<td>0.0871</td>
<td>341.1</td>
<td>28</td>
<td>2.4</td>
</tr>
<tr>
<td>12</td>
<td>Be</td>
<td>0.0002</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Mo</td>
<td>0.0002</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Table 1-3 Pollutants: Measured Values of Concentrations in Air, Water, and Soil**
needed per head. The fresh water requirements for different uses during 1974, and estimated figures for the year 2000 A.D. for India have been shown in Table 1-1.

Table 1-1  FRESH WATER REQUIREMENTS IN INDIA

<table>
<thead>
<tr>
<th>Uses</th>
<th>1974</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td>350</td>
<td>630</td>
</tr>
<tr>
<td>Domestic and Livestock</td>
<td>15</td>
<td>34</td>
</tr>
<tr>
<td>Industrial</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Thermal Power</td>
<td>10</td>
<td>60</td>
</tr>
</tbody>
</table>

* In thousand million m$^3$

Thus it can be seen that in the beginning of the twenty first century, fresh water requirement will be more than doubled compared to that in 1974. Therefore, the need to ensure adequate fresh water supplies to an expanding population and increasing industry and agriculture is becoming a national problem.

Water is considered polluted when it is altered in composition or condition so that it becomes less suitable for any or all of the functions and purposes for which it would be suitable in its natural state. This definition includes changes in physical, chemical and biological properties of water, or such discharges of liquid, gaseous or solid substances into water as will or are likely to
create nuisance or render such waters harmful to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational or other legitimate use of water, or to livestock, wild animals, fish or other aquatic life.

Pollution may be accidental, and sometimes with grave consequences, but is most often caused by the uncontrolled disposal of domestic and industrial wastes containing a variety of pollutants.

Industrial pollutants are even more difficult to characterise, and detailed inventories of industrial wastes on a national scale are practically non-existent. Industrial wastes usually contain traces or larger quantities of the raw materials, intermediate products, final products, co-products, and by-products, and of any auxiliary or processing chemicals used. The composition and amounts of pollutants discharged by a specific industry can usually be determined only by detailed analysis of its effluents. The complete enumeration of the substances present in industrial waste waters as a whole would run into thousands. They include detergents, solvents, cyanides, heavy metals, mineral and organic acids, nitrogenous substances, fats salts, bleaching agents, dyes and pigments, phenolic compounds, tanning agents, sulfides and ammonia. Of the compounds mentioned, many are biocidal and toxic.
The concentration of pollutants present in original waters is normally altered when the water is treated before discharge. The fate of pollutants after release to natural water will in general depend on their nature (solubility, biodegradability) and on the nature of the recipient water body.

If present above a certain level, some chemical pollutants may constitute a direct toxic hazard when ingested through water. The chemical pollution may also harm through the water contents, and also influence man's health indirectly by disturbing the aquatic ecosystems, or by accumulating in aquatic organism used in human food.

The various chemical and biochemical transformations that pollutants may undergo in the aquatic environment also deserve attention. In the early 1950's, fishermen around Minimata Bay, Japan, were stricken with a mysterious neurological illness. It was also found that other animals such as fish, cats and birds were affected. The source of illness was finally traced to high concentrations of organic mercury contained in fish from the bay; the mercury was found to be contributed by a chemical plant in the area. A similar problem was noted later in Niigata, Japan, where additional deaths and cases occurred. The total number of those died or were disabled was 121, both in Niigata and Minimata Bay.23,24.
A specific disease known as 'itai-itai' in Japan has been attributed to cadmium. It appears to be largely confined to post-menopausal women who had borne several children, leading, in some cases, to rapid progressive reduction in stature, multiple fractures and finally skeletal collapse in the terminal stages of the illness. The associated levels of cadmium contents in the rice diet in the contaminated area were up to 3.4 ppm in the brown rice, and 0.5 ppm in white rice. The use of cadmium-contaminated water from rivers for drinking purposes also appears to have been a factor. It has been estimated that nearly 100 people had died from this cause upto the end of 196525.

The biological effects of local increase in the concentrations of toxic metals in the marine environment are evidently wide spread. Cancerous growths, skin ulceration, tail deformities, genetic changes in fish, leukaemias, and tumor growth in shellfish have been ascribed to the presence of environmental pollutants26. A number of research workers reported the contamination of sea water through water pollutants due to discharge of wastes into the sea27-31.

Metals present in effluents discharged into water ways can, of course, cause toxicity problems, and can enter fresh water, biological food chain, en route to sea. A small portion of metal discharged into water courses never reaches the sea, for pollutant elements present in
rivers can accumulate in stream sediments,\textsuperscript{32} or can contaminate the soil in adjoining low lying land when flooding occurs, or when river water is used for irrigation. The problem of cadmium toxicity which arose in Japan when water which was contaminated with cadmium was used to irrigate rice fields. The resultant disease problem can properly be regarded as an indirect consequence of pollution of the hydrosphere. The extent to which soils in Netherlands in areas near the mouth of the Rhine and Meuse are contaminated, is substantial.\textsuperscript{33}

Problems of this kind can arise as a result of mining activities, and in Colorado which produces 60\% of the world supply of molybdenum, the mountain streams which drain the mining areas are often enriched with molybdenum. Jackson et al.\textsuperscript{34} have observed significant increase in Mo-level in Lucerne in this area.

When industrial effluents are discharged directly into land lakes or into water-ways leading to lakes, any metal present will, of course, accumulate in lakes and it is a matter of speculation to what extent the variety of biological damage which has been observed in fish in lake Erie\textsuperscript{35} is the result of metal pollution. The concentration levels of a number of toxic metals (As, Sb, Bi, Co, Ni, Pb, Ag, Cd, Mn, Li, Rb, Be, and Mo) have been determined in the samples of water from Chittaurgarh Fort area, and the values have been reported in Table 1-3.
Neoplasms in fish, affecting various parts of the anatomy, are common in Great Lakes of North America, and there is evidence that these can be environmentally induced. Sonstegard\textsuperscript{36} has reported the occurrence of tumor of the lips in "white suckers" in a heavy polluted basin in this area. Maxfield et al.\textsuperscript{37,38} have reported toxic effects on fish and wild fowl, evidently due to high levels of heavy metals in Loeur L' Alene River in Idaho.

Recent informations\textsuperscript{39} have shown that waste waters discharged by some mineral based industries have a high load of dissolved salts (about 2500 ppm) with a number of toxic elements present in them. The alkalinity of the effluents discharged by an alumina plant is quite high (mean pH value 10.3). The fluoride contents\textsuperscript{39} in the effluents of an aluminium smelter plant is also high (mean value 3.3 ppm). Dissolved salts may be harmful to aquatic life, not necessarily from toxicity but from change in osmotic pressure. Excessive soluble salts may also render water unusable because of its effects on corrosivity of the water. Even the soluble salts of relatively non-toxic metals may cause pollution in a river by reacting with the natural bicarbonate alkalinity to yield an objectionable reddish brown OH\textsuperscript{-} floc, and subsequently deposit on the bottom of the stream bed. The slime resulting from an iron ore screening plant has also been reported\textsuperscript{40} to be contaminated with a number of toxic metals (Cu, Co, Ni, Pb, Zn, Ag, As, Cd, Sb, Mn, Cr, Be Li
and Rb). Such effluents if discharged into a natural water stream without a treatment are bound to pollute the natural water stream.

The Environmental Protection Agency of United States estimates that one-third of stream miles in the United States are polluted, and less than 10% of the water sheds are characterised as unpolluted or only moderately polluted. The typical water pollutants have been described in Table 1-2.

**Table 1-2 Typical Water Pollutants**

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Biological</th>
<th>Physical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acids</td>
<td>Bacteria</td>
<td>Heat</td>
</tr>
<tr>
<td>Alkalis</td>
<td>Viruses</td>
<td>Colour</td>
</tr>
<tr>
<td>Salts</td>
<td>Other pathogens</td>
<td>Odour</td>
</tr>
<tr>
<td>Pesticides</td>
<td>Algae</td>
<td>Radioactivity</td>
</tr>
<tr>
<td>Detergents</td>
<td>Faecal wastes</td>
<td>Suspended solids</td>
</tr>
<tr>
<td>Specific cations</td>
<td>Lignins</td>
<td>Sand silt</td>
</tr>
<tr>
<td>Phenols</td>
<td></td>
<td>Sludges</td>
</tr>
<tr>
<td>Other organics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Infectious organisms are carried into surface and ground waters by sewage from cities, and wastes from tanning, meat packing and other industries. Pesticides, synthetic industrial chemicals, detergents and organic
materials are toxic to fish, plant life, and humans. These pollutants resist ordinary waste treatment processing and may have long term effects which are beginning to be understood now.

Nitrogen and phosphates are two primary plant nutrients that are naturally present in small amounts in water. When these nutrients are added to water by sewage effluents, agricultural runoffs, and industrial wastes, the ecological balance is displaced, and desirable aquatic plant and animal forms are replaced by unwanted ones. Power plants use tremendous amounts of water for cooling. The heated water is then ejected to a stream or lake. The rise in temperature reduces the oxygen carrying capacity of the water, and causes the disruption of the normal aquatic life. Oxygen demanding wastes in sewage effluents, and from the food processing industry, paper-mills, etc. when disposed off in the environment, the available oxygen supply of the watershed is depleted and aquatic life destroyed.

1.7 SURFACE SOILS: POLLUTANTS AND THEIR IMPACTS:

The pollutants gain their entry into the surface soils through a number of channels: air to soils, effluents to soil and solid wastes to soil. It has been reported that a 500 MW thermal power station firing 25% ash fuel produces about 38.5 tonnes of ash per hour. The flyash consists of dust of sizes below 35 µ, and contains
combustible grit of over 35 μ. It has been further reported that the approximate distances to which the dust particles travel before settling down on earth, from a chimney of 60 meters height, in wind of 8 km per hour are: 140 μ - 90 meters; 104 μ - 195 meters; 14 μ - 365 meters; 61 μ - 520 meters; 46 μ - 930 meters. This is to illustrate how the particulate pollutants of the atmospheric air gain their entry into the surface soil. Patel and Pandey have exhaustively studied the alkalinization of soil through thermal power plant flyash fallout. The element-concentrations (ppm) in the top 30 cm of the soil in the contaminated area have been reported by them as follows (The values in parenthesis are those in the uncontaminated soil of same geochemical composition):

Li, 8.0 (2.5); Na, 7100 (4800); K, 21000 (13600);
Rb, 1.9 (0.5); Co, 1.1 (0.25); Be, 1.3 (Nil);
Ba, 210 (150); Ca, 31750 (29000); Mg, 16500 (11500) and Sr, 18.8 (8.0). The alkalinisation of the soil around the thermal power plant as a result of flyash fall out is thus clear by the above data. Even at a depth of 90 cm, the concentrations of all these elements in the contaminated soils were found to be much higher than those in the top 30 cm thickness of the soil in the uncontaminated area. The input of macroelements to the soil horizon as shown by their per cent increase has been reported in the order: K > Na > Mg > Ca; for micro elements the order is: Ca > Rb > Li > Sr > Ba (in the case of Be, a trace presence
of 1.3 ppm is observed compared with its total absence in the uncontaminated soil. The higher concentrations of the elements in the soil samples of the contaminated area, upto a depth of 90 cm as reported by the workers show that the surface deposition of the elements has penetrated into the soil to a considerable depth. The migration of these elements through leaching action has been reported by the workers in the following order: $K > Mg > Ca > Na > Ba > Sr > Li > Rb > Be > Co$.

Seth and Pandey have reported the permeation of fluoride in surface soil in the vicinity of a phosphatic fertilizer plant where fluorapatite, $3Ca_3(PO_4)_2CaF_2$, is used as a raw material. They have reported that the total fluoride in the uppermost layer of 10 cm thickness of soil in the contaminated area was 1.25 to 11.25 times higher in comparison to that in the uncontaminated area. The permeation of the fluoride in the lowermost layer up to 50 cm depth has been reported to be ranging from 26.03 to 98.74 per cent of the total fluoride present in the uppermost layer of 10 cm thickness.

It has been reported that a traffic frequency of 20 per minute contaminated the vegetation and soil samples of grassland along a highway with Pb, Cd and Cu. The presence of a number of toxic metals (As, Sb, Bi, Co, Ni, Pb, Ag, Cd, Mn, Li, Rb, Be and Mo) has been determined in the samples of surface soil of Chittaurgarh Fort area during the studies here, and the values have been shown in Table 1-3.
Pawar and Dubey have reported the impact on biological properties of soil which suffered from heavy air pollution at an industrial area. The fungal population of the soil was found reduced up to 75% in the area.

Ajmal et al. have found that soils irrigated with dairy processing effluents showed increased values of pH, organic matter, calcium carbonate, water soluble salts, cation exchange capacity, nitrogen, phosphorus, and electrical conductivity. It has also been reported that brewery effluents when applied to fertile soil resulted in increase in values of K, CaCO$_3$-content and decrease in the soil pH.

1.8 OBJECT AND SCOPE OF THE WORK:

An environmentalist’s concern is to identify a pollutant, study its effects and devise means to remove or minimise the damage resulting from the pollutant. A complete and ideal environmentalist shall have to extend his imaginations starting from the uppermost layer of the atmosphere down to the bottom of an ocean. The aforesaid idealism may be hard to achieve or may require a full life span to reach somewhere near to it. A humble beginning in the right direction would be to understand a pollutant in all its physical states i.e. gaseous, liquid and solid. Under this ideology and objectivity, selected pollutants in the three physical states have been chosen to study their genesis, hazardous strengths, and effects on the
environment, with a consciousness of their relevance to the people around.

Under the category of gaseous pollutants, sulphur dioxide has been chosen here. Apart from the hazards associated with sulphur dioxide, its damaging effects over monumental buildings in the country have been receiving wider attention since about a decade. The protection of Taj Mahal from the attack of SO$_2$ has been a challenge to so many environmental talents. Surprisingly, the concern has been found confined to the Taj Mahal only, although several monumental structures of historical significance in the country contain the same type of carbonated rocks as are found in the structures of Taj Mahal, and thus have the same susceptibility of getting corroded in the ambient presence of SO$_2$. The famous monumental structures in the Chittaurgarh Fort area of Rajasthan standout as one such example. Although these structures at present stay at almost zero level presence of SO$_2$, the days are not far off when SO$_2$ emanating from coal fired industrial units will start touching the carbonated rock surfaces of the structures of this area. A small beginning in the setting up of a thermal power station barely 5 km away from the monument area has already been noticed during the field study of the area.

One may be inclined to think as to what will be the fate of the monuments if the pressure of SO$_2$ starts building up, and encircles the entire structure-system
the monumental complex. Will there be any damage at all? Will the damage be slow, then how slow? And if it is fast then how fast will it be? For answering these questions, a laboratory modelling of the situation was required. It was found that the ultimate damaging form of $\text{SO}_2$ was as $\text{H}_2\text{SO}_4$. The kinetics of the damage of corrosion-prone carbonated rocks of the building structures by $\text{H}_2\text{SO}_4$ solutions of varying strengths has been investigated in the laboratory, and conclusions with regard to the survival probabilities of the building rocks have been drawn on empirical line.

The ties of rice and liquors particularly with the poor classes of the society can be quite understood. The entire Chhattisgarh area—known as the rice bowl of India—is dotted by a number of rice mills which manufacture the parboiled variety of rice. Distilleries of varying sizes are also located in the area. Both of these industries throw out effluents in sufficient volumes causing hygienic problems to the people in the surrounding areas. It is these effluents which have been selected for scientific investigations here. In the case of rice mill effluents, the studies run from their genesis—stage to the treatment-stage. In the case of distillery wastes, the impact over the growth parameters of certain species has also been studied.

For the particulate pollutants, a cement plant as a recognised source of dust emission has been selected.
A number of toxic elements in the suspended particulate matter have been estimated. The studies with regards to the alkalisation and calcification of the surface soil in the vicinity of a cement plant have also been carried out.
REFERENCES


