

## CHAPTER SIX

### THE EFFECTS OF AIR POLLUTION

#### 6.1 General

The extent of the effects of pollution on humans, animals, plants and infrastructure depends on the duration, concentration and toxicity of the pollutant. The following adverse effects of air pollution have been reported.

##### 6.1.1 Effects of Pollution on Human and Animal Life

The two parts of the human body which are susceptible to air pollutants are the eyes and the respiratory system. Air pollutants irritate the eyes and the eyes normally flush out foreign materials using tears. Consequently pollutants can cause eyes to appear red and watery. More severe is the passage of air carrying different types of pollutants into the lungs, causing a variety of breathing related diseases. One frequently reported medical condition in South Durban is asthma.

A health study conducted at Settlers Primary School located between two refineries (Engen and Sapref) revealed a very high level of Asthma. This was found to be triggered by sulphur dioxide SO<sub>2</sub> and nitrogen oxides NO<sub>x</sub> released mainly from Engen during the day. Other pollution related cases reported include cancer (mainly Leukaemia), skin diseases and allergies. The severity of health problems linked with pollution in South Durban can be deduced from the number of complaints registered between 1998-2002. During this period more than 800 complaints were registered and are categorised in the table below.

**Table 6.1:** Summary of pollution related complaints in South Durban (1998-2002)

Smell	Total	Feel	Total	Sight	Total	Noise	Total
Sulphur	169	Burning eyes, nose and throat	18	Flare	103	Hissing	43
Gas	160	Breathing problems	18	Fallout	52	Undefined noise	26
Unspecified bad smell	147	Vibration	10	Smoke	31	Siren	10
Oily	61	Nausea	8	Fire	6	Blasting	6
Rotten eggs	56	Unspecified sickness	2	Toxic cloud	5	Rumbling	4
Petrol	28	Skin irritation	2	Steam	3		
Burning, unspecified	25	Dizziness, nausea	2	Dust	2		
Gunpowder	13	Dizziness	2	Oil spill	1		
Burning rubber	12	Cough	2				
Diesel	10						
Sour	7						
Bitter	7						
Pungent	6						
Solvent	6						
Acrid	5						
Sweet	1						
Hot plastic	1						

### 6.1.2 Effects of Pollution on Buildings and Infrastructure

As far as infrastructure is concerned, sulphur dioxide damages the protective coating of paints on buildings exposing the material underneath. A concentration of 2ppm sulphur dioxide in the atmosphere is said to delay the dry time of paint by 100%. A polluted atmosphere corrodes metals. Stone buildings are composed of calcium, magnesium and limestone which are readily dissolved by acids from a polluted atmosphere. Sulphur dioxide is also said to reduce the breaking strength of cotton cloth. Leather becomes brittle when exposed to sulphur dioxide and ozone, rubber loses some of its elasticity with continued exposure to higher concentrations of ozone and paper deteriorates rapidly with higher concentrations of sulphur dioxide.

### 6.1.3 Effects of Pollution on Plant life

Atmospheric pollutants also inhibit plant growth and development. It has been well documented that ozone, sulphur dioxide, fluoride, nitrogen dioxides and carbon monoxide can be detrimental to vegetation. Exposure to high concentrations for only a few hours are sufficient to cause symptoms such as bleached spots and dwarfing of leaves, affecting the aesthetic beauty of the environment. Furthermore, plugging of stomata and reduction of transpiration and respiration functions of leaves occur with increasing concentration of particulate matter, irrespective of the composition of the particulates.

## 6.2. Individual Pollutants, Sources and Effects

From air quality monitoring stations and from community grab samples using the bucket system, a number of pollutants have been identified in the South Durban basin. Community samples capture a wider range of emissions in the air when an incident occurs. Air monitoring stations in the South Durban Basin records daily emissions of only four chemicals.

Below: Table 6.2 are sample readings of a community grab sample and a government monitoring station's reading.

**Table 6.2:** Compound monitored

COMPOUND	
Chloromethane	1,1-Dichloroethane
Vinyl Chloride	Methyl tert-Butyl Ether
Bromomethane	Vinyl Acetate
Chloroethane	2-Butanone
Acetone	cis-1,2-Dichloroethene
Trichlorofluoromethane	Chloroform
1,1-Dichloroethene	1,2-Dichloroethane
Methylene chloride	1,1,1-Trichloroethane
Trichlorotrifluoroethane	Benzene
Carbon Disulfide	Carbon Tetrachloride
trans-1,2-Dichloroethane	1,2-Dichloropropane

COMPOUND
Sulphur dioxide
Ozone
Nitrous oxide
Particulate matter

Pollutants monitored by  
City Health

A community grab sample result, 2003

**6.2.1 Sulphur dioxide (SO<sub>2</sub>).** It is a colourless gas, and has a clearly detectable pungent odour and taste. When dissolved in water, it produces sulphurous acid and in the atmosphere when combined with water vapour forms acid rain. Some sources of SO<sub>2</sub> emissions are fossil fuel, including coal and oil-fired power plants and boilers, ore smelters and oil refineries.

Depending on the level of human exposure to it, SO<sub>2</sub> can result in irritation of the respiratory system, leading to asthma and chronic bronchitis. Sulphur dioxide can also cause damage to plants (especially their leaves) and can reduce crop yield. SO<sub>2</sub> corrodes and damages electrical equipment and building materials (<http://www.dec.state.ny.us>). In the south Durban basin for example, it is a major cause of respiratory problems. This was proven in Settlers school study. NGOs like the SDCEA has constantly been putting pressure on refineries in South Durban to cut down the levels released into the atmosphere.

**6.2.2 Carbon monoxide (CO).** Carbon monoxide is a colourless, odourless, gas emitted into the atmosphere as a result of combustion processes. Carbon monoxide is produced primarily by the incomplete combustion of fuels and other organic materials. Other sources of CO are the exhaust fumes of automobiles, refuse and agricultural burnings and industrial processes (<http://www.dec.state.ny.us>). In the South Durban case, the oil refineries as well as other sources mentioned above are the major contributors of carbon monoxide. Periods of CO high concentrations in Durban are usually in the morning and evening rush hours when the volume of motor vehicles traffic is the greatest. Nocturnal inversions (see sections 3.3 and 3.3.1) tend to make the CO problem more prevalent during the winter months. When CO enters the bloodstream, it displaces the oxygen that is carried to the cells inhibiting the blood's ability to carry oxygen to body tissues and organs like the heart and brain. Once in the blood it can weaken heart contractions, reduce a healthy person's ability to perform manual tasks and can produce fatigue, headaches, weakness, confusion, disorientation, nausea, and dizziness. Many pollution related complaints from South Durban residents are of this nature. For example, of the 64 complaints based on feelings from 1998-2002, 19% (16) were about nausea and dizziness. Definitely, this and the other effects like weakness, fatigue and headaches would have an adverse impact on the concentration of learners within the affected areas in the South Durban area.

**6.2.3 Benzene.** Benzene is an aromatic Volatile Organic Compound (VOC). The main sources of benzene in the atmosphere are combustion in oil refineries and the distribution of petrol. The two refineries in South Durban engaging combustion in their processes are Engen and Sapref. These refineries also transport petrol to filling stations and in the process emit benzene. Apart from these sources, benzene is emitted from a vehicle exhaust. Benzene is a known carcinogen, that is, a substance that causes cancer. From a grab sample obtained during a refinery-related incident in 2003 (Table 6.2), benzene was identified among other chemicals in the sample indicating the risk to which the South Durban Community is exposed.

**6.2.4 Nitrogen dioxides (NO<sub>2</sub>) and Nitric oxide (NO).** It is a reddish brown gas with a highly detectable pungent odour and very corrosive. It is produced from the reaction of atmospheric nitrogen and oxygen during high temperature combustion processes such as the burning of fuel (coal, oil, gas) and internal combustion (motor vehicles). On the other hand, Nitric oxide is a colourless, odourless gas, with the same source as NO<sub>2</sub>. Combined together NO and NO<sub>2</sub> are commonly referred to as NO<sub>x</sub> (<http://www.dec.state.ny.us>). These compounds are also monitored by monitoring stations in the South Durban Basin. NO<sub>2</sub> can cause inflammation of the lungs and bronchial tubes at high concentrations and less severe respiratory problems at lower-

concentrations. NO<sub>x</sub> contributes to haze, reduces visibility, causes serious injury or death to plant tissue, deteriorates fabrics, and forms nitrate salts that can corrode metals (<http://www.dec.state.ny.us>).

Nitric acid, a product of NO<sub>2</sub> may also combine with water droplets (like SO<sub>2</sub> does) to produce acid rain.

**6.2.5 Ground-level ozone (O<sub>3</sub>).** It is produced in the atmosphere by the photochemical reaction of nitrogen oxides and reactive hydrocarbons, which are volatile organic compounds. Ozone is emitted from motor vehicle exhausts, gasoline and oil storage/transfer. In the stratosphere, ozone helps to protect us from harmful ultraviolet radiation but at ground level, it is a pollutant. Its health effects at low concentrations include eye irritations and at higher concentrations it can create severe respiratory problems, especially in the elderly and small children. It can also damage surfaces, fabrics and rubber materials as well as some crops, vegetation and trees. Ozone is also one of the chemicals monitored in the South Durban area and from 1998-2002, 56% of complaints in South Durban were either on burning eyes or on breathing problems.

**6.2.6 Lead.** It is a poisonous substance found in gasoline and is emitted into the atmosphere by gasoline combustion. However, with the elimination of lead in gasoline in more recent times, there has been a significant decrease to public exposure. Lead also results from combustion of solid waste, oils, emissions from iron and steel production, lead smelters and gasoline stations.

If inhaled, it can retard the production of haemoglobin. High concentrations can cause lead poisoning resulting in fatigue, cramps and loss of appetite to anaemia, kidney disease, mental retardation, blindness and death (<http://www.dec.state.ny.us>).

**6.2.7 Particulate Matter (PM).** This refers to small particles of solid or semi-solid materials, liquid droplets, aerosols and combinations thereof that are present in the air. Its sources in South Durban include diesel combustion, automobile exhaust fumes and stack emissions. Although various sizes exist, monitoring stations within the South Durban basin only monitor the levels of PM<sub>10</sub> (Particulate matter of size 10 microns). Particulate matter reduces visibility and creates haze or fog when combined with water vapour. During winter mornings, fog is observed over the South Durban area possibly contributed by particulate matter from industrial combustion activities in the basin. It is believed to cause cancer and heart attacks and can result in corrosion of metals and electrical equipment as well as building materials.

**Table 6.3:** Smell types by industry

Industry	Compound	Process	Smell
Resins	storage of resins		pungent
Rubber	SO <sub>2</sub>	compounding and vulcaning	
Paint	Ammonia, SO <sub>2</sub> H <sub>2</sub> S	Reduced Sulphur	pungent, irritating
Soap & detergent	Fats, oil & grease	Oleum sulphonation Liquid sulphur trioxide sulphonation	
Petroleum	H <sub>2</sub> S, SO <sub>2</sub> , Mercaptans	Catalytic cracking, distillation, venting, sulphur removal	rotten eggs,
Paper & Pulp	SO <sub>2</sub> , H <sub>2</sub> S	Steam from boilers	rotten eggs

**Table 6.4:** Some compounds and their smell types by industry  
(Source: Modified from: <http://www.barc.usda.gov>)

<b>Compounds</b>	<b>Odour</b>
Ammonia	Sharp pungent
Chlorine	Pungent, suffocating
Hydrogen sulphide	Rotten eggs
Sulphur dioxide	Pungent, irritating
<b>Amines</b>	
Dibutylamine	Fishy
Dimethylamine	Putrid, fishy
Ethylamine	Amonical
Methylamine	Putrid, fishy
Cadaverine	Putrid, decaying flesh
<b>Organic Sulphurs</b>	
Diphenyl sulphide	Decayed cabbage
Dimethyl sulphide	Decayed vegetables
Thiocresol	Rancid
Thiophenol	Putrid, garlic-like
Allyl mercaptan	Strong garlic
Amyl mercaptan	Unpleasant, putrid
Benzyl mercaptan	Unpleasant, strong
Crotyl mercaptan	Skunk-like
Ethyl mercaptan	Decayed cabbage
Methyl mercaptan	Decayed cabbage
Propyl mercaptan	Unpleasant
<b>Other organics</b>	
Acetaldehyde	Pungent, fruity
Chlorophenol	Medicinal
Indole	Fecal, nauseating
Pyridine	Irritating
Skatole	Fecal, nauseating

#### **Results of air pollution on human health: The case of Settlers Primary School**

An 18 day study investigating air contaminant exposures, acute symptoms and disease aggravation among students and teachers at the Settlers school in South Durban was carried out by the University of Michigan in collaboration with the University of Natal (faculty of medicine), Technikon Natal, and Peninsula Technikon from 19 April to 6 May, 2001. The study included continuous measurement of sulphur dioxide (SO<sub>2</sub>), nitrogen oxides (NO, NO<sub>2</sub>, NO<sub>x</sub>), particulate matter (PM10), carbon monoxide (CO), total reduced sulphur (TRS) and volatile organic compounds (VOC). The results revealed that the prevalence of severe and moderate to severe Asthma was strikingly high among students ie: 54 times higher than the international average. The study also provided strong evidence that ambient air pollutants exposures are associated with acute changes in health status among students with moderate to severe Asthma.

## Exercises

1. Some of the gases emitted include, PM10, SO<sub>2</sub>, NO<sub>x</sub>, O<sub>3</sub>, and many more, which may move to the ceiling of the atmosphere. What would be the effects on plants, rivers and buildings in the event of rainfall?
2. What are some global effects of high emissions of gases into the atmosphere in recent times?
3. Draw 2 graphs representing the smell and feel types found in Table 6.1. (Label number of complaints on the x-axis and smell type on the y-axis).
4. From the graph, list 2 smell types that were must reported by South Durban residents?
5. Which compounds would you suggest are responsible for the smell types?
6. Which industries in South Durban are likely responsible for those smell types?
7. Find below a table representing pollutants monitored by eThekweni City Health.

Pollutants	Odour
Ozone	
Sulphur Dioxide	
Nitrous oxide	

Identify the odour and possible health effect associated with each pollutant.

## General Exercises

1. Conduct a mini survey on one of these: any street in your area, around your school or in your school and find out whether any of the residents or learners is suffering from pollution related problems. Report on your findings.
2. Create a map of polluting industries in your area of residence. Write about the pollutants they produce. What are their effects in your area or school?
3. Produce a map of polluted areas in your neighbourhood indicating the pollution types (air, noise, water, aesthetic or scenic). Suggest ways of solving the problems.
4. Table 6.2 represents partial results from a community grab sample. Research on their odour and possible health effect associated with each compound.
5. The South Durban Community Environmental Alliance (an environmental NGO in the South Durban basin) stores data on SO<sub>2</sub> emissions in South Durban. Contact them and obtain the most recent emissions data (last two months).
  - a) Plot them on a suitable graph (bar/line graph).
  - b) Did emissions in the atmosphere exceed WHO/DEAT threshold during the months?  
WHO/DEAT threshold stands at 191 ppb (parts per billion). **Note:** X-axis = time; Y-axis = emissions in parts per billion (ppb).
  - c) Which stations recorded the exceedances and by how much?
  - d) Comment on the possible health or environmental effects of such exceedances.
  - e) A common saying among South Durban residents is “People before development”. Does this suggest no development at all? Explain.
  - f) Another growing phrase among communities around the world suffering from environmental injustice like South Durban is “Not in my back yard” (NIMBY). Comment on this in relation to the South Durban situation. Do certain activities in your neighbourhood necessitate that expression?