CHAPTER III
AIR POLLUTION

INTRODUCTION

The third major component of the biosphere is air without which no life can survive, except some lower forms of bacteria (Basu, 1986, p. 4). The air we breathe should be sanitary, wholesome and enjoyable. The respiratory system maintains more intimate and extensive contact with the human body (Pande, 1988). The trouble with air pollution is that one cannot escape from it. If water is polluted one can avoid drinking it, or may drink it after purification. But one cannot avoid breathing polluted air, one has to inhale it as it comes. The major problem in dealing with air pollution, is that most of what constitutes it is invisible. Black smoke from factory chimney or exhaust fumes from motor vehicles can be seen and hence easy to control. But those from only a small fraction of the pollutants are relatively less harmful. It is more difficult to identify many of the potentially more dangerous gases which may not be noticeable in normal atmospheric conditions. These include carbon monoxide, sulphur dioxide, nitrogen oxide and cancer producing hydrocarbons, which can be detected only with special instruments. Air pollution is mainly cause of the rapid population growth, urbanisation and industrialisation.
Among them emergence of industrial pollutions and discharge of automobiles smoke in urban centers have prime importance in increasing air pollution. Rapid industrialisation, and urbanisation have led to an increase in environmental pollutants that pose a serious threat to public health. We are moving too fast towards total industrialisation, without taking proper precautions and safety measures for instance the Bhopal's Multinational Union Carbide case. Harmful pollutants may have a sudden effect due to high toxicity or a slow, cumulative, chronic effect or both. High rate of illness and death due to diseases of respiratory tract, have been recorded in the urban centers (WHO, 1971). A majority of such deaths and illness occurred among the elderly and those with pre-existing cardio-respiratory diseases or disabilities (Villiers, 1970, 163). The earth's atmosphere is a mixture of gases that not only sustains life on this planet but also plays a vital protective role. The atmosphere consists of a mixture of life-giving oxygen (23 per cent) and nitrogen (75 per cent) which together make up almost 99 per cent of its volume. The rest is accounted for by carbon dioxide (0.04 per cent), water vapour and several other gases in traces only. Surprisingly, it is not the oxygen but two of the minor constituents of the atmosphere, carbon dioxide and ozone, that hold the key to human survival. It has been proved that even small change in the level of these two gases may have far reaching effects on human well being (Basu, 1988, p. 5) (Table 3.1 & Fig. 3.1).
EFFECTS OF AIR POLLUTION ON VEGETATION

EMISSIONS — SO₂ (OXIDES NITROZON)
NO
O₂ OTHERS

ACID DEPOSITION

DIRECT DAMAGE AND ON LEAVES

DISTURBANCE OF STAMATA

INCREASED TRANSPERSION

BARK DAMAGE

DIAMAGE TO TREE CROWN

EARLY LEAF FALL
GROWTH DISTURBANCE
INCREASED SUSCEPTIBILITY TO FOREST AND PEST

WATER DEFICIT

NUTRIENT DEFICIENCY

DISTURBANCE OF NUTRIENT UPTAKE

EFFECT ON SOIL ORGANISM

DAMAGE TO FINE ROOTS

DISTURBANCE OF WATER UPTAKE

RELEASE OF TOXIC METAL IONS

SOIL ACIDIFICATION

LEACHIN OF NUTRIENT

EFFECT OF WEATHER

DRY WEATHER

INCREASED EVAPTRANSPERSION

LOW PRECIPITATION
### Table 3.1
**Component of Air**

<table>
<thead>
<tr>
<th>Component</th>
<th>Per cent by volume</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Major Component</strong></td>
<td></td>
</tr>
<tr>
<td>1. Nitrogen</td>
<td>(78.09)</td>
</tr>
<tr>
<td>2. Oxygen</td>
<td>(20.94)</td>
</tr>
<tr>
<td>3. Water vapour</td>
<td>(0.1 - 5)*</td>
</tr>
<tr>
<td><strong>B. Minor Components</strong></td>
<td></td>
</tr>
<tr>
<td>1. Argon</td>
<td>(9.34 x 10^{-1})</td>
</tr>
<tr>
<td>2. Carbon-dioxide</td>
<td>(3.25 x 10^{-2})</td>
</tr>
<tr>
<td><strong>C. Trace Components</strong></td>
<td></td>
</tr>
<tr>
<td>1. Neon</td>
<td>(1.82 x 10^{-3})</td>
</tr>
<tr>
<td>2. Helium</td>
<td>(5.24 x 10^{-4})</td>
</tr>
<tr>
<td>3. Methane</td>
<td>(2 x 10^{-4})</td>
</tr>
<tr>
<td>4. Krypton</td>
<td>(1.14 x 10^{-4})</td>
</tr>
<tr>
<td>5. Nitrous oxide</td>
<td>(2.5 x 10^{-5})</td>
</tr>
<tr>
<td>6. Hydrogen</td>
<td>(5 x 10^{-5})</td>
</tr>
<tr>
<td>7. Xenon</td>
<td>(8.7 x 10^{-6})</td>
</tr>
<tr>
<td>8. Sulphurdioxide</td>
<td>(2 x 10^{-8})</td>
</tr>
<tr>
<td>9. Ozone (trace)</td>
<td></td>
</tr>
<tr>
<td>10. Nitrogen d oxide</td>
<td>(1 x 10^{-5})</td>
</tr>
<tr>
<td>11. Ammonia</td>
<td>(1 x 10^{-6})</td>
</tr>
<tr>
<td>12. Carbon monoxide</td>
<td>(1.2 x 10^{-5})*</td>
</tr>
<tr>
<td>13. Iodine (trace)</td>
<td></td>
</tr>
</tbody>
</table>

*The corresponding values in parts per million (ppm) are obtained by multiplying the per cent volumes by 10^4. Thus, nitrogen (78.09 x 10^4 ppm), Oxygen (20.94 x 10^4 ppm), Carbon dioxide (325 ppm) etc.*
CONCEPT OF AIR POLLUTION

Air is never devoid of impurities because such gases as sulphur dioxide, hydrogen sulphide, carbon monoxide, methane etc., are being let into it by natural processes such as dust storms, forest fires, decay of vegetation, and volcanic eruptions. This is a kind of natural pollution and it hardly attain serious proportion in terms of total air pollution problem except perhaps in the immediate vicinity and that too far a very limited period only (Meethan, 1964, p. 146). The problem of air pollution derives its importance and severity with the increase of human activities for better living.

Air pollution has been defined as community air pollution, i.e., the presence in the ambient atmosphere of substances produced by the activities of man, in concentration, sufficient to interfere, directly or indirectly, with his comfort, safety, health or with the full use and enjoyment of his property (Pande, 1988, p. 30). Air pollution means the presence in the outdoor atmosphere of one or more contaminants, such as dust, fume, gas, mist, strong odours, smoke, vapour etc. These pollutants may be injurious to human health, animal and plants. It can also be inferred that the more presence of sources of emission dose not necessarily constitute air pollution. However, it is possible for unfavourable meteorological factors to interact with the emission factor to create undesirable air
quality. If this quality deteriorates sufficiently the atmospheric environment begins to exert adverse effects on man and his environment consequently the air pollution is anything in the air that we consider undesirable from health point of view.

MAIN AIR POLLUTANTS

Air pollutants can be conveniently divided into those arising from natural sources (volcanic eruptions, organic matter decay, etc.) and those produced by man and the industrial society. In general, the pollutants which have natural origin contribute largely to global atmospheric pollution. The pollution of air in industrial societies is from two main sources which merit consideration. The first are the materials which exist as gases or small particles of soot or ash emitted into the air through the chimneys of industrial factories, power generating or refuse incinerating plants and the like; and the second is the automobile with its internal combustion engine (Waddington, 1978, p. 267). A pollutant is any form of energy or matter causing pollution (Strahler, 1977, p. 54). There are various types of air pollutants, out of them five main pollutants covered more than 90 per cent of district pollution (De, 1986, p. 83). These are:

1. Carbon monoxide, CO
2. Nitrogen Oxides, NOX
3. Hydrocarbons, HC
4. Sulphure oxides, SOX

5. Particulates matter

Out of these main pollutants some other pollutants important in terms of their toxicity are viz. Photo-chemical oxidents, Hazardous toxicants and odours (Jain & Others, 1977, p. 170). The main air pollutants are "sulphur compounds" such as $\text{SO}_2$ and $\text{SO}_3$ (Oil for industries and domestic use is a main sources), Carbon monoxide (mainly from internal combustion of motor vehicles); nitrogen compounds such as NO and NO$_2$ (these come from fossil fuel such as oil and coal used in industries, heating and automobiles) hydrocarbons (Motor vehicles and the industries are main source).

**TABLE 3.2**

<table>
<thead>
<tr>
<th>PRIMARY POLLUTANT SOURCES AND AMOUNT</th>
<th>(Million tonnes year$^{-1}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollutant Source</td>
<td>Weight of pollutant produced</td>
</tr>
<tr>
<td></td>
<td>$\text{CO}$</td>
</tr>
<tr>
<td>Transportation</td>
<td>69.7</td>
</tr>
<tr>
<td>Fuel combustion (Stationary source)</td>
<td>1.2</td>
</tr>
<tr>
<td>Industrial processes</td>
<td>7.8</td>
</tr>
<tr>
<td>Solid waste disposal</td>
<td>7.8</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>8.5</td>
</tr>
<tr>
<td>Total weight of each pollutant produced</td>
<td>95.0</td>
</tr>
</tbody>
</table>

The other significant air pollutants such as bad odours, photo-chemical oxidant, hazardous toxicants such as mist and dust, CO₂ etc. are normal constituents of atmosphere, they are considered to be pollutants when they exist in abnormally high concentration (Table 3.3 show Air quality standard for primary pollutants).

**TABLE 3.3**

**AIR QUALITY STANDARDS FOR PRIMARY POLLUTANTS**

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Tolerance ppm</th>
<th>Level mg/m³</th>
<th>Relative Toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>9.0</td>
<td>10,000</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>( Not to be exceeded more than once/year for 8-hour period )</td>
<td>35.0</td>
<td>40,000</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td></td>
<td>19,300</td>
<td>2.07</td>
</tr>
<tr>
<td>SOX</td>
<td>0.50</td>
<td>1,430</td>
<td>28.00</td>
</tr>
<tr>
<td>NOX</td>
<td>0.25</td>
<td>514</td>
<td>77.8</td>
</tr>
<tr>
<td>Particulates</td>
<td>-</td>
<td>375</td>
<td>106.7</td>
</tr>
</tbody>
</table>


Some main pollutants i.e. sulphur dioxide, hydrogen sulphide and nitrogen oxide also come from natural sources.
like forest vegetation (Table 3.4).

**TABLE 3.4**

REDUCTION OF SELECTED GASEOUS POLLUTANTS BY FOREST VEGETATION (MANAGED AS A GREEN "SANITARY CLEARANCE ZONE")

<table>
<thead>
<tr>
<th>Pollutants</th>
<th>Concentration of pollutant (mg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1000 m from source</td>
</tr>
<tr>
<td>Sulphur dioxide</td>
<td>0.27</td>
</tr>
<tr>
<td>Hydrogen sulphuric</td>
<td>0.07</td>
</tr>
<tr>
<td>Nitrogen oxides</td>
<td>0.22</td>
</tr>
</tbody>
</table>

1. Particulates

Particulate matter is discrete mass of any material, except pure water, that exists as a liquid or solid in the atmosphere under normal conditions. They are present in the atmosphere in fairly large numbers and sometime pose a serious air pollution problem (De, 1986, p. 104). The most important physical property of particulates is their size, which range from a diameter of 0.002 µ (about the size of small molecule) to a diameter of 500 µ (µ = 10$^{-6}$ meter) with life time varying from a few seconds to several months. The life time of these particulates, depends on the settling rate, which again depends upon the size and density of the particles and turbulence of air. Particulate vary in size
from ultramicroscopic particles, consisting of a few molecules clustered together, to grains of ash or dust large enough to see individually under a magnifying glass. The presence of particulate matter in the atmosphere is based on size and is categorised in two types; (i) particles less than 2.5 μm in diameter (fine particles), and (ii) particles greater than 2.5 μm in diameter (coarse particles). Particles larger than 10 μm would normally remain suspended in the air for much longer period. During cold and humid temperature these serve as nuclei for condensation of water vapour and produce fog (Agrawal, 1987, p. 228). Particulates matter in the atmosphere arise from natural sources as well as from other human activities. The sources of particulates matter may be classified under four categories; (i) fuel combustion and industrial operation (mining smelting, polishing, furances) and particulate emission (material handling, leading and transfer operation), (iii) non industrial fugitive processes (roadway dust, agricultural operations, construction, fire etc.) (iv) transportation sources (vehicle exhaust and related particles from fire, clutch and brake wire).

Particulates of larger size and weight will quickly fall out of air stream while particulates of below 20 μm size will stay in room air for sufficiently longer time to be of some health significance. Particulates above 15 μm are caught in the natural human nasal filter passage or at back
of throat while particles of 6-16 u in diameter get deposited on the moist walls of lower respiratory tract. Particulates can cause increased morbidity and mortality in the exposed population by aggravating diseases such as bronchitis, and cardiovascular diseases. Particulates can be from soil, clothes and buildings and can hamper visibility (Jain & Others, 1977, p. 175-176). Soot, lead particles from exhaust asbestes, flyash, volcanic eruptions, pesticides, sulphuric acid, mist, metallic dust, cotton and cement dust etc., are injurious to human health. When inhaled by man they cause respiratory diseases such as tuberculosis and cancer (Agrawal, 1987, p. 230 and De, 1986, p. 109).

2. Hydrocarbons

The term hydrocarbon embraces all those organic substances solely composed of carbon and hydrogen (Higgins & Others, 1975, p. 111). Natural sources particularly trees, emit large quantities of hydrocarbons in the atmosphere. Hydrocarbons is a general term used for several organic (aromatic) compounds such as nephthen, olifine and paraffine, emitted form numerous sources especially when petroleum fuel is burned. All anthropogenic sources contribute 15 per cent of the hydrocarbons, out of them automobiles is main source which releases 570 x 10^6 tons of hydrocarbons in to the atmosphere. In Sagar district 55 per cent hydrocarbons come from petrol, 3.3 per cent from coal; 2.2 per cent from wood,
28.3 per cent from incinerators and refuse burning, and 11.3 per cent comes from solvent evaporation. In Sagar district more hydrocarbons are released from two/three wheeler vehicles (Agrawal, 1987, p. 223). In addition, hydrocarbons may cause breathing problem and eye irritation. In combination of nitrogen oxide, hydrocarbons impact can be significantly increased, and produces photochemical smog and pan which is characterised by brown, hazy fumer which cause irritation to the eyes and lungs.

Reactive hydrocarbon

\[
\begin{align*}
\text{RCH}_2^+ & \rightarrow \text{RCH}_2\text{O}_2^- \\
\text{RCH}_3 & \\
\text{NO}_2 + \text{HO}^+ & \rightarrow \text{RCHO} + \text{HO}_2^- + \text{NO}_2 \\
\text{NO} & \\
\text{O}_3 & \\
\text{O}_2 & \\
\end{align*}
\]

(A)

Fig. 1 Smog forming reactions.
3. Sulphur Oxides

Sulphur oxide is noxious pollutant with cooking smell, which is generally released by burning fossil fuel combustion (Villers, 1970, p. 167). Solid and liquid fossil fuel normally produced about 30 parts sulphur dioxide (SO₂) of total smoke volume, which is colourless gas with pungent odour. It is a complex mixture of sulphur dioxide (SO₂), sulphur trioxide (SO₃), sulphuric acid (H₂SO₄), and sulphurous acid (Jain & Others, 1977, p. 176). Out of them only sulphur dioxide (SO₂) acts as a noxious pollutant, which is most dominant portion of sulphur oxides concentration such as, the sulphur-dioxide parameter (Singh, 1985, p. 86). Sulphur material produces high amount of sulphur dioxide in combustion. Sulphur trioxide is also produced during oxidation (De, 1986, p. 100).
\[ \text{S} + \text{O}_2 \rightleftharpoons \text{SO}_2 \]
\[ \text{SO}_2 + \text{O}_2 \rightleftharpoons \text{SO}_3 \]

Only in Bina railway station area 0.48 tons of sulphur dioxide is released per day as a result of coal burning and nearly 0.03 tons is emitted into Sagar city environment and nearly 0.01 tons is released in Khurai urban center environment due to domestic coal burning (Meethan, 1964, p.146). In Bina railway station area sulphuric acid pollutants also occur due to coal burning in the presence of water vapour (from steam engines).

\[ \text{H}_2\text{O} \]
\[ \text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3 \]
\[ \text{H}_2\text{O} + \text{SO}_3 \rightarrow \text{H}_2\text{SO}_4 \text{ (Sulphuric acid)} \]

Many other activities of man like electricity generating plant and industrial uses of fossil fuel appear to be major generators of sulphur dioxide pollutants. Construction work and transportation also produce a minor quantity of sulphur dioxide due to the operation of diesel engine. The irritant and inflammatory effect of \( \text{SO}_2 \) in conjunction with the existence of a chronic respiratory diseases especially in the elderly persons has been established. Generally sulphur dioxide (\( \text{SO}_2 \)) pollution results in higher morbidity, increased mortality, increased incidence of bronchitis, respiratory diseases, emphysema, and general deterioration of health. It can also cause increased
corrosion of metal, chronic plant injury, excessive leaf
dropping and reduced productivity of plants and trees. The
effect of sulphurdioxide pollution in the presence of parti-
culate can result in synergistic impact on the environment.
Synergistic impacts of sulphur dioxide in the presence of
nitrogen dioxide have also been noted. For example, a
concentration of 0.04 ppm sulphur dioxide alone does not affect
bronchitis or lung cancer patients. However, this concen-
tration of SO₂ combined with 160 mg/increases mortality of
bronchitis and lung cancer patient (U.S. Department of

4. Nitrogen Oxides (NO, NO₂, N₂O)

Many nitrogen oxides are found in urban environment.
The most important are nitric oxide (NO), nitrogen oxide and
nitrous oxide (N = 0) present in atmosphere in appreciable
concentrations. Nitrogen oxides are emitted by exhausts
from high temperature combustion sources. They result from
the reaction of nitrogen with photochemical. Many human
activities generate nitrogen oxides which are emitted into the
air. Industrial operation and maintenance of motor
vehicles and stationary combustion sources (like plants,
natural gas burning, diesal-operated construction machineries),
are some of the source of nitrogen oxides. However a large
portion of nitrogen oxides is produced from natural sources
due to bacterial action in forest, swamps and park. There
is very little documental information on the health effects
of nitrogen oxides present in concentration normally in ambient air. The human threshold for sensing the odour of nitrogen oxides is about 0.12 ppm. Nitrogen oxide is about four times more toxic than nitric acid (Air Quality Criteria for Nitrogen Oxide, U.S. Department of Health, Education and Welfare, Washington, D.C., March 1970). Secondary effects due to nitrogen oxide pollution include economic loss from damage to vegetation and deterioration of materials, shifting land use patterns, reduced property value, and increased accident occurrence can accompany the formation of smog and other direct effects.

5. Carbon Mono-oxide

It results from incomplete combustion of carbonaceous material used as fuels in vehicles, space heating, industrial processing and the burning of refuse and can cause death at high concentration (Meethan, 1964, p. 146). All activities that involve the combustion of organic material are sources of CO. CO is also formed by explosions, firing of weapons and can occur naturally. Adverse health effects consist of impaired time interval discrimination physiologic stress on heart patient. Presently the identified specific secondary impacts due to increased carbon monoxide emission are those related to human health, economic loss, increased accidents etc. Long term secondary effects on the ecosystem have been established. Carbon monoxide has much greater affinity for hemoglobin than oxygen and exerts its effect by interrupting the normal oxygen supply to the tissues. The gas is released,
but slowly, and continued exposure leads to increasing degree of saturation of the blood. Individuals with existing lung or heart disease, associated with low grade of oxygen deficiency particularly prove to have deteriorating affect due to increased in carbon monoxide level. It is however the extra work load imposed on the heart muscle of cardio-respiratory patients, by level of 5-10 per cent carboxy haemoglobin that is of immediate concern to the human health.

6. Photochemical Oxidents

Products of atmospheric reaction between hydrocarbons and nitrogen oxide which are initiated by sun light are called photochemical oxidants. All activities that generate oxides of nitrogen and hydrocarbons simultaneously contribute to the generation of photochemical oxidant. Injury to vegetation is one of the earliest manifestations of photochemical air pollution. The oxidant can cause both acute and chronic injury to leaves.

7. Hazardous Toxicants

Many kinds of hazardous air pollutants are released in to the environment. Some of these toxic elements or compounds are arsenic, asbestos, barium, beryllium, baron, cadmium, chromium, copper, lead, molybdenum, nickle, palladium, titenium, tungstan, vanedium, zinc, zirconium, radio active wastes, murcury and phenol. These toxic substances of certain concentration may cause serious damage
to the health and welfare of an exposed community. Hazardous toxicants may be generated by human activities such as construction, operation/maintenance, repair of existing systems, industrial activities, development/research/testing operations and demolition of structure. The manufacturing of clock, card, tubing, tape, taine, soap, thread, cement products, fireproofing, and insulating material, paper, mill-board, felt, floor tile, paints, coating, and plastics produces visible emissions of asbestos. Hazardous toxicants can create serious health problems and diseases of a chronic nature. For instance, exposure to asbestos dust at high concentration and for longer duration can cause asbestos and bronchial cancer (Environmental Protection Agency, 1973). Beryllium is another hazardous air pollutant which can seriously affect human health, the effects are acute and chronic, lethal inhalation, skin and conjunctival effects, cancer induction, and other beryllium diseases. The lower beryllium concentration produces a beryllium disease and is found to be greater than 0.01 microgram per cubic metre.

8. Odour

Odours are generally caused by organic and sulphur compounds and also by the presence of minute quantity of other pollutants in the ambient air. The resulting odour characteristics are described by commonly accepted odour
discriptions. Malodour can effect both health and welfare of a community. These result in loss of personal and community pride reducing property values, tarnishing silver and paints, corrosion of steel, reducing appetite, producing nurse and vomiting, causing headache, and disturbing sleep and increases the incidence of cancer. Additional effects of malodours include the lowering of socio-economic status, damaging community reputation, discouraging capital investment in a community, and even discouraging tourism. Effects on the ecosystem and animal population have not yet been well established.

SOURCES OF AIR POLLUTION

The sources of air pollution may be classified into two categories:

1. Direct sources such as smoke or other polluted air from automobiles (Photograph 3.1), industries, coal and other kinds of fuel used as energy for domestic purpose (Photograph 3.2).

2. Indirect sources such as bad odour from human, animal and industrial wastes (Photograph 3.3 & 3.4). These sources are as follows:

A. Direct Sources

1. Automobiles

2. Chemical and Rubber factory

3. Garbage and refuse accumulation, transportation, dumping and burning.
4. Burning of coal for domestic or commercial purposes.
5. Rising of dust in places where digging operations are conducted.

B. Indirect Sources

1. Human wastes
2. Animal wastes
3. Open drainage and sewerage system
4. Contaminated wastes from Hospitals
5. Municipal city wastes
6. Industrial wastes
7. Market and establishment wastes
8. Human congestion
9. Unhygienic khatlas, cow-dungs

These sources of air pollution may be grouped in the following categories on the basis of their pollutant:

A. Major sources of sulphur dioxide in Sagar district:
1. Domestic coal burning,
2. Industrial sources (coal or fuel oils),
3. Vehicular traffic, and
4. Railway shunting yards.

B. Major sources of suspended particulate matter are
1. Vehicular traffic, and
2. Industries.
C. Major sources of Nitrogen dioxide and carbon monoxide are

1. Vehicular traffic, and
2. Industries.

The problem of air pollution is more serious in large cities and industrial towns (Map 3.1). The urban centres are characterised by the high degree of population concentration, industrial and technological development and tremendous social changes for better living. The main sources of air pollution are industrial activities automobiles and concentration of population in urban areas of Sagar district. The urban centres are the main air pollution areas of the district (Map 3.1). There are eleven urban centres in the district. But the problematic urban centres are Sagar city, and Bina town. Therefore, the following section presents a micro analysis of air pollution in Sagar city and Bina town.

Among the various sources of air pollution, the contribution of automobiles is the largest source. The number of automobiles in Sagar district are increasing at a rapid rate each day. As a result of more vehicles on the road now the environment is becoming more polluted both the rural as well as urban centres. Besides the quantity of smoke emitted by the vehicles is much more due to poor maintenance of vehicle and fuel adultration. In the absence of deterrent laws no attention is paid towards
SAGAR DISTRICT
MAIN AIR POLLUTION AREAS

- BINA
- KHURAI
- SAGAR
this single major source of pollution. There are 15,095 motor cycles, 1,560 trucks, 962 taxies, 649 buses, 5,206 tractors, and 3,645 other vehicles in Sagar district. Out of them about 15 thousand vehicles are in Sagar city. While the remaining vehicles are in the other towns and rural areas of the Sagar district. Among these, automobiles, buses, and trucks produced more pollutants (Photograph 3.5). But in Sagar district these two automobiles are not much harmful because the city bus services is limited in the Sagar city only and the number of city buses are only 12 in this city including military vehicles. The main sources of air pollution in the cities of the Sagar district are cars, jeeps, tempos, diesel engine taxies, autorickshaws, scooters, motor cycles, mopeds etc.

In Sagar city the problem of air pollution due to the plying of these automobiles is of grave concern in Katara bazar, Gujrati bazar, Parkota and Kotwali road areas particularly during the evening hours between 3 P.M. to 9 P.M. The other important air polluted areas are Bhagwanganj, Bada bazar, Bus stand, Apsara cinema, Peeli kothi, Civil Lines, Mall road, Gulab road, etc. (Map 3.2). In Bina urban centre main source of air pollution is railway junction, the automobile traffic and pollution from domestic sources. In other urban and rural areas of district, air pollution is mainly related to automobile,
domestic and agricultural activities.

Gujrati bazar, the central zone of Sagar city, is the main air polluted zone of the city. The main sources of pollution are automobiles and higher density population. All major shops and four theatres are located in this area. People frequent this area from all parts of the city for the purpose of marketing and entertainment. The people bring their own vehicles such as scooters, motor cycles, mopeds, cars, jeeps etc. Besides, the military buses, school-buses, dairy trucks, municipality trucks are also seen on the roads of this area. Over crowding in this area is during evening hours especially from 3 to 8 P.M. The length of road from Katra mosque to Radha cinema is nearly 500 metres and it should normally take 45 seconds to 1 minute for a vehicle to cover this distance. But during rush hours a vehicle usually take 15-30 minutes to pass through (Photograph 3.6). During this period hundreds of vehicles cover this track and smoke as well as other dangerous pollutants from the exhaust are released in this area. In a hour about 2,000 vehicles pass through this area during peak time and burn nearly 300 litres of fuel resulting in 24 grams of hydrocarbons which is released into atmosphere of this area in a hours time. Beside hydrocarbons other pollutants such as nitrous oxide, sulphurdioxide and carbon monoxide are also produced in high quantity (Acharan, 2 Aug., 1988). This pollution
effects the pedestrians shopkeeper, vendors and even the drivers of the vehicle. The people do not follow traffic rules, and the even shops situated at the road sides, have encroached the footpath forcing the pedestrian to use the road (Photograph 3.6). As a result all vehicles generally move in first gear and therefore this area may be called as "low gear" area as well as highly polluted area of Sagar city. Mixed traffic also play an important role in creating serious automotive air pollution in this area (Photograph 3.7).

In Parkota the road is lined by high walls on both sides, and is the second polluted zone of the city in term of pollution due to automobile movement roads connect the city with all major educational institutions, administrative departments, and other government and private establishments, bus stand, hospitals etc. The width of this sloping road is not more than 20 feet, therefore it is busiest and most crowded especially during morning and evening office hours (Photograph 3.8). The entire vehicles which enter the city centre pass through this narrow road, especially three-wheeler diesel engine taxies and autorickshaws and other light vehicles. There are 1,100 autorickshaws and nearly 200 three wheeler diesel taxies in Sagar city and these pass through this road 20-30 times in a day to meet the transportation needs of the people. Since the road from Katra towards Parkota rises steeply due to a peculiar geographical location of the city (Photographs 3.9, 3.10).
The vehicles move in low gear and slowly due to heavy traffic there by releasing more pollutants in a already congested area. In the morning at about 10 A.M. and during evening at about 4 P.M. there is virtually a traffic jam due to the passing of a cattle to and from the Sagar lake. These animals move freely on road unattended and create serious traffic jam problems. Due to this traffic on the road move at a snail's pace polluting the atmosphere all the move.

In Katara bazar, the heart of the Sagar city, more than 500 autorickshaws and three wheeler taxies (tampo) exaust smoke over day, especially in the afternoon and evening hours. This is also the main market of the city and connects important places by road. All autorickshaws and taxies are also parked in this area, because it is the main taxi stand of the Sagar city. They keep on moving over area to collect passengers (Photograph 3,11), in stead of waiting at the stand. The keep on moving up and down the road. It is a general estimate that autorickshaws releases smoke for about 30 to 40 minutes during the search for passengers. Katra bazar is a one way traffic zone all vehicles entering the city have to pass through Katra bazar and hence high volume of air pollution in the area.

Kotwali road is fourth important zone of air pollution again due to automobiles. It is more congested than Parkota road and is very steep. Generally this road connects main
city and Government offices to Bada-Bazar area. Bada bazar particularly the Sarafa, is bullion market of Sagar. This narrow road becomes more congested due to road side parking, with steep slope, therefore the vehicles especially school buses and police vans release more smoke. This problem becomes more serious when heavy traffic comes from other side because of narrow road.

The other important area of air pollution due to automobiles, are Bada bazar, Galla Mandi, Bhagwanganj, Moti Nagar, Rahatgarh bus stand (Photograph 3.12). Apsara theatre, Station road, Jhansi road, main bus stand area, Gopalganj, and Makronia tiggada.

Next to Sagar, Bina town is the second main air polluted zone due to automobiles, especially the railway engines (Photograph 3.13). The Bina junction connects the southern part of the country to the northern parts, therefore, many important trains both passengers and goods pass through this town. Moreover, the road traffic also contribute to the air pollution. The Bina-Khurai area is an important agricultural zone of the district where a large number of tractors are being used in agricultural sector. About 600 tractors visit this urban centre every day from rural areas for the purpose of transportation of goods and passengers. In addition, Bina is an important agricultural machinery and equipment centre in Sagar.
district. There are 100 tractor repairing shops in this centre, and the tractors from rural area also came here for repairs. Consequently among automobiles railway engines and tractors are main source of air pollution in Bina urban centre.

According to the quantity and quality of air pollution Bina urban centre can be divided into five zones. These are Railway station area, Survodiya Chouk, Cinema tiggada, Jhansi gate and Etawa bazar (Map 3.3).

The main air polluted area of the Bina town is the railway station zone (Map 3.4). They are spread over 5 square kilometres and cover half of the total population. It is the main railway junction of Madhya Pradesh and is connected to all the 6 metropolitan cities of India. There are 46 passenger trains, out of them 18 are steam powered and remaining are diesel powered trains, and about 150 goods trains cross through Bina per day. Locoshed also located at Bina, and there are 34 steam engines which consume 160 ton of coal a day. Out of these 3 engines are used for shunting work and they are operated for minimum 16 hours a day. It is estimated that in standing position all engines consume 1 ton of coal in an hour. When coal is burnt it produce a lot of sulphur dioxide and other pollutants in the Bina railway station area (De, 1986, p. 5). In presence of water vapour coal also produced carbon monoxide ($\text{CO}$), carbondioxide ($\text{CO}_2$) and hydrocarbons
pollutants like Meetan ($CH_4$), and $CH_3 OH$ etc.

\[
\begin{align*}
C + H_2O & \rightarrow CO + H_2 \\
CO + H_2O & \rightarrow CO_2 + H_2 \\
CO + 3H_2 & \rightarrow H_2O + CH_4 \\
CO + 2H_2 & \rightarrow CH_3 OH
\end{align*}
\]

There are no diesel engine at Bina station, but nearly 125 diesel engines pass through this junction and it is estimated the consumption of diesel is about 312 litres per day in standing position only, releasing 1,560 millilitre carbon monoxide into the atmosphere of the area.

The total transportation sources are responsible for 74 per cent carbon monoxide in this urban centre. Out of them combustion is primarily accountable source for it (De, 1986, p. 96). As result this area of Bina town as well as Sagar district has high level of carbon monoxide, nitrogen oxides, and hydrocarbons pollutant. The density of pollutants is more in the morning and evening.

During the early morning hours between 3 to 10 A.M. most of the trains passing through this junction stop at Bina. Since some of these trains are pulled by steam engines which burn coal a lot of smoke consisting of harmful pollutants are released every day in to the atmosphere. Even the diesel engines release similarly dangerous compounds polluting the air around the station area.
A steam engine before it becomes operational burns a lot of coal in standing position for about 3 to 4 hours, in order to build up steam pressure. One can imagine the quantity of pollutants released into the atmosphere by about 16 steam engines during the period mentioned above at Bina junction. Diesel locomotives operating during the period also increase the quantity considerably both in the morning hours as well as evening (Photograph 3.14).

In the adjoining Locoshed area about 10 steam engines are repaired round the clock and hence pollutants are also emitted while testing these locomotives. There are about 700 workers engaged in loco work out of which 343 workers are involved in technical and allied jobs. 21 workers perform the task of coal loading and unloading a process during which a lot of coal dust is raised in the area. They work for eight hours everyday and even do overtime. According to a health survey most of the loco workers suffer from respiratory tract diseases. Symptoms such as constant coughing and irritation in eyes are common. The workers associated with loading and unloading of coal are the worst affected since they are also exposed to flyash and coal dust at a very close range.

High pollution rate and dust particles are a constant source of health hazard to these workers (Table 3.2).
TABLE 3.5

FLY ASH COMPOSITION (COAL COMBUSTION)

<table>
<thead>
<tr>
<th>Component (per cent expressed as)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silicon (SiO$_2$)</td>
<td>17.3 - 63.6</td>
</tr>
<tr>
<td>Aluminium (Al$_2$O$_3$)</td>
<td>9.81 - 58.4</td>
</tr>
<tr>
<td>Potassium (K$_2$O)</td>
<td>2.8 - 3.0</td>
</tr>
<tr>
<td>Iron (Fe$_2$O$_3$)</td>
<td>2.0 - 26.8</td>
</tr>
<tr>
<td>Carbon (C)</td>
<td>0.37 - 36.2</td>
</tr>
<tr>
<td>Sodium (Na$_2$O)</td>
<td>0.27 - 0.09</td>
</tr>
<tr>
<td>Sulphur (SO$_2$)</td>
<td>0.12 - 24.33</td>
</tr>
<tr>
<td>Calcium (CaO)</td>
<td>0.12 - 14.3</td>
</tr>
<tr>
<td>Phosphorus (P$_2$O$_5$)</td>
<td>0.07 - 47.2</td>
</tr>
<tr>
<td>Magnesium (MgO)</td>
<td>0.06 - 4.77</td>
</tr>
<tr>
<td>Carbonate (CaO$_3$)</td>
<td>0.0 - 2.6</td>
</tr>
<tr>
<td>Titanium (TiO$_2$)</td>
<td>0.0 - 2.8</td>
</tr>
</tbody>
</table>

The problem assumes serious proportions during the winter season because the smoke spreads in a very wide area around the Railway station. Due to condensation process in the early hours of the morning, the smoke does not rise high in the atmosphere but spreads around the area (Photograph 3.15 & 3.16) posing a serious threat to the health of the inhabitants of the zone. Sulphur dioxide, one of the main pollutants released into the atmosphere is dangerous to health. Most of the people residing in the area are chronic
asthma patients some deaths on account of this disease have also been reported (Acharan, 1988).

'Sarvodaya Chouraha' is a main road junction of Bina. State highway No. 14 also passes through this crossing. From the traffic point of view this is the busiest and most crowded section of Bina. About 80 per cent of vehicle repair workshops are located in this densely populated area. On the basis of a survey, an estimated 100 tractors are repaired in these workshops everyday. During the harvest and sowing season these workshops function round the clock. Obviously a lot of diesel is burnt during repair work for testing resulting in a thick blanket of smoke over the area. The regular traffic flow through this area also contributes to the pollution rate. As estimated 12 buses, 300 trucks and other kinds of light motor vehicles and two wheelers cross this point each day. There are also five transport agencies and other industries functioning in this area. High percentage of harmful gases such as carbon monoxide, nitrogen oxide, sulphur dioxide and other pollutants of the air have been traced in the environment of this Area (Jain & Others, 1977, p. )

Since most of the tractors passing through this busy crossing do not have horns they increase the acceleration of their vehicles to attract attention of pedestrians and other vehicle drivers. A pressure on acceleration in a slow moving traffic produces more smoke on an average. The
net result is enhanced pollution (Photograph 3.17).

According to a health data available two cases of cancer have been reported in this area and one of them has died at a relatively young age. Both these persons were residents of this area. The residence of one these cancer patients is situated on the first floor of a building whose ground floor is used as 5 workshops for tractors.

It is noteworthy that both these cancer patients were non-smokers. Hence we see that petro-chemical oxidants are one of the main sources of air pollution in the district and also responsible for a number of diseases.

DUST POLLUTION

Dust, the ground layer of the atmosphere is one of the most widespread harmful ingredients. Its concentration depends on the discharge of industrial enterprises, Colin erosion of soil, etc. Besides due to its physiochemical effect on living things, dust creates a mechanical influence which depends on the size of the particle, its shape and hardness. Where the lower limit is 1 μ and the upper exceeds 200 μ (Came Zaionchorskii, Ya, 1969) distinguishes dusts that are a public nuisance, and dust that pollute the atmosphere. The former includes particles over 10 μ in size and settles in the vicinity of the source while the latter includes finer fraction which remains suspended in the atmosphere and constitutes a
permanent pollutant.

Pasceri, Friedlender, Chepil and Kasbine (1965) suggested a dust classification by degree of dispersal in ground layer of the atmosphere. The first include finely disperse particles, up to 15 u in size, and are permanently present in the atmosphere. Hygienically the most dangerous in this group, are particles up to 5 u, the second group includes dust of a moderate degree of dispersion, with particle size of 15 u to 40 u; it is always present in the air of industrial cities; the third is that of coarsely-disperse dust with particles in range of 40 - 100 u, which usually settle within two kilometer of source and are observed during dust storms. Finally, the fourth group includes gigantic particle sizes (100 - 220 u) found in the immediate vicinity of sources and during violent dust storms. The dust have more complex chemical composition (Guniya, 1974, p. 110), in a dust of inorganic substance chemical spectral analysis reveals more than 20 different metallic elements mostly calcium, magnesium, alluminium, iron as well as silicon (Aleksandrov & Others, 1968; Katz, 1962; Feit, 1961; Cholk, 1962; Stokham, 1966). The amount of magnesium, lead, copper, zinc and manganese are relatively high (Guniya, 1974, p. 112). Their chemical composition varies according to meteorological conditions and meteorological phenomena (Aleksandrov, 1968).

The dust pollution may be observed through out the
whole year in Sagar district, but it becomes serious during summer, especially in rural areas. During summer, winds assume a stormy character that is why the proportion of dust in the atmosphere increases considerably. This dust enters the houses through windows and doors while in the rural areas it comes mainly through the roof of the house. This dust may fall in the open drinking water sources, as well as water which has been stored for this purpose. Besides, the dust also falls in the food which has been left open in a house moreover, in the sweet shops, where sweets are kept uncovered (Photograph 3.18). The dust pollution becomes serious, especially in the open shops which have established in the open ground temporarily. This dust pollution may be observed in the shops of weekly market and during cultural function time such as Mela, Ursa, etc.

The urban centres are not free from dust pollution. The automobiles and industrial activities are the main source of dust pollution in these areas. The roads of the district are very rough (Map 3.4) and mostly unmetalled and therefore, when vehicles run on the roads a huge amount of dust can be seen rising in the air, which may effect the human eyes. During summer dust may be found in drinking water and as well as in food. In Sagar city the main dust pollution area are Katra and Gujrati bazar, Apsara cinema area, railway station road, Rahatgarh bus stand and main bus stand, Gopalganj, Gallamandi, and Bada bazar. Similarly in Bina town the main areas of dust pollution are Survodaya
MAP 3.4
SAGAR DISTRICT
SOURCE OF DUST POLLUTION
(NET WORK OF UNMETALLED ROAD)

*********** = UNMETALLED ROAD
Chouk, Eatala bazar, Kotwali area, Jhansi fatak etc.

Dust particles are the second important pollutants of air in Bina after smoke (Photograph 3.19). But dust creates more serious problems than the smoke released by automobiles. Except in rainy days alone the problem due to dust in the air is indeed acute. Most of the roads in this city are narrow. Besides a major portion of these roads are not metallic (tar covered) (Map 3.5). Even the existing metallic roads are badly maintained. As a result even the metallic roads are covered by thick layers of dust. Whenever a vehicle moves on these roads it blows along with smoke a lot of dust in the air making it impossible for a person following the vehicle to drive on. The problem is much more serious if a truck is moving ahead of a vehicle. The dust virtually blinds the eyes of the driver following the truck momentarily.

Often in order to avoid this dust storm drivers try to overtake the vehicles immediately ahead and thus a number of accidents take place on account of this reason. An estimated 2000 vehicles ply in the Sarvodaya Chowk and Eatala bazar area everyday out of which 700 vehicles are heavy. The dust on the roads remains suspended in the air (Photograph 3.20) throughout the day making breathing difficult in the area. Usually the effect of dust particles in the air due to the movement of a vehicle remains for about 10-15 minutes before they settle down again. But the
first 3 minutes are the most difficult and unbearable (Photograph 3.21). Besides this usual source of dust, about 300 tractor trolleys and five to seven hundred bullockcarts laden with grass reach the city everyday. Dust particles of organic nature from the grass due to wind are spread around in this area. These dust particles are more harmful on inhaling.

There are about 50 tractor repairing shops located in this area in which there are 10 lathe machines, 2 crank-shaft grinders, 25 drill machines which produce inorganic dust particles. Roughly about 300 workers who operate machines suffer from various health problems on account of the dust particles that they inhale or which fall into their eyes. Among these workers 15 are suffering from eye sight problem and more than 200 are Asthma patients.

In Etawa bazar, the Kotwali area is more prone to dust pollution because of open ground space, concentration of animals and heavy traffic. As a result the roads in Etawa bazar are always covered with deep layers of dust which rises into the air each time a vehicle passes. Respiratory diseases among the residents of the area are very common. Due to strong winds dust storms are also very common in this area (Photograph 3.22).

Old persons suffer more because they remain at have most of the time. According to a survey conducted in a
100 square metres area of the residences located by the side of the road the figures are alarming. During the last 10 years 1 person is reported to have died due to cancer, 3 persons due to Asthma and at present 4 persons ranging in the 40 to 58 years age group are suffering from chronic Asthma and a 35 year old man is suffering from tuberculosis. Medical science has long back established a relationship between dust particles and incidence of Asthma. In Galla Mandi area of Bina the grain is cleaned by about 700 workers each day. Out of this total, 300 are female workers and about 100 children in the age group of 10-15 years are also engaged in filtering process of wheat. Organic dust always remains suspended in the air of this 2000 square metre area. Some of the women workers also bring their infants to the place of work. A large number of children and workers suffer from respiratory diseases such as Asthma and even eye problems. The children are more prone to these diseases.

Small industries and saw mills in Bina are also responsible for dust pollution. The Saw mills alone produce 500 Kg of dust per day. Yet another major source of dust pollutant is the husk locally known as 'Bhusa'. Bina receives about 12,000 tons of bhusa from the Surrounding rural areas. Both loading as well as unloading of bhusa and even storing creates dust pollution. About 90 per cent of the workers engaged in this task suffer from Asthma and eye diseases because they work with hardly any
protective clothing on. (Photographs 3.23 & 3.24). Wheat thrashing is another process which raises a lot of dust particles in the air (Photographs 3.25, 3.26 & Map. 3.6).

In Sagar city the problem of dust pollution exists in both the outerparts as well as heart of the city. (Map.3.7) The problem is more grave in the Rahatgarh bus stand and Sadar bazar area due to heavy traffic throughout the day and also due to the repair workshops situated here (Mishra, 1988). Rough surface of roads, broad open ground, Saw mills, workshops are the main sources of dust in the area. The dust rises in the air due to wind and the movement of about 1200 light and 500 heavy vehicles passing through the area. The entire area always seems to be engulfed in a dust storm.

Galla mandi area has its own share of organic dust problem due to filtering of grains (Photograph 3.27 & 3.28) and loading and unloading of other agricultural products. The Gulab road area has dust problem too which is inorganic in nature due to the concentration of workshops in this area (Photograph 3.29).

Makronia and the main bus stand areas are yet other examples of dust polluted areas (Photograph 3.30, 3.31) due to heavy traffic on the roads round the clock.

The low living standards of families in Sagar district is the result of lower purchasing power and
DUST POLLUTION

THRESING STATIONS IN BINA TOWN

MAP 3.6

WEST RAILWAY COLONY

TO BHOPAL

TO BHOPAL

EAST RAILWAY COLONY

TO BHOPAL

TO SAGAR

TO SAGAR

TO JHANSI GATE

TO JHANSI

TO KHIMLASA

LOOP LINE

SINDHI COLONY

THRESING STATION

GWAL TOLY

MAHAVIR CHOUK

CINEMA TIGGADA

SURVODIYA CHOUK

EATAWA
SAGAR CITY
MAIN DUST POLLUTION AREAS
therefore more than 90 per cent families depend upon the traditional means of fuel energy, such as firewood, dung cakes, kerosene etc. A few families, especially in urban centres, use cooking gas for this purpose. Among the various sources the dung cakes are very common and majority of rural population use this fuel for cooking food (Photograph 3.34). The burning cakes produced those gases which are very harmful to the human health. Similarly, the smoke emitted from other kinds of fuels is also harmful if the houses do not have proper ventilation system.

This type of smoke pollution is very common in rural areas and effects the ladies who cook the food for the families. In rural areas dung cakes are mostly used for cooking and other heating purposes, which produced about 28,000 kilogram of poisonous gases per year in Sagar district (Acharan, 1988). Besides, majority of rural houses have only one door and there is no proper ventilation system. The height of the houses is also low and roof is made of tiles, stone chips, grass and leaves of palm and tree. These characteristics of the houses increase the volume of smoke within the house at the time of cooking. Generally, the woman who prepares food for the family inhales 17 pollutants and 14 carcogenic elements, which are released due to burning of dung cakes. These pollutants are also harmful to other members of the family, especially the infants and children. The problem become more serious in grass roof houses because it act as a barrier
not allowing the smoke to pass. The smoke pollution causing throat and eye diseases in rural areas (Patty, 1967). Naryaoli village of Sagar district situated in forest area reported about 725 dye disease case during the year 1986, which is 6.16 per cent of that of the district figure. The women of rural areas suffered from chronic diseases due to air pollution. The problem becomes serious when the vegetables are fried. The persons feel eye irritation and inhaling problem. Pollution effect becomes serious during rainy season due to use of raw wood for fire. The smoke of raw wood called "P-cam", which is rich in benzoporin elements, is heavy than general wood. Due to its dangerous effects this smoke is called "sweet slow poison" (Acharan, 1988). In the cold season for heating the surrounding atmosphere in rural area generally dung cakes are used. The smoke of this fuel effects all persons who sit around the fire. Another wood waste obtained from gram called "Tantra", is used for heating purposes. The burning of this fuel produces heavy amount of smoke. It generally burns without a flame. The poor families mainly use waste wood which should not be otherwise used for cooking food. Another harmful pollutant benzene is also produced during wood burning (Shuster, 1975), in presence of oxygen and nitric oxides, the photochemical decomposition is much easy to benzene than other hydrocarbon (Atkinson, 1975), causing formation of acrolein, glyoxal and primarily nitrobenzene and nitrophendes (Nojama, 1976), in presence of light carbon monoxide and nitric oxide benzene produced 2,4-dinitrophenol
(Nojima, 1975). Therefore the women especially of rural areas breaths the pollutants, which effect central nervous system (Marian, 1974; Goodman, Gilman, 1970, p. 930; Conning and Gordon, 1980).

The coal is a single element which gives large number and amount of various pollutants viz. carbon monoxide (Detwylor, 1971), nitrogen oxide, sulphur dioxide, hydrocarbons (De, 1986) and arsenic (Newland, 1982). Coal is used mainly in urban centres of the district, where it is used for cooking, for heating and other domestic and non-domestic uses. Coal burning for domestic uses is the main source of smoke pollution in urban areas. Generally, this smoke pollution become more serious intensely populated areas, where huge quantity of coal is used as a fuel.

In railway colony area of Bina town however nearly 500 sigries alone burnt every morning and evening which together create serious pollution problem on the road causing loss of awareness and judgement, which are responsible many automobile accident (Map 3.8). In this area due to photochemical reaction a deep photochemical smoke layer deposits over road as well as children's playground, causing loss in stamina and consciousness, domestic coal burning entiñe the city also contribute significant amount of smoke in Bina town environment (Photograph 3.32, 3.33, 3.34 and 3.35). In Sagar city the problem more serious during the winters because the smoke produce from
the coal and other sources together form a thick layer of smoke over the city due to photochemical oxidents (Photographs 3.36, 3.37). Which is injurious to plants (Jain & Others, 1977, p. 190). Tea stalls also use a large quantity of coal in the district. In Bina town 120 small hotels use more than one tons coal per day. Similarly in Sagar city about 700 small and big hotels use nearly 10 tons coal per day. The result is more pollutants in the form of smoke released (Photograph 3.39) in the atmosphere. The defecultive structure of the hotel building (Photograph 3.39) create serious health problem, especially to their workers. It is observed that about 70 per cent hotel workers of the district suffer from headache. It is estimated that the domestic use of coal leaves 80 – 16,000 Kg arsenic into the atmosphere annually. Even a middle size hotel, which used 50 Kg coal per day releases 4,000 – 1,800,000 ug arsenic per day in the hotel environment (Waldbott, 1973). Arsenic and its compound are poisonous and cause chronic diseases in district especially among hotel workers (Newland, 1982 and De, 1986). Arsenic enters the human body on inhalation, ingestion, and is absorbed through the skin. Arsenic contact of hari serves as an indicator of exposure to the metal. Upon inhalation of arsenic a mild bronchitis and nasal irritation follows. The hotel workers can lead to perforation of the nasal septum (Waldbott, 1973). Arsenic also effects other person too who drink water and take food from these rough
and open coal burning hotels (Newland, 1982). Hydrocarbons pollutants also causes lacrimation, coughing, sneezing, headache, nervous weakness and bronchitis disease in hotel workers (Jain & Others, 1977, p. 181).

There are 70 per cent hotel workers of the district who suffer from headaches and cough. Carbon monoxide attracts hemoglobin and displaces oxygen to from carboxy hemoglobin.

\[ O_2Hb + CO \rightarrow COHb + O_2 \]

The carboxyhaemoglobin is a strong complex compound so that the net result is reduction in the blood's capacity for carrying oxygen. The concentration of nitrogen oxides in these hotels kitchen is responsible for inflammation of lung tissues of hotel workers (De, 1986).

Effects of exposure to various level of NO\textsubscript{2} on human health =

<table>
<thead>
<tr>
<th>Level of NO\textsubscript{2} ppm</th>
<th>Duration of exposure</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 - 100</td>
<td>up to 1 hour</td>
<td>Inflammation of lungs tissues for 6-8 weeks</td>
</tr>
<tr>
<td>150 - 200</td>
<td>-</td>
<td>Bronchitis fibrous obliterans fatal result within 3-5 weeks of exposure</td>
</tr>
<tr>
<td>&gt; 500</td>
<td>2 - 10 days</td>
<td>Death</td>
</tr>
</tbody>
</table>
Kerosene is used in both urban and rural areas of the district, for cooking and lighting. In urban centres kerosene is used as a source of fuel gas. It is important pollutant in term of hydrocarbons and aromatic compound pollutants. In rural areas kerosene pollution is more harmful than urban areas of district because they used kerosene lamps, which produce more brownish-black smoke during burning. This brownish-black smoke of kerosene lamps contain high degree of carbon than other facts especially sulphur oxides (Acharan, 1988). In the district 29 lakh liters of kerosene was consumed in 1988, only in Bina town 300 KL of a kerosene was use during this period. On account of power maintenance cost and easy to use wick stoves which provide heat energy by using kerosene as a fuel are becoming more popular. A wick stove which is used indoors release a lot of hydrocarbons and kerosene into the air. In rural areas "petromax" a kind of kerosene lamp is used during social and cultural functions, as a source of light. This lamp has a very high pollution rate.

Personal pollution problem is another air pollution problem in the study area. Smoking is one of them which effects human health. Tobacco in the form of cigarettes or bidi has many dangerous pollutants such as tar, nikotine, carbon monoxide, cadmium, nitrogen oxide, carbondioxide, amonia, benzene, formeldehyde, hydrogen sulphide etc., when it is burnt (Singh, 1985, p. 100), 60 per cent smoke of
every cigarette pollutes surrounding environment (Doyle, 1974, p. 13). Sixty per cent population of district directly affected and remaining 40 per cent population indirectly affected by personal (smoking) pollution. In the study area smoking is a common habit, both in old and young generation. Smoking of a family member is also harmful to other members of their family, especially in slums, because of there over crowding (Photographs 3.40 and 3.41).

Moreover, Sagar district is the main bidi making area of the State. Therefore, bidi smoking is very common habit in rural areas. It is evident from the fact that bidi smoker are 70 per cent in rural areas, which is more harmful than cigarette smoking due to untreated tobacco and leaf.

In the study area smoking is serious problem in cinema halls, buses, trains and other public places. There are 15 cinema hall and about 100 VDO centres in rural areas generally known as tobacco pollution chambers as well as carbon dioxide chambers because there is no control on smoker, in such big cinema hall nearly 500 bidi, cigarette burnt at show time which create serious health problem to all ordinance especially last two shows when halls already fullfil with cigarette smokes. During the survey of Bina town theatre about 60 per cent ordinance especially ladies and those who are non-smoker feeling headache in theatre
environment (Agrawal, 1987, p. 210). The other main pollutants of cigarette smoke, viz., benzene and cadmium, affected district population significantly (Merian, Zandar 1982, p. 149). Cadmium pollutants in cinema halls, as well as in district environment create pathological problem (Table 3.6).

**TABLE 3.6**

PATHOLOGICAL EFFECTS OF CADMIUM

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Daily intake (in Fig.) for 1-3 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>175</td>
</tr>
<tr>
<td>Anaemia</td>
<td>530</td>
</tr>
<tr>
<td>Retardation of growth</td>
<td>1300</td>
</tr>
<tr>
<td>Abnormalities of pancreas of spleen</td>
<td>1300</td>
</tr>
<tr>
<td>Heart abnormalities</td>
<td>2125</td>
</tr>
<tr>
<td>Liver and kidney damage</td>
<td>5250</td>
</tr>
</tbody>
</table>


High quantity cigarette, bidi smoking in public place, especially cinema hall of the district supporting incidence of cancer in district population due to smoke's aromatic compounds such as anthracene benzo, and fluoranthene, indeno (1,2, 3-cd) pyrene and benzo-pyrene (Kraybill, 1977, p. 50).
Besides the above mentioned sources of pollution there are many other human activities especially in urban areas which increase the pollution in the atmosphere. Usually solid wastes are disposed off by reducing them to ashes. Huge solid waste dumps are burnt on the spot producing a lot of smoke containing all sort of poisonous compounds both organic and inorganic in nature (Photograph 3.42). Even the construction or maintenance of roads is an activity which releases pollutants in the air (Photograph 3.43). Shoe repairing involving the use of plastic and rubber (Photograph 3.44, 3.45), Brick kilns (Photograph 3.46 and 3.47), open latrines and open space used for the disposal of night soil are all other activities which enhance the existing pollution rate. A polluted environment is always a threat to human health and welfare.

Effects of Air Pollution in Sagar District

Diseases due to air pollution are very common. In the study area there are sufficient cases of air pollution related diseases which are registered in various government health centres. But the data related to the occurrence of diseases is in complete and the figures usually provided by health authorities are much low than actual number of particular diseases. Illiteracy, ignorance about diseases, poverty, poor health facilities and indifferent response of government doctors are some of the main factors, responsible for incomplete data. Even private doctors do not maintain
proper registers.

Air pollution in Sagar district is dangerous but not alarming. Some air pollutants like dust, smoke released from coal and wood burning, fossil fuel, combustion in automobile and solid waste disposal are the main responsible pollutants in air pollution. Effects of air pollution generally changes with the changing climate and socio-economic status of population in the area. In the absence of reliable data the present study had to depend on field surveys and observation. Air pollution effects may be divided into four categories: (i) effects on human health, (ii) effects upon animal (iii) effects on vegetation, and (iv) socio-economic effects of air pollution in Sagar district.

Effects on Human Health

Perticulates such as dust, grass dust, smoke from domestic sources are main air pollutants in study area which also occur in the entire district. The problem is equally serious in rural and urban areas of district. When these air pollutants, enter human body on inhalation, injection or by drinking polluted water (Vorwald, 1952, p. 486), it causes serious health hazards in district population (Dorn, 1952, p. 507). The diseases due to air pollution viz. bronchitis, emphysema and cardiovascular diseases are found in the study area. There are 20,509
cases of diseases due to air pollution which are registered in different Government health centres during 1986, which is 4.8 per cent of total district diseases. Highest number of bronchitis, emphysema diseases registered in Rehli Primary Health Centre, where 11 per cent cases are

**TABLE 3.7**

**AIR POLLUTION’S DISEASES IN SAGAR DISTRICT - 1986**

<table>
<thead>
<tr>
<th>Name of Disease</th>
<th>Cases recorded in Government hospitals/Primary Health Centre/Sub-centre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tuberculosis of respiratory system and all other types of tuberculosis</td>
<td>608</td>
</tr>
<tr>
<td>2. Whooping cough</td>
<td>756</td>
</tr>
<tr>
<td>3. Eye irritation and others</td>
<td>11,764</td>
</tr>
<tr>
<td>4. Chronic diseases</td>
<td>1,070</td>
</tr>
<tr>
<td>5. Acute respiratory infections</td>
<td>19,914</td>
</tr>
<tr>
<td>6. Pneumonia</td>
<td>5,453</td>
</tr>
<tr>
<td>7. Bronchitis, Emphysema and Asthma</td>
<td>20,509</td>
</tr>
<tr>
<td>8. Hypyema and Obscess of lungs</td>
<td>1,987</td>
</tr>
<tr>
<td>9. Other diseases of respiratory system</td>
<td>6,891</td>
</tr>
<tr>
<td>10. Skin diseases</td>
<td>32,109</td>
</tr>
</tbody>
</table>

Source: Chief Medical Officer, Sagar District, 1986.

registered, and secondly in Banda where per centage of Bronchitis is 6.25. It is a fact that dust pollution and release of smoke mainly occurs in rural dwelling areas and
during the survey it was observed that women of rural areas mostly suffer from Bronchitis. Out of them 60 per cent have not taken any treatment. Tuberculosis is another important disease related to air pollution and is caused due to dust pollutants rich in silica (SiO$_2$) (Baetjer, 1952, p. 513). In Sagar district it is mainly observed in Agasod PHC of Bina tahsil, where it is mainly reported in the workers who are engaged in stone mining. There are 68 cases of tuberculosis reported in 1986. High incidence of tuberculosis also observed in crushing workers. But generally these workers do not go to hospitals for checkup. Dust from floor mills is also harmful to human health (Wittich, 1952, p. 520). The stinking smust of floor mills atmosphere is harmful to human health. Generally a single smutted wheat kernel contains 6,000,000 to 9,000,000 spores (Carygill, 1938). Smuts problem also occurs in grain storage centres, and even during harvesting time, smuts dust problem also occur in Dal mills and its nearby areas, which causes skin allergy and asthma (Wittich, 1952, pp. 520-521). In the study area 9,000 floor mills and nearly 90 dal mills are located and nearly 3,000 persons work in these mills. There were 20,509 cases of Asthma reported in year 1986. In Bina urban town, it was observed during a survey that in areas, which are full of dust from 3 cotton mills, 5 floor mills incidence of Asthma is common. For instance in 5 families, 7 older persons out of 12 are suffering from asthma, out of them 5 persons have died at
a very early age. Nearly 3,000-4,000 women and children working in Galla mandi are exposed to dust particles which are air borne. About 12 per cent of women workers in relatively old age group are Asthma patients and children especially infants suffer from skin infections. There are 32,109 cases of skin infection reported and out of them 57.65 per cent skin diseases are due to air pollution. It has also been observed that infections of skin diseases are more common in Dal mill and floor mills workers because they work in close room atmosphere where there is no proper ventilation. Particulate matter in the district atmosphere are also causing serious visibility problem and eye irritation and eye diseases (Jain & Others, 1977, p. 173). In Sagar district there are 11,774 eye infection cases registered in Chief Medical Office register out of them 10.24 per cent cases were registered in Rehli Primary Health Centre and in Agasod where stone mines are located. This alone accounts for 16.95 per cent of cases registered.

Carbon monoxide (CO) is the main pollutant which is produced due to coal burning and fossil fuel burning in automobile (De, 1985, p. 85). The pollutants are responsible for respiratory infections, bronchitis and pneumonia, vomiting etc. (Von Oettingen, 1944, p. 117). Coal also produces smoke which supports pneumonia disease in the district population (Schnurer, 1938). In the study area 5,453 cases of pneumonia were reported. About 40.80
per cent cases were recorded in Bannad primary health centre and 26,832 respiratory diseases was recorded mainly in rural areas like Surkhi, Deori, Maharajpur and Malthone which is about 57.56 per cent cases of district's total. Respiratory diseases are caused by CO and smoke as shown by Brinton (1949) and Collen (1944). Other air pollutants like sulphur dioxide, sulphur trioxide etc. are also found in the environment of the district due to automobile and other sources, causing tuberculosis in study area (Gardner, 1942). There are 82.39 per cent cases of tuberculosis registered in only two Primary Health Centres Deori and Khurai. Hydrocarbons pollutant's effects can be seen in Khurai, Sanodha and Dhanā area, where 65.47 per cent cases are of whooping cough. Other toxicants are also causing chronic diseases in district population (Environmental Protection Agency, 1949). In the study area, there are 1,070 cases of chronic diseases reported in 1986, out of them 20.18 per cent were recorded in Banda Primary Health Centre. Air pollution also affects natural gain of vitamin D in district population (Blume, 1952, p. 499).

REFERENCES


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