NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF SCIENCES AND TECHNOLOGY

COURSE CODE: EHS 212

COURSE TITLE: POLLUTION CONTROL

COURSE GUIDE

EHS 212
POLLUTION CONTROL

Course Team A. Zakariyau (Course Developer/Writer) – Environmental Health Department, Niger State Local Government Service Commission
Prof. A. Afolabi (Programme Leader) – NOUN
Dr.O. S. Ibrahim (Course Coordinator) – NOUN

NATIONAL OPEN UNIVERSITY OF NIGERIA

National Open University of Nigeria
Headquarters
14/16 Ahmadu Bello Way
Victoria Island, Lagos

Abuja Office
5, Dar es Salaam Street
Off Aminu Kano Crescent
Wuse II, Abuja

e-mail: centralinfo@nou.edu.ng
URL: www.nou.edu.ng

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CONTENTS **PAGE**

INTRODUCTION

EHS 212 – Pollution Control is a course that carries three credit units for students pursuing the BSc Environmental Health. The course consists of 5 modules broken into 19 units that involve the basic concepts in science and environmental health. Before the period of Industrial Revolution in Europe, the question of pollution was not an issue in the agenda of development. This could be explained to the relatively serene environment at the time and the low level of knowledge of the potential hazards of pollutants to human health and the environment. The study of environmental pollution and control became more pertinent when industrial effluents discharged into water bodies affect the quality of water for drinking and the consequent effects on marine life. Exhausts from chimneys pollute the air and affecting the ambient air quality of industrial layouts and surrounding settlements.

Later developments bordered on commercial agriculture and the quest for mass production to feed both the industries as raw materials and the sprawling urban population. This was predicated by the increased use of synthetic agricultural chemicals and pesticides to assure mass production. These chemicals leach and pollute large areas of land resources and water bodies.

In Nigeria, concerns over the environment and pollution gained momentum in the late 80s when an Italian ship imported large quantities of toxic wastes into the country through clandestine arrangements. The Government responded by instituting the then Federal Environmental Protection Agency (FEPA) and the subsequent policies and regulations that came into force.

Pollution is the presence of substances (pollutants) and conditions (temperature, energy) that adversely affect the health and well-being of people within a community and the environment.

Pollution affects environmental media and can cause ill-health and a high cost on the ecology and economy. Essentially human activities are greatly responsible for modern concerns of pollution and of course some natural events.

WHAT YOU WILL LEARN IN THIS COURSE

This course carries three credit units. The course guide informs you about what to expect from this course material. Studies in pollution control experiences you with the conditions that are described as pollution, the likely sources, the different types of pollutants and the regulatory and technology frameworks in their control. Perhaps the

exposure patterns to pollutants are of utmost interest to the environmental health personnel and physicians that are most concerned about pollution control.

COURSE AIMS

The main aim of this course is to provide a sound understanding of pollution and their causes to enable a well-informed strategy to controlling them. The aim of the course will be achieved by:

- introducing you to pollution control practices right from the local approach to the use of modern techniques
- inderstanding the concept of pollution
- classifying the various forms of pollution
- understanding the methods of controlling pollution
- explaining different environmental media
- providing you the basic knowledge of living with pollution free environment.

COURSE OBJECTIVES

To achieve the aims set out for this course, overall objectives are stated. In addition, each unit also has specific objectives. The unit objectives are included at the beginning of a unit.

At the end of this course, you should be able to:

- define and explain the concept of pollution
- identify different types of pollutants
- explain varying forms of pollution
- describe sources of pollution
- state the different environmental media
- discuss the impact of pollutants on the environment and human health
- explain the strategies for the control of pollution.

WORKING THROUGH THE COURSE

This course has been carefully prepared to ease your understanding of the subject. References, tables and case studies have been included where necessary to facilitate your learning. You are therefore advised to make further references and study the cases where applicable to enhance your learning.

COURSE MATERIALS

You will be provided with the following materials:

i. Course Guide
ii. Study Units
iii. Text Books
iv. Assignment File

STUDY UNITS

There are 5modules in this course broken down into21 study units. The modules and the study units are:

Module 1

Unit 1 Definition and Concept of Pollution
Unit 2 Types and Classification of Pollutants and Contaminants
Unit 3 Environmental Media 1 (Air)
Unit 4 Environmental Media 2 (Water)
Unit 5 Environmental Media 3 (Soil)
Unit 6 Environmental Media 4 (Food)

Module 2

Unit 1 Anthropogenic Sources of Pollution
Unit 2 Natural Sources of Pollution
Unit 3 Noise Pollution in Nigeria

Module 3

Unit 1 Monitoring of Pollutants and Contaminants
Unit 2 Assessment of Pollutants
Unit 3 Exposure Patterns
Unit 4 Overview of Current Global Pollution Concerns

Module 4

Unit 1 Impact of Pollutants on Human Health
Unit 2 Impact of Pollutants on the Ecosystem
Unit 3 Economic Impact of Pollution

Module 5

Unit 1	Definition and Concept of Pollution Abatement and Control
Unit 2	Institutional Arrangement for Pollution Control
Unit 3	Policy and Legislation Measures on Pollution Control
Unit 4	Industrial Methods of Pollution Control
Unit 5	Waste Management Control Measures

Module 1

In unit one you will be taken through the concept and definition of pollution. Unit two exposes you to the types and classifications of pollutants and contaminants. In unit three, four, five and six, you will learn about environmental media of pollution in air, water, soil and food respectively.

Module 2

Module two contains units 1,2 and 3. In unit 1, you will be taken through anthropogenic sources of pollution, while in unit 2 you will go through natural sources of pollution and unit 3 will dwell on noise pollution in Nigeria.

Module 3

This module is designed to take you through the concepts of monitoring of pollutants and contaminants in unit 1, the assessment of pollutants in unit 2, exposure patterns in unit 3 and overview of current global pollution concerns in unit 4.

Module 4

Unit 1 takes you through impacts of pollutants on human health, unit 2 on impacts of pollutants on the ecosystem and unit 3 – economic impact of pollution.

Module 5

In module five, there are five units in which unit 1 takes you through the definition and concept of pollution abatement and control, unit 2 on institutional arrangement for pollution control, unit 2 on policy and legislative measures on pollution control. Unit 4 is to take you through industrial methods of pollution control while the last unit – unit 5 is on waste management control measures of pollution.

TEXT BOOKS AND REFERENCES

The following are list of website addresses and text books that can be consulted for further reading:

Amadi, A. N. (2011). *ABC of Environmental Health*.Owerri: Readon Publishers Ltd.

Victor, M. & Ehlers, C. E. (n.d).*Municipal and Rural Sanitation* (6th ed.). London: McGraw-Hill Book Company.

Simmons, I. G. (1993).*Earth, Air and Water*. NY: Routledge, Chapman and Hall, Inc.

Joseph, A. &Salvato, P. E. (1982).*Environmental Engineering and Sanitation*.John Wiley and Sons, Inc.

ASSIGNMENT FILE

In this file, you will find all the details of the work you must submit to your tutor for marking. The marks you obtain for these assignments will count towards the final mark you obtain for this course. Further information on assignments will be found in the Assignment File itself and in the assessmentsection of this course guide.

TUTOR-MARKED ASSIGNMENTS

The Tutor-Marked Assignment is the continuous assessment component of your course. It accounts for 30% of the total score. The TMA will be given to you by your facilitator and you will return it after you have done the assignment.There are 21 TMAs in this course. You need to submit all the TMAs. The best 4 will therefore be counted. When you have completed each assignment, send them to your tutor as soon as possible and make sure that it gets to your tutor on or before the stated deadline. If for any reason you cannot complete your assignment on time, contact your tutor before the assignment is due to discuss the possibility of extension. Extension will not be granted after the deadline, unless on exceptional cases.

FINAL EXAMINATION AND GRADING

The examination concludes the assessment for the course. It constitutes 70% of the whole course. All areas of the course will be examined, revise the whole course. You might find it useful to review your self-assessment exercises and TMAs before the examination. You will be informed of the time for the examination.

PRESENTATION SCHEDULE

The presentation schedule included in this course guide provides you with important dates for completion of each tutor-marked assignment. You should therefore try to meet the deadlines.

COURSE MARKING SCHEME

Assignment	Marks
Assignments 1-21	21 assignments, 30% from the best 3 Total = 10% x 3 = 30%
End of Course Examination	70% of overall course marks
Total	100% of course materials

ASSESSMENT

There are two types of assessments for this course. These are the tutor-marked assignments (TMAs) and the end of course examination. You are advised to attempt all the TMAs with all sincerity as that will assist you greatly.

HOW TO GET THE MOST FROM THIS COURSE

In distance learning, the study units replace the lectures in the conventional systems. This is one of the great advantages of distance learning; you can read and work through specially designed study materials at your pace, and at a time and place that suit you best. Think of it as reading the lectures instead of listening to a lecturer. In the same way that a lecturer might set you some reading to do, the study units tell you when to read your set books or other material, and when to undertake computing practical work. Just as a lecturer might give you, in class, exercises, your study units also provide exercises for you to do at appropriate points. Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit as how a particular unit is integrated with the other units and the course as a whole.

Next is a set of learning objectives. These objectives itemise what you should be able to do by the time you have completed the unit. You should use these objectives to guide your study. When you have finished the unit, you must go back and check whether you have achieved the objectives. If you make a habit of doing this you will significantly improve your chances of passing the course. Exercises are interspersed within the units and answers are given. Working through this exercise

will help you to achieve the objectives of the unit and help you to prepare for the assignments and examinations.

The following is a practical strategy for working through the course:

1. Read this course guide thoroughly
2. Organise a study schedule. Refer to the 'course content', for more details.
3. Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their course work. If your get into difficulties with your schedule, please let your tutor know before it is too late.
4. Turn to unit 1 and read the introduction and the objectives for the unit.
5. Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow.
6. Review the objectives for each study unit to confirm that you have achieved them. If your feel unsure about any of the objectives, review the study materials or consult your tutor.
7. When you are confident that you have achieved a unit's objective, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.
8. When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your tutor's comments.
9. After completing the last unit, review the course and prepare yourself for final examination. Check that you have achieved the unit objectives (listed at the beginning of each unit) and the course objectives listed on this course guide.

FACILITATORS, TUTORS AND TUTORIALS

There are eight hours of tutorials provided in support of this course. You will be notified of the dates, times and location of these tutorials as well as the name and phone number of your facilitator, as soon as you are allocated a tutorial group.

Your facilitator will mark and comment on your assignments, keep a close watch on your progress and any difficulties you might face and provide assistance to you during the course. You are expected to mail your tutor-marked assignment to your facilitator before the scheduleddate (at least two working days are required). They will be marked by your tutor and returned to you as soon as possible.

Do not hesitate to contact your facilitator by telephone or e-mail if you need assistance. The following might be circumstances in which you would find assistance necessary, hence you would have to contact your facilitator if you:

- do not understand any part of the study or the assigned readings
- have difficulty with the self-tests
- have a question or problem with an assignment, with your tutor's comments or with the grading of an assignment.

You should endeavour to attend the tutorials. This is the only chance to have face to face contact with your course facilitator and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study.

To gain much benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participating actively in discussions.

SUMMARY

This course intends to provide you with the skills and knowledge of pollution control. At the end of this course, you will be able to answer the following questions:

- define pollution
- explain different types of pollution
- explain the major classifications of pollutants
- state the different media of pollution
- describe sources of pollution
- describe the exposure patterns of pollution
- explain some regulatory and policy framework in controlling pollution
- discuss the environmental, health and economic impact of pollution
- describe the pollution abatement devices and methodologies.

We wish you success in this noble endeavour.

MAIN COURSE

CONTENTS **PAGE**

MODULE 1

UNIT 1 CONCEPT AND DEFINITION OF POLLUTION

CONTENTS

1.0 INTRODUCTION

Pollution threatens the basic and fundamental life support system of our dear earth (water, Air and soil). This development underscores the significance of pollution control in Environmental Health. In this unit, we shall be discussing common definitions and types of pollution in our environment.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- define pollution
- explain different types of pollution.

3.0 MAIN CONTENT

3.1 Concept of Pollution

Often things or items or media (water, food, soil, Air) are found in their natural, pure and pristine forms as expected in both quality and quantity. When an undesirable substance which normally is not an aspect of that originalitem/mediais found in such a noticeable concentration as to affect the value of such item/media, pollution has taken place. The phenomena of pollution occur in our environment every day as a result of our daily endeavours/activities either deliberately or by share coincidence. Pollution also occurs by means of natural events such as bush fires, wind storms, climate change etc. At a micro level we pollute the water we reserved for drinking even at home by pouring some ink or paint or saw dust into the reservoir thereby making it noticeably changed or polluted and unattractive for drinking. At larger level a stream can be polluted by emptying large human excreta into it.

3.2 Definitions ofPollution

Pollution is the introduction of contaminants into the natural environment thatcauses adverse change.

The Wikipedia encyclopaedia define Pollution as ‘’defiling or making impure, especially contamination by noxious substances’’ another definition given is ‘’contamination of the environment as a result of human activities’’.

The free dictionary by Farlex, also defined pollution as ‘’the presence of substances and conditions that adversely affect the health and well-being of people within a community’’.

Pollution is ‘’ the act or process of polluting or the state of being polluted, especially the contamination of soil, water, or the atmosphere by the discharge of harmful substances. (The free dictionary by Farlex).

In all the above shades of definitions the common denominator is that in any act of pollution, something else not being an original component of the item has been introduced to cause a significant departure from its natural acceptable form. Technically speaking therefore, for pollution to have taken place the pollutants (contaminants) must be in such a quantity or volume to cause adverse change (colour, odour, organic content, temperature, taste, etc.) to the environmental item. It also holds therefore that the mere drop of an ink in a dam of water may not necessarily translate to pollution or a presence of 0.001 count of E.coli in a litre of water making it polluted water. Most authorities have set

standards for which pollution would have taken place, especially for water and ambient air regulatory authorities. In Nigeria, there is a national water quality standard and the state water supply authorities also have state water quality standards as test cases for water pollution or acceptable water quality.

3.3 Forms of Pollution

By convention pollution or environmental pollution are described in accordance with the forms they present. The major forms are as follows:

- Air pollution – the release of chemicals and particulates into the atmosphere. Common gaseous pollutants include carbon monoxide, sulphur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides produced by industry and motor vehicles. Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight.
- Light pollution –includes light trespass, over illumination and astronomical interference.
- Littering – the criminal throwing of inappropriate man-made objects, unto public and private properties.
- Noise pollution – which encompass road-way noise, aircraft noise, industrial noise, as well as high-intensive sonar.
- Soil contamination – occurs when chemicals are released by spills or underground leakages. Among the most significant soil contaminants are hydrocarbons, heavy metals, herbicides, pesticides and chlorinated hydrocarbons.
- Radioactive contamination – resulting from 20^{th} century activities in atomic physics, such as nuclear power generation and nuclear weapons research, manufacture and deployment.
- Thermal Pollution is a temperature change in natural water bodies caused by human influence, such as use of water as coolant in a power plant.
- Visual pollution, which can refer to presence of overhead power lines, motor way, billboards, scarred landforms, (as from strip mining), open storage of trash, municipal solid waste or space debris.
- Water pollution – by the discharge of waste water from commercial and industrial waste into surface waters, discharges of untreated domestic sewage, and chemical contaminants, such as chlorine, from treated sewage; release of wastes and contaminants into surface runoffs flowing to surface waters (including urban runoff and agricultural which may contain chemical fertilizers and pesticides) waste disposal and leaching into ground water, eutrophication and littering.

3.4 Indoor Air Pollution

Indoor air pollution is the presence of pollutants in the air in dwelling places. We are exposed to chemicals and particulates in the air we breathe, and the air we breathe is mostly inside the building where we spend almost all of our time.

For example, combustion that takes place inside homes and other buildings through cooking and heating often produces elevated levels of carbon monoxide, nitrogen oxides, hydrocarbon and repairable particulates. According to Masters (2005), cigarette smoke emits carbon monoxide, benzene, acrolein, and other aldehydes, and particulate, as well as about 4000 other chemicals. Some photocopying machines emit ozone. Building materials such as particle board, plywood, emit urea formaldehyde.

Chipped and peeling paint containing lead becomes air-borne toxic dust. A great number of volatile organic compounds are emitted from household cleaning products, paints, carpeting, and a variety of other chemicals we use in our homes.

Many pollutants, such as cigarette smoke and radon gas, if they are emitted outdoor, have plenty of dilution air. So people tend not to be exposed to hazardous levels of contamination. However, these pollutants can be concentrated especially indoor leading to harmful exposure levels. Sources of Indoor air pollutants include the following:

S/N	POLLUTANT	SOURCES
1.	Asbestos and other fibrous aerosols	Friable asbestos, vinyl floor and Cement products.
2.	Carbon monoxide	Kerosene and gas space heaters, gas stoves, wood stoves, fireplaces and smoking.
3.	Formaldehyde	Particle board, panelling, plywood carpets, ceiling tile, urea formaldehyde form insulation, other construction material.
4.	Inhalation particulate matter	Smoking, vacuuming, wood stoves, fireplaces.
5.	Nitrogen dioxide	Kerosene and gas space heaters, gas stoves.
6.	Ozone	Photocopying machines.
7.	Radon and Radon progeny	Diffusion from soil, ground-water, building materials
8.	Insecticides	Aerosol sprays.

9.	Tobacco	Cigarettes.
10.	Bacteria, viruses, pollens	Pets, Plants, Humans.

4.0 CONCLUSION

In conclusion, pollution and its control is a very important aspect of Environmental Health practice. We have been able to properly define pollution and explain it where it occurs and differentiate the various forms of pollution as they happen. Next unit we are going to consider the different types of pollutants and their classification.

5.0 SUMMARY

Inthis unit we defined pollution and appreciated the fact that when we talk about pollution, we mean that something not naturally an aspect of a medium and perhaps with a potential danger to the health of man has come into a media (water, air, soil etc), which, has defiled its quality. There are also different types of pollution such as air, water and soil pollution.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define pollution.
2. List five types of pollution.

7.0 REFERENCES/FURTHER READING

Amadi, A. N. (2011). *ABC of Environmental Health.* Owerri: Readon Publishers Ltd.

FEPA (1991).Guidelines and Standards for Environmental Pollution Control in Nigeria.

Emel, K. (2006). "Heavy Metal Pollution in Water."*Journal of Chemical Education,* 90 (8), 421- 423.

Okereke, C. D. (2006). *Environmental Pollution Control (*1st ed.*).*Barloz Publishers Inc.

UNIT 2 TYPES AND CLASSIFICATION OF POLLUTANTS

CONTENTS

1.0 INTRODUCTION

In the last unit we defined pollution and also explained the various types of pollution. In this unit we are going to describe the types and classification of pollutants in the environmental media which is responsible for pollution.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- describe the types of pollutants
- explain the classifications of pollutants.

3.0 MAIN CONTENT

3.1 Types of Pollutants

A pollutant is a substance or energy introduced into the environment that has undesired effects, or adversely affects the usefulness of a resource. Pollutants can be in the form of solid particles, liquid droplets,

or gases. In addition, they may be natural or man-made. A pollutant may cause long or short-term damage by changing the growth rate of plant or animal species, or by interfering with human amenities, comfort, health, or property values. A pollutant is a waste material that pollutes air, water or soil. Three factors determine the severity of a pollutant: its chemical nature, the concentration and the persistence.

3.1.1 Different Types of Pollutants by Absorptive Capacity

Stock pollutants – Pollutants that the environment has little or no absorptive capacity is called stock pollutants e.g. persistent synthetic chemicals, non-biodegradable plastics, and heavy metals. Stock pollutants accumulate in the environment over time. The damage they cause increases as more pollutant is emitted, and persists as the pollutant accumulates. Stock pollutant can create a burden for future generations by passing on damage that persists well after the benefits received from incurring that damage have been forgotten.

Fund pollutants – are those for which the environments have some absorptive capacity. Fund pollutants do not cause damage to the environment unless the emission rate exceeds the receiving environment's capacity (e.g. carbon dioxide, which is absorbed by plants and oceans). Fundpollutants are not destroyed, but rather converted into less harmful substances, or diluted/dispersed to non-harmful concentrations.

3.1.2 Notable Pollutants

Notable Pollutants include the following groups:

1. Heavy metals
2. Persistent organic pollutants (POP)
3. Environmental persistent pharmaceutical pollutants (EPPP)
4. Polycyclic aromatic hydrocarbons
5. Volatile organic compounds
6. Environmental xenobiotics.

3.2 Classification of Pollutants

Pollutants may be classified by various criteria:

- By the origin: whether they are natural or man-made (synthetic)
- By the effect: regardless of origin: on an organ, specie or ecosystem
- By the properties: mobility, concentration, persistence, toxicity
- By the controllability: ease or difficulty of removal.

Some pollutants are biodegradable and therefore will not persist in the environment in the long term. However, the degradation products of some pollutants are themselves polluting such as the products DDE and DDD produced from degradation of DDT.

Generally pollutants may be classified into primary and secondary pollutants thus:

3.2.1 Primary Pollutants

Primary pollutants are pollutants that are directly emitted from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulphur dioxide released from factories.

Major primary pollutants include:

- Sulphur Oxides (SOx) – especially sulphur dioxide, a chemical compound with the fomula SO_2 is produced by volcanoes and in various industrial processes. Since coal and petroleum often contain sulphur compounds, their combustion generates sulphur dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4,and thus acid rain. This is one of the causes of concern over the environmental impact of the use of these fuels as power sources.
- Nitrogen Oxides (NOx) – especially nitrogen dioxide are emitted from high temperature combustion, and are also produced naturally during thunderstorms by electrical discharge. Can be seen as the brown haze dome above or plume downwind of cities. Nitrogen dioxide is the chemical compound with the formula NO_2. It is one of the several nitrogen oxides. This reddish- brown toxic gas has a characteristic sharp, biting odour. NO_2 is one of the most prominent air pollutants.
- Carbon monoxide (CO) – is colourless, odourless, non-irritating but very poisonous gas. It is a product by incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.
- Carbon dioxide (CO_2) – a colourless, odourless, non-toxic greenhouse gas also associated with ocean acidification, emitted from sources such as combustion, cement production and respiration. It is otherwise recycled in the atmosphere in the carbon cycle.

3.2.2 Secondary Pollutants

These are not emitted directly. Rather, they form in the environment when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone – one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary, that is, they are both emitted directly and formed from other pollutants.

- Secondary pollutants include particulate matter formed from gaseous primary pollutants and compounds in photochemical smog. Smog is a kind of air pollution; the word ‘’Smog’’ is a portmanteau of smoke and fog. Classic smog results from large amounts of coal burning in an area caused by a mixture of smoke and sulphur dioxide. Modern smog does not usually come from coal but from vehicular and industrial emissions that are acted on in the atmosphere by ultraviolet light from the sun to form secondary pollutants that also combine with the primary emissions to form photochemical smog.
- Ground level ozone (O_3) formed from NOx and VOCs. Ozone (O_3) is a key constituent of the troposphere. It is also an important constituent of certain regions of the stratosphere commonly known as the ozone layer.
  Photochemical and chemical reactions involving ozone drive many of the chemical processes that occur in the atmosphere by day and by night. At abnormally high concentrations brought about by human activities (largely the combustion of fossil fuel), it is a pollutant, and a constituent of smog.
- Peroxyacetyl nitrate (PAN) – similarly formed from NOx and VOCs.

3.2.3 Contaminants

These are mostly referred to microorganisms and life forms that affect food stuff, water and at some instances air and soil. They include bacteria, viruses, fungi, and insect larvae.

3.3 Classification of Pollutants on the Basis of State

3.3.1 Chemical Pollutants

Environmental chemicals in the technical sense of the word are broad based and may be classified into four categories:

- Desirable e.g. foodstuff
- Harmless and inert (oxygen and hydrogen)

- Desirable in small quantities toxic in large quantities
- Toxic in any quantity.

In pollution control the most serious of concern is the fourth category (Toxic in any quantity). These can constitute chemical pollutants whether in the food, air, water or soil. Examples are Mercury (organic and inorganic), lead and other metal complexes. However, the third category (Desirable in small quantities toxic in large quantities) is also very important in pollution control especially in determining water quality standards for human drinking. For example Chlorine is desirable in the purification of water for drinking, however when it is present in larger unacceptable quantities, it becomes a toxic pollutant. Other examples include aluminium, bismuth, bromine and copper.

3.3.2 Biological Pollutants

These are essentially microbial lives that access any of our environmental media to constitute pollution. They may be bacteria, viruses, fungi and other life forms. Different types of bacteria can harbour toxins of different types and virulence. Bacteria may pollute the air, water, and soil or food media. Bacteria (clostridium, staphylococcus, or salmonella species) in food are responsible for most outbreak of food borne diseases. Plants are other veritable sources of biological pollutants to the environment. The cotton pod tree found in most part of northern Nigeria breaks the pod especially in the dry season and release tiny fibres into the air which changes the micro-composition of the air and can negatively impact on the respiratory tract of the population living around.

3.3.3 Physical Pollutants

These pollutants are exemplified by energy or radioactivity that introduces to the environment and causing noticeable changes or impacts that are not normal to the environment. Examples of this energy include heat, radiation and noise. The ambient physical temperature of a given environment is known with the range from season to season. However, certain human activities such as industrial engine operations or accidental bush fires or climatic changes can introduce an increase in heat regimes previously unknown, which can be described as heat pollution. Similarly, noise from machines (grinding machines, aircrafts, industrial machines etc.) above normal tolerable levels constitutes pollutants. The same goes with radiant energy from x-ray machines, nuclear plants and some mining sites. All these constitute physical pollutants because they are neither biological agents nor chemical agents but rather physical agents that constitute energy or radiation that affect the environment.

4.0 CONCLUSION

Pollutants are of different types and classifications. It is important to distinguish the different types of pollutants that we are in contact with in order to guide most appropriately the most effective and safe methods of handling them.

5.0 SUMMARY

In summary, pollutants may exist either in solid, liquid or gaseous forms. Depending on the chemical constituent of pollutants some could be persistent in nature in the sense that they are not easily degradable and may remain active for a very long period of time in the environment. Pollutants could also be highly toxic and can exist in natural form or synthetic/man-made pollutants.

In the classification of pollutants, two major classes are identifiable as ‘’Primary’’ and ‘’Secondary’’. However, classification of pollutants can also be made based on certain criteria e.g. – Origin, effect, property and controllability.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the two major classifications of pollutants in the environment.
2. Write notes on the following:

    a. Fund pollutants.
    b. Stock pollutants.

7.0 REFERENCES/FURTHER READING

Masters, G. M. (2005). *Introduction to Environmental Engineering and Science (2nd ed.).* New Delhi: Prentice hall of India.

Oreyomi, M. K. (2005). *Principles and Practice of Environmental Health (2nd ed.).* Lagos: Kinson Press.

Uvarov, E. B., Chapman, D. R & Alan, I. (1971).*A Dictionary of Science (4th ed.).*HarmondsWorth, Middlesex: Penguin.

UNIT 3 ENVIRONMENTAL MEDIA 1 (AIR)

CONTENTS

1.0 INTRODUCTION

Air is a very important component of the natural environment. Indeed it can be described as the most important life support component; hence man can survive for weeks without food and days without water but can hardly survive minutes without air.

As important as air is to man, it is a medium through which pollutants can get to human body and cause ill-health. When pollutants get into the air media in such a state as to call for concern, air pollution has taken place. The study of air as a media of pollution is very important to environmental health.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- describe air media and the different strata of the atmosphere (air)
- define air pollution
- explain different types of air pollution.

3.0 MAIN CONTENT

3.1 Air Media

Air is a colourless, odourless, tasteless, gaseous mixture, mainly Nitrogen (approximately 78%) and oxygen (approximately 21%) with other lesser gases that surround the earth. Air as a medium is a composition of thick envelop of gases surrounding the surface of the

earth. It is also called the atmosphere. There are five layers that make up the atmosphere thus; the troposphere, stratosphere, mesosphere, thermosphere and the exosphere.

The most important layers that are affected by pollution are the troposphere and to a certain extent stratosphere.

The troposphere is the layer nearest the earth crust. It extends from the ground level to about 17km above the sea level (Oreyomi, 2005). It is the densest of all the layers, containing about 75% of the total gaseous mass of the atmosphere. The gases present in the troposphere are oxygen, nitrogen, carbondioxide, noble gases, water vapour, dust particles and some other substances.

The troposphere is the most important layer of the atmosphere because of its paramount biotic activities. It is characterised by the following:

- weather phenomena such as cloud formation
- irregular and violent movements of the air known as turbulences
- temperature decrease with increase in altitude at an average rate of 6.50C per kilometre (Lapse rate). That is, '' the higher you go, the cooler it becomes''
- pressure decrease with increase in altitude.

The tropopause demarcates the troposphere from the stratosphere and prevents the mixing of air between them (Agbi, 2003; Oreyomi, 2005).

The stratosphere is described as the earth's global sunscreen. Within it is the well acknowledged ozone layer known for its protective shield against the sun's ultra-violet radiation where it prevents it from reaching the earth's surface. According to Corson (1990), the stratosphere extends from above the upper limit of the troposphere to about 50km above the earth's surface.

3.2 Air Pollution

Air, in its natural, unfouled composition is a supporter of life and very essential for the survival of all higher forms of life on the planet. Although slight variations may exist, depending on the location, air (as well as other environmental media), through a process of self cleansing maintains a degree of consistency in the constitution of its natural components. However, owing to certain natural processes and events, coupled with human activities, extraneous materials are often released into the atmosphere, thereby altering the natural quality of the air beyond its self-cleansing capacity at a particular time or period. It is this

undesirable change in the characteristics of air that is termed air pollution.

The United Nations Environment Programme (UNEP, 1986) defined air pollution as the presence in the out-door atmosphere of one or more contaminants, such as dust, fumes, gas, mist, odour, smoke or vapour, in quantities or characteristics, and of duration such as to be injurious to human, plant or animal life or to property or which unreasonably interfere with the comfortable enjoyment of life and property.

Another more encompassing definition is offered by Masters (2005) who states that air pollution is the introduction of materials or energy into the air which alter it in composition or condition, directly or indirectly, and inhigh enough concentrations or levels as to harm humans, animals, vegetation or materials.

3.3 Types of Air Pollution

Air pollution is classified in two ways: based on origin and location (Agbi, 2003).

3.3.1 Based on Origin

1. **Natural:** This emanates from natural phenomena such as volcanic eruptions, Landslides, Windstorms, Earthquakes, Forest-fires, Putrefaction of plants and animals.
   Most pollutants entering the atmosphere come from the above sources. However, natural air pollution sources, according to Chiras (1998), do not raise the ambient concentrations of a given pollutant very much, because they are usually widely dispersed or infrequent events. For example, diffuse organic processes such as bacterial decay of organic matter produce insignificant amounts of pollution over large areas.
2. **Man-made or Anthropogenic:** This is caused by human activities. They could be many and varied, stationary (e.g. Industrial and domestic sources) or mobile (e.g. Vehicular sources). Achalu and Achalu (2004) and Oreyomi (2005) identified the following human activities as major sources of air pollution: Transportation, industrial processes, municipal solid waste disposal, incineration, cooking, bush-burning, power generators etc.

3.3.2 Based on Location

This can be out-door or in-door. Out-door pollutants may be primary pollutants released directly in a harmful form. They require no further

modification in order to render them harmful, examples include – particulate matter, Carbon monoxide, sulphur dioxide etc.

They may also be secondary pollutants, by contrast, modified to hazardous forms after they enter the atmosphere or are formed by chemical reactions as components of the air mix and interact. Examples include carbon dioxide which reacts with water vapour in theatmosphere to form carbonic acid.

4.0 CONCLUSION

In this unit we have discussed air as a medium for pollutants and the different types of air pollution. Air pollution in whatever form it presents can be very inimical to human health especially at this era of massive natural resources exploitation, industrialisation and the preponderance of motor vehicles and the release of exhaust of petroleum products used as fuel for energy. Next unit we are going to examine another environmental media of pollution – Water.

5.0 SUMMARY

Air is a medium for pollutants and pollution. It is made up of five important layers thus; troposphere, stratosphere, mesosphere, thermosphere and exosphere. The most important of these layers that affect pollution are the troposphere and the stratosphere. Air pollution is the introduction of materials or energy into the atmosphere which has the potential to cause harm to health and the environment. There are different types of air pollution which can be classified either based on origin or based on location.

6.0 TUTOR-MARKED ASSIGNMENT

1. List the five layers of the atmosphere (Air).
2. Explain the classification of air pollution based on origin.

7.0 REFERENCES/FURTHER READING

Burnett, R.T., Cakmak, S. & Brook, J. R. (1998).“The Effect of the Urban Ambient Air Pollution Mix on Daily Mortality Rates in 11 Canadian Cities.”*Canadian Journal of Public Health*, 89, 152–156.

Buzzelli, M., Jerrett, M., Burnett, R. &Finklestein, N. (2003).“Spatiotemporal Perspectives on Air Pollution and Environmental Justice in Hamilton, Canada, 1985–1996.”*Annals of the Association of American Geographers*, 93, 557–573.

Douwes, J., Gibson, P., Pekkanen, J. & Pearce, N. (2000).“Non-eosinophilic Asthma: Importance and Possible Mechanisms.”*Thorax*, 57 (7), 643–648.

Finkelstein, M. M,,Jerrett, M. & Sears, M. R. (2004). “Traffic Air Pollution and Mortality Rate Advancement Periods.”*American Journal of Epidemiology*, 160, 173–177.

Finkelstein, M. M. et al. (2003). “Relation between Income, Air Pollution and Mortality: A Cohort Study.”*Canadian Medical Association Journal*, 169, 397–402.

Finkelstein, M. M., Jerrett, M. & Sears, M. R. (2005).“Environmental Inequality and Circulatory Disease Mortality Gradients.”*Journal of Epidemiology and Community Health*, 59, 481–487.

Jerrett, M. et al. (2001).“A GIS – Environmental Justice Analysis of Particulate Air Pollution in Hamilton, Canada.”*Environment and Planning A*. 33, 955–973.

Jerrett, M. et al. (2004).“Do Socioeconomic Characteristics Modify the Short Term Association between Air Pollution and Mortality? Evidence from a Zonal Time Series in Hamilton, Canada.”*Journal of Epidemiology and Community Health*, 58 (1), 31–40.

Jerrett, M. et al. (2005).“Particulate Air Pollution, Social Confounders, and Mortality in Small Areas of an Industrial City.”*Social Science Medidicine*, 60, 2845–2863.

Levy, D., Gent, M. & Newhouse, M. T. (1977).“Relationship between Acute Respiratory Illness and Air pollution Levels in an Industrial City.”*American Review of Respiratory Disease*, 116, 167–173.

Nystad, W., Magnus, P. (&) Gulsvik, A. (1998).“Increasing Risk of Asthma Without Other Atopic Diseases in School Children: A Repeated Cross-Sectional Study After 13 Years.”*European Journal of Epidemiology*. 14, 247–252.

Pearson, L., Watchel, H. &Ebi, K. L. (2000).“Distance-weighted Traffic Density in Proximity to a Home is a Risk Factor for Leukemia and Other Childhood Asthma.”*Journal of Air Waste Management Association*, 50,175–180.

Peden, D. B. (2000).“Development of Atopic and Asthma: Candidate Environmental Influences and Important Periods of Exposure.”*Environronmental Health Perspective*, 108, 475–482.

Pengelly, D., Kerigan, A. T., Goldsmith, C.H. & Inman, E.M. (1984).“The Hamilton Study: Distribution of Factors Confounding the Relationship between Air Quality and Respiratory Health.”*Journal of the Air Pollution Control Association*, 34, 1039–1043.

Ronmark, E., Lundback, B., Jonsson, E. &Platts-mills, T. (1999).“Different Pattern of Risk Factors for Atopic and Nonatopic Asthma among Children – Report from the Obstructive Lung Disease in Northern Sweden Study.”*Allergy*, 54, 926–935.

Sahsuvaroglu, T. &Jerrett, M. (2003).“Proceedings of AIRNET Annual Conference/NERAM International Colloquium, November 5–7, 2003, Rome, Italy; 2005; Waterloo, Canada.”*Institute for Risk Research;* 2003.

Sources of Uncertainty in Estimating Morbidity and Mortality Attributable to Air Pollution, pp. 89–112.

Sears, M. R. (1997). “Epidemiology of Childhood Asthma.”*Lancet,* 350, 1015–1020.

Shima, M., Nitta, Y. & Adachi, M. (2003).“Traffic-related Air Pollution and Respiratory Symptoms in Children Living Along Trunk Roads in Chiba Prefecture.”*Japan Journal of Epidemiology*, 13, 108–119.

Singh, J. (Ed). (2005). *Environment and Development: Challenges and Opportunities*. New Delhi: I.K. International.

Statistics Canada.“Population and Dwelling Counts, for Canada, Provinces and Territories, 2006 and 2001 Censuses – 100% Data.”http://www12.statcan.ca/english/census06/data/popdwell/Table.cfm

Wagner, R. H. (1971). *Environment and Man*. New York: W.W. Norton and Company.

WHO (1990).*Recommended Health Based Limits in Occupational Exposure to Selected Mineral Dust (Silica, Coal):* WHO

Technical Report Series. No 734. Geneva: World Health Organisation.

Zmirou, D. et al. (2004). "Traffic Related Air Pollution and Incidence of Childhood Asthma: Results of the Vesta Case-Control Study."*Journal of Epidemiology Community Health*, 58 (1), 18–23.

UNIT 4 ENVIRONMENTAL MEDIA 2 (WATER)

CONTENTS

1.0 INTRODUCTION

Water is another important media of pollution. Pollutants find themselves in water and become sources of danger to human health and the environment. The significance of water in relation to pollution cannot be overemphasised given to its importance in our day to day living. Indeed, man cannot survive without water, however, again polluted water can be very inimical to human health and hence the need for study of the media and the pollution that comes through it.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- describe water media
- define two major sources of water pollution
- explain types of water pollution.

3.0 MAIN CONTENT

3.1 Describing Water Media

Water is in fact the commonest compound on earth and is not only essential for life but has become interwoven with human livelihoods in various inextricable ways. As compound water is made up of two elements- Hydrogen and oxygen (H_2O) Water is found on land, in the oceans and in the atmosphere, and comes in different forms: as a liquid, as a solid (ice and snow) and as a gas. In free form it may be totally pure

or may carry dissolved burdens of minerals, giving rise to the labels fresh, brackish, and salt. It may carry many other substances in solution and in suspension, too. Water is best described as ‘’Universal solvent’’ for its ability to dissolve almost every element. It is driven in a cycle by the energy of sun (Hydrologic cycle of evaporation and transpiration, condensation, precipitation, and runoff, usually reaching the sea) and is present in very large quantities (perhaps 1.39 x 109 km -3 is present on the planet).

Ninety six point six (96.6%) percent of the planets water is found in oceans, 1.7 per cent in ground water, 1.7 per cent in glaciers and the ice caps of Antarctica and Greenland, a small fraction in the other large water bodies, and 0.001per cent in the air as vapour, clouds (formed of solid and liquid water particularly suspended in air) and precipitation.

Only 2.5 per cent of the earth’s water is fresh water, and 98.8 per cent of that water is in ice and ground water. Less than 0.3 per cent of all fresh water is in rivers, lakes, and the atmosphere, and an even smaller amount of the earth’s fresh water (0.003%) is contained within biological bodies and manufactured products.

As explained above, water is driven in hydrologic cycle by the energy of sun. When it falls back as rain it gets in contact with everything along its way to the ground. Similarly it dissolves those things along its way. Those things it comes into contact with could be chemical elements, dust, smoke, soot, etc. depending on the amount it dissolves, water as an environmental media becomes polluted.

3.2 Sources of Water Pollution

According to Nigerian water quality standard (2007) water is polluted by both anthropogenic and natural substances. In some cases the pollution can be severe and detrimental to health, in which case pollutants can cause illness and even death. Other substances may be found in water, which are merely undesirable, because they create bad aesthetic view, taste and odour, stain fabrics and fixtures or ultimately have financial implications depending on the intended use of the water.

There are many specific causes of water pollution, but it is important to first understand two broad categories which are **point** and **non-point** or **diffuse** sources. The point sources of water pollution include wastes generated by human settlement, domestic, commercial and industrial activities including those of petroleum related industry, energy utilisation activities and the precipitation of atmospheric pollutants. The non-point sources of water pollution include run-off from agricultural

lands treaded with fertilizers and pesticides, which cause nutrient enrichment and Eutrophication of surface water.

Water pollutant types may be categorised into:

i. Physical pollutants – include silt, clay, discarded objects, decaying organic matters which generally affect the aesthetic quality of surface waters.
ii. Chemical pollutants- include non-biodegradable, toxic heavy metals such as lead, cadmium and mercury, as well as persistent and hazardous organic pollutants such as pesticides, phenols and polynuclear aromatic hydrocarbons (PAHs).
iii. Biological pollutants – arising from the discharge of effluents from energy and manufacturing industries into surface waters – weeds, micro-organisms, etc.
iv. Radioactive pollutants – include radioactive, substances or effluents carrying such substances, containing radioisotopes such as Radium 226, Strontium 90 and Cesium 137.

3.3 Types of Water Pollution

3.3.1 Precipitation Pollution

Wet precipitation such as rainfall is not exempted from pollution. This is so because the processes leading to the formation of precipitation can be initiated by dust particles from any sources, ranging from salt particles from the field, ash emitted from volcanic eruption, toxic dust particles such as chromium or asbestos, particulates from smokestacks, crystals of salt evaporated from sea spray, or pollens in air, or combustion by-products of coal or fossil fuel. The increasing concentration of greenhouse gases containing carbon dioxide, oxides of nitrogen and sulphur, beyond threshold levels, are responsible for acid rain which adversely affects forestry and agricultural soil fertility.

3.3.2 Surface Water Pollution

Natural sources of surface water pollution in streams, lakes, ponds, etc., include silt and clay, decaying algae (some algae release toxic compounds) dead leaves during leaf fall and other organic matter. The flow of some streams originates from springs which may contain large concentration of salts. Disposal of untreated industrial, municipal and domestic waste into stream, lake and rivers has been the major anthropogenic source of surface water pollution. In addition, effluent from municipal treatment plants, with unknown and unusual chemicals contained in the industrial process because of trade secrets, find their way into water courses. Agricultural activities have been known to

contribute to surface water quality deterioration. Evaporation has also been known to consume much of the water applied during irrigation thus concentrating the salts present into the water and soil. The remaining may either infiltrate, where it becomes more highly mineralised or flow across the surface into streams, lakes and rivers.

3.3.3 Ground Water Pollution

Ground water is generally not pure since dissolution of substances take place in the course of percolation of water through geological formations. In fact, chemical composition of ground water is normally considered on the basis of its intended use such as domestic, industrial, irrigation or other uses. The principal inorganic chemicals in water are the cations magnesium, calcium, sodium and potassium, while important anions are carbonates, bicarbonates, sulphates and chlorides.

4.0 CONCLUSION

Water as a medium for pollution is very important in environmental health practice. Often we have our sources of water polluted through our activities or through some natural events. Water pollution is a phenomenon that can be responsible for illnesses in man and cause a lot of damage to the ecosystem. The prevention and control of water pollution has become so important that governments all over the world are laying emphasis on it and making necessary policies in that connection.

5.0 SUMMARY

You must have learnt how water as a medium of pollutants can cause water pollution. Water pollutants are of different categories such as chemical pollutants, biological pollutants, radiological pollutants etc. Water pollution again is of different types and sources. For example precipitation, surface and ground water pollution and anthropogenic and natural sources respectively. In the next unit we are going to consider another important media of pollution; which is soil.

6.0 TUTOR-MARKED ASSIGNMENT

1. List five (5) anthropogenic sources of water pollution.
2. Explain the term ‘’biological pollutants’’.

7.0 REFERENCES/FURTHER READING

Egborge, A. B. M. (1998). Solutions to Water Problems in the Niger Delta, First UrhoboEconomic Summit on Oil Gas and Sustainable Development.

Andrew, D., Arnold, E. &Leonore, S. (2001). Standard Methods for the Examination of Water and Waste Water, (20th ed.).*American Public Health Association*,pp 235-237

World Health Organisation (2007).Water Borne Diseases.

World Health organisation (2003).Hardness in Drinking Water.

UNIT 5 ENVIRONMENTAL MEDIA 3 (SOIL)

CONTENTS

1.0 INTRODUCTION

Soil represents the sojourn of man. It is the place where we live and carry out our lives activities. The food we eat are nurtured by the soil, we build our houses on the soil etc. The activities we carry out on the soil turn out to generate some by-products which often are described as wastes. Most of these wastes, depending on their nature and characteristics end up deposited on the soil. Therefore the soil turns to become a medium for these wastes which are also described as pollutants. The pollution of soil has a far reaching implication on public health and the environment. In this unit you are going to learn about the characteristics of the soil as a medium and how it becomes polluted.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- describe soil media
- explain some properties of soil
- discuss soil pollution and its sources.

3.0 MAIN CONTENT

3.1 Soil Media

Soil media, also called ‘’Land’’ occupies about 28 per cent of the surface of the earth after water which occupies 72 per cent. The history of soil dates back to billions of years ago perhaps, since the creation of the universe. It is the comfort station of man as it provides him with the necessary basement to undertake his basic functions of life. The soil is the platform which man builds his house, cites his industries, builds his roads and above all cultivates his crop for food and survival. Therefore the importance of soil to human life cannot be over emphasised.

Soil is a natural body that consists of layers (soil horizon) composed primarily of minerals, which differ from their parent materials in their texture, structure, consistency, colour, chemical, biological and other physical characteristics. The result soil is the end product of the influence of the climate (temperature, precipitation), relief (slope), organisms (flora and fauna), parent materials (original minerals), temperature and time. Of all the factors that influence the evolution of soil, water is the most powerful due to its effect on the solution and precipitation on minerals, plant growth, the leaching of minerals from the soil profile, and the transportation and deposition of the materials of which the soil is composed.

3.1.1 Chemical and Colloidal Properties

The chemistry of soil determines the availability of nutrients, thehealth of microbial populations and its physical properties. In addition, soil chemistry also determines its corrosivity, stability and ability to absorb pollutants and to filter water. It is the surface chemistry of clays and humus colloids that determines soil chemical properties. The very high specific surface area of colloids gives soil its great ability to hold and release cations in what is referred to as cation exchange. Cation exchange capacity is the amount of exchangeable cations per unit weight of dry soil and is expressed in terms of milliquivalents of hydrogen ion per 100 grams of soil. A colloid is a small insoluble, nondifusable particle larger than a molecule but small enough to remain suspended in a fluid medium without settling. Most soil contains organic colloid particles as well as the inorganic colloidal particles of clays.Soil is made up of varieties of mineral resources ranging from silica, metals, nitrates and coal to gases like carbon, oxygen, hydrogen, etc.

As far as pollution is concerned, many things can be introduced into the soil to make it foul for judicious use or having negative impact on environmental health. Some important soil media subject to pollution

include; farmlands, urban environment, the rural areas, estates, schools, markets, homes etc. Heavy metals on soil from industrial wastes dumps, domestic or commercial use of batteries can be a source of soil pollution.

3.1.2 Physical Properties of Soil

The physical properties of soil, in order of decreasing importance, are texture, structure, density, porosity, consistency, temperature, colour, and resistivity. These determine the availability of oxygen in the soil and ability of water to infiltrate and be held in the soil.

3.1.3 Soil Atmosphere

The atmosphere of soil is radically different from the atmosphere above. The consumption of oxygen by microbes and plant roots decrease oxygen concentration while their release of carbon dioxide increases carbon dioxide concentration. Atmospheric carbon dioxide concentration is 0.03 per cent, but in the soil pore space it may range from 10 to 100 times that level. In addition the soil voids are saturated with water vapour. Adequate porosity is necessary not just to allow the penetration of water but also to allow gases to diffuse in and out. Movement of gases is by diffusion from high concentration to low concentration. Oxygen diffuses in and is consumed and excess levels of carbon dioxide, which can become toxic, diffuse out with other gases as well as water.

3.2 Soil Pollution

Soil pollution results from the build-up of contaminants, toxic compounds, radioactive materials, salts, chemicals and cancer causing agents. The most common soil pollutants are hydrocarbons, heavy metals (cadmium, lead, chromium, copper, zinc, mercury and arsenic) herbicides, pesticides, oils, tars, PCBs and dioxins.

Until 1970s, there was little talk of soil pollution and its devastating effects. In the 1980s, the US superfund was created to set guidelines for the handling of hazardous materials and soil contamination cleanup.In the US alone there are more than 200,000 sites awaiting cleanup, which is very expensive and labour-intensive work. Even a small cleanup project can cost $10,000,while larger areas require millions of dollars to clean it up for future use.

3.2.1 Causes of Soil Pollution

Following world-war 2 and Vietnam, scientists discover high incidences of mutation, miscarriage, mental defects, cancer and sickness in areas where nuclear warheads had been dropped. Food shortage also alerted officials that something was seriously wrong with the local soil. DDT and dioxin were two of the worst pollutants from war aftermath. In some cases, agricultural processes cause soil pollution. High level of radionuclide like nitrogen and phosphorus can be found surrounding farm centres containing high pollution densities of livestock. Pesticides applied to plants can also seep into the ground, leaving lasting effects. Heavy metals can arrive in the soil by using polluted water to wet crop and by using mineral fertilizers.

Industry is to be blamed for some of the biggest soil-pollution disasters. Heavy metals come from iron, steel, power and chemical manufacturing plants that recklessly use the earth as a dumping ground for their refuse. Plants that burn their waste on one-site are guilty of releasing heavy metals into the atmosphere, which come to settle in the soil,thus leaving behind lasting effects for years to come. Even companies that try to dispose of their waste properly contribute to the problem when faulty landfills and bursting underground bins leach undesirable toxins into the soil. Mining leaves a tremendous impact on the surrounding communities. Studies show that people living near mines have a 70 per cent higher risk of kidney disease, 64 per cent higher risk for chronic obstructive pulmonary disease and a 30 per cent higher risk of high blood pressure.

Before purchasing land for development or inhabiting, it is important to have a soil test performance to ensure a sound investment. A soil test can reveal the presence of nitrogen, phosphorus, potassium, sulphur, calcium, magnesium, iron, manganese, copper, zinc, boron, molybdenum and aluminium. It can also analyse soil acidity, electrical conductivity, organic matter, moisture content and identify dangerous soil contaminants like benzene, petroleum hydrocarbons, xylene and toluene. Even if the soil is in fine condition for planting, land owners can use their soil test to make more informed decision regarding fertilizer, and crop growing.

3.2.2 Case Studies of Soil Pollution

In the snowy winter of 1976, chemical waste began to seep above ground in school playground and communities in Niagara Falls New York. The area suffered high incidences of still born births, miscarriages and birth defects. Officials soon realised that there were over 400 toxic substances in the air, water and soil many of them cancerous. As it turns

out, the area has been used as a chemical dumping ground for more than 22,000 tons of toxic waste at the turn of the century, when no one was aware of the hazardous impact it could have decades later.Another one of the most infamous cases of soil pollution happened in Chernobyl, a small town in Russia. A nuclear power plant exploded in April of 1986, which caused a seven fold increase in birth defects, a marked increase in cancer that was passed down to future generations, livestock death and mutation and tainted agriculture. It is estimated that 40 per centof Chernobyl is still uninhabitable due to radiation contamination that is ten times the normal level in some places. Ethiopiais both filled with both air and soil pollution. The worst area is in Somalia'sAyaha valley near Hargeysa. To boost their economy, many farmers began using chemical fertilizers and pesticides to increase productivity without understanding the full ramifications. Over their war torn years, metal drums holding 14,200 litres of chemicals like fenitrothion, malathion, diazionon and Durban were punctured. As a result, land pollution has caused widespread famine and sickness. China is a nation that is developing rapidly, perhaps faster than safety permits. ''It is estimated that nationwide 12 million tons of grain are polluted each year by heavy metals that have found their way into soil''. According to incomplete statistics, about 10 million hectares of arable land in china has been polluted.

3.2.3 Impact of Soil Pollution

People living near polluted land have higher incidences of migraine, nausea, fatigue, miscarriage and skin disorders. Long term effects of pollution include cancer, leukaemia, reproductive disorders, kidney and liver damage as well as central nervous system failure. Children often suffer from developmental problems and weakened immune systems.

Chemicals can sometimes absorb into food like lettuce and spinach and be ingested. Other times the pollutants simply kill the plant, which has created widespread crop destruction and famine in other parts of the world. The entire ecosystem changes when materials are added to the soil, as microorganism die off or move away from contaminants.

Predators who feed off the microorganismsand worms in the polluted soil will also be affected. Researchers found that some species of birds like the peregrine falcon, the brown pelican and the bald eagle prey to DDT poisoning, which caused egg shells of future generation to thin. Mother birds would arrive home to omelettes in their nets, as the thin shells could not support the weight of the incubating offspring. Mortalityrates increased, nearly sending the birds to extinction.

If nothing is done to clean up soil pollution, water supplies could become contaminated, threatening the human species. Sudden fires and building structures may corrode and once beautiful regions will turns into cesspools, experts warn.

3.2.4 Prevention of Soil Pollution

Naturally, prevention is the best cure for soil pollution. States can enact tough legislations to stop illegal dumping of wastes. Education and awareness related to actions that promote prevention of soil pollution of any magnitude is imperative. Mining control legislations are also important in the prevention and control strategies.

4.0 CONCLUSION

Soil also called land is an important medium in the environment which is subject to pollution. Varied types of pollutants ranging from hydrocarbons, heavy metals, to herbicides, pesticides etc. can lead to the pollution of soil and subsequent unpleasant impacts. Soil is made up of different properties, chemical, colloidal properties. In the next unit we shall consider another media in the environment.

5.0 SUMMARY

In our discussion on soil media, we've been able to establish the fact of soil as a medium for pollutants and soil pollution. Soil as a medium is made up of properties which describe its value. Soil pollution occurs through so many events which may be either human or natural. Examples of such human events include war and industrial activities. The example of natural event is volcanic eruption.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the concept of soil pollution.
2. Describe two sources of soil pollution.

7.0 REFERENCES/FURTHER READING

Okereke, C.D. (2006).*Environmental Pollution Control,*Barloz publishers.

Wikipedia: Electronic Waste, (2010).http://en.wikipedia.org/wiki/ main

Wisegeek: What is Integrated Waste Management/ (2010) http>//www.wisegeek.co,/

Helmlich, J.&Hughesk, C. (2010).Integrated Solid Waste Management: *The Ohio University Fact Sheet.*

UNIT 6 ENVIRONMENTAL MEDIA 4 (FOOD)

CONTENTS

1.0 INTRODUCTION

Food is very important to our lives. It provides the necessary nutrients we require to keep life moving on. The foods we eat are produced from the environment and are therefore subject to environmental pollution. There are varying types of pollutants and sources of pollution that affect our food. In this unit we will consider how food is a medium for pollutants and the various sources and means it can be polluted.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain food as a medium for pollutants
- state the different types of pollutants/contaminants that can affect food
- list the various sources of food contamination
- describe the mechanism of nutrient uptake by plants.

3.0 MAIN CONTENT

3.1 Food Media

Food is anything we eat to provide us the necessary ingredients the body require to keep alive. Food includes all sources of protein, vitamins, carbohydrates, essential minerals and trace elements. They come in different food types like yam, corn, cereals, vegetables etc. Food is available for consumption either in their natural form or after being

processed (cooked, heated, fried, chilled, roasted etc.) depending on the nature of the food.

Food is an important medium of pollutants and contaminants. The modern concept of food contamination/pollution include consideration of the production process e.g. the agrochemicals applied (fertilizers, pesticides, herbicides etc.), the site of cultivation, including the soil content and proximity of the farmland to sites of pollution. These are essentially due to concerns of crop uptake of heavy metals in soil and other pollutants that can be picked and going through the food chain to harm consumers. During food preparation important considerations include the surfaces which the food comes into contact with and the ingredients added to the food and other likely sources of pollution. Unsafe food causes many acute and life- long diseases ranging from diarrhoeal diseases to various forms of cancer.

3.2 The Mechanism of Nutrient Uptake

All the nutrients with the exception of carbon are taken up by the plant through its roots. All those taken through the roots, with the exception of hydrogen which is derived from water, are taken up in the form of ions. Carbon, in the form of carbon dioxide, enters primarily through the stomata of the leaves and where the plant releases oxygen as a by product of photosynthesis. All the hydrogen utilised by the plant originates from soil water and results in the release of further oxygen. Plants may have their nutrient needs supplemented by spraying a water solution of nutrients on their leaves, but nutrients are typically received through the roots by:

1. mass flow
2. diffusion
3. root interception.

The nutrient needs of a plant may be carried to the plant by the movement of the soil solution of water in what is called mass flow. The absorption of nutrients by the roots from the water, with which it is in contact, causes the concentration of nutrients in that area to be depleted. Nutrients then diffuse from area with higher concentration to lower concentration thereby bringing more nutrients to the roots of the plants. Plants also send out roots constantly to seek new sources of nutrients in a process called root interception. Meanwhile, older less effective roots die back. Water is lifted to the leaves where it is lost by transpiration and in the process, it brings with it soil nutrients.

3.3 Food Contamination/Pollution

Persistent Organic Pollutants (POPs), heavy metals, dioxins etc., can find themselves (pollution) in the food of man through crop uptake. This all depends on the aggregate of inputs and the environment which food is produced.

Bacteria and illness can spread from the transporting of foods. New microbe strains of foodrelated illnesses are evolving and becoming anti-biotic resistant.

3.3.1 Source or Points of Food Contamination

Slaughter: When healthy animals are slaughtered for food, there are bacterial microbes in their intestinal track. During the processing of these animals, the carcass can become contaminated by small amounts of these microbes.

Watering: Fruits and vegetables can become contaminated by unclean water during irrigation. The water can contain raw human sewage or animal manure.

Handling: People who handle fruits and vegetables can spread infection, if they are sick themselves. They can easily spread food related diseases by just touching the food.

Utensils: Using the same utensil in the kitchen can spread food related illness. If you use a knife to cut meat and then cut fruits and vegetables, it can contaminate the food.

Warm conditions: Leaving food out for a long period of time can cause contamination. Bacteria multiply in these conditions. Foods should always be refrigerated after a meal.

Raw foods: Heat kills most bacteria related to food contamination. Even fruits and vegetables are less likely to cause illness if they are cooked thoroughly.

4.0 CONCLUSION

Food contamination is a very important subject in environmental health control practices, especially at this era where most part of our days are spent outside homes and the necessity for us to rely on foods prepared for public sale. Environmental health officers have the professional responsibility to protect food meant for public consumption and ensuring their safety.

5.0 SUMMARY

You have learnt in this unit the importance of having the knowledge food as medium for pollution and the various sources of such pollution. Food can also be contaminated by means of nutrient uptake from the soil. That underscores the importance of what we input (quality and quantity) during the production of the food crop, e.g. pesticides, fertilizers, etc. In the next unit we will delve into other issues that are of interest to pollution.

6.0 TUTOR-MARKED ASSIGNMENT

1. Write notes on the following:

    a) Mass flow
    b) Diffusion
    c) Root interception.

2. Explain three sources of food contamination.
3. List five pollutants that can affect food.

7.0 REFERENCES/ FURTHER READING

Amadi, A. N. (2007). Influence of Sanitation on the Dynamics of Amoebiasis in an Urban Environment in Abia State, Nigeria.*Journal of Environmental Health,* 4 (1).

Ukoli, F. M. A. (1991). *Prevention and Control of Parasitic Diseases in Tropical Africa*. London: University press Plc.

WHO (1997). Poor Sanitation: The Global Magnitude of the Problem. *Environmental Health Newsletter*, (27), 1.

MODULE 2

Unit 1 Anthropogenic Sources of Pollution
Unit 2 Natural Sources of Pollution
Unit 3 Noise Pollution in Nigeria

UNIT 1 ANTHROPOGENIC SOURCES OF POLLUTION

CONTENTS

1.0 INTRODUCTION

Human activities are largely incriminated for environmental pollution everywhere in the world. These activities range from agriculture, mining, industries to construction and poor state of waste management. In this unit we shall be looking at the various human activities and how these activities contribute to sources of environmental pollution.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- identify the various human activities that contribute to pollution
- differentiate between point and diffused sources of pollution
- state the major pollutants involved.

3.0 MAIN CONTENT

3.1 Air Pollution

Air Pollution is addition of harmful substances to the atmosphere resulting in damage to the environment, human health, and quality of life. One of many forms of pollution, air pollution occurs inside homes, schools, and offices; in cities; across continents; and even globally. Air pollution makes people sick—it causes breathing problems and promotes cancer—and it harms plants, animals, and the ecosystems in which they live. Some air pollutants return to Earth in the form of acid rain and snow, which corrode statues and buildings, damage crops and forests, and make lakes and streams unsuitable for fish and other plant and animal life.

3.1.1 Stationary/Point Sources

‘’Stationary/Point Sources’’ include smoke stacks of power plants, manufacturing facilities (factories), cement, fertilizers, metal smelting, paper (pulp), textiles, flour milling, quarrying, oil refineries, road construction,etc. and waste incinerators, as well as furnaces and other types of fuel-burning heating devices. In developing and poor countries, traditional biomass burning is the major source of air pollutants; traditional biomass includes wood, crop waste and dung.

3.1.2 Diffuse/Mobile Sources

“Diffuse/Mobile Sources’’ include motor vehicles, marine vessels, aircraft and the effect of sound etc. Others include:

- Chemicals, dust and controlled burn practices in agriculture and forestry management. Controlled or prescribed burning is a technique sometimes used in forest management, farming, prairie restoration or greenhouse gas abatement. Fire is a natural part of both forest and grassland ecology and controlled fire can be a tool for foresters. Controlled burning stimulates the germination of some desirable forest trees, thus renewing the forest.
- Fumes from paint, hair spray, varnish, aerosol sprays and other solvents.
- Waste deposition in landfills, which generate methane. Methane is not toxic; however, it is highly flammable and may form explosive mixtures with air. Methane is also an as phyxiant and may displace oxygen in an enclosed space. Asphyxia or suffocation may result if the oxygen concentration is reduced to below 19.5 per cent by displacement.

- Military, such as nuclear weapons, toxic gases, germ warfare and rocketry.

3.2 Water Pollution

Agriculture and the incidence of use of agrochemicals are largely responsible for water pollution in both the developing and the developed world. Herbicides for example are used to kill weeds. They are derived from trinitrophenol (2:4 D and 2:4:5 T) and contain the impurity dioxin, which is very toxic and causes fatality even in low concentrations. A millionth of a gram can kill many humans. It also causes spontaneous abortions, haemorrhaging and cancer. Agent Orange (50% 2:4:5 T) was used as a defoliant in Vietnam. Eleven million gallons were used and children born since then to American soldiers, who served in this conflict, have shown increased physical and mental disabilities. It affects the head of the sperm and the chromosomes inside it. When you compare the DNA of a plant with the DNA of a human, you will immediately see why Herbicides kill humans so easily.

Rainfalls over agricultural land wash pesticides and residue of fertilizers into water bodies and pollute them.

3.3 Land/Soil Pollution

Land Pollution is the degradation of earth's land surfaces. Human activities are the main factor and their misuse of land resources. Haphazard disposal of urban and industrial wastes, exploitation of minerals, and improper use of soil by inadequate agricultural practices are a few factors. Urbanisation and industrialisation are major causes of land pollution.

The Table 1.1 gives examples of sources of pollution and the potential pollutant discharge which could arise as a result of human activities:

Table 1.1: Sources of Pollution and the Potential Pollutants

Example of Sources of Pollution	Point Source or Diffuse	Potential Pollutant
Effluent discharges from sewage treatment works	Point source	Nitrogen (N) and phosphorus (P), POPs, pathogens, litter, oxygen depleting substances, suspended solids and settled solids.
Industrial effluent	Point source	N, Oxygen depleting

discharges treatment		substances, and a broad spectrum of chemicals, suspended solids etc.
Industrial Processes	Point source	Broad spectrum of chemicals released to air and water.
Oil storage facilities	Point source	Hydrocarbons.
Urban storm Water Discharges	Point source – arising from storm water runoff (from paved areas and roofs in towns and cities) entering the sewer network.	N, P, Oxygen depleting substances, pathogens, suspended solids, and settled solids.
Pesticide Use	Diffuse	Broad Spectrum of Chemicals.
Fish Farming	Point Source	N, P, Oxygen depleting substances, suspended solids, and settled solids.
Landfill Sites	Point Source	N, Ammonia, Oxygen depleting substances, Broad spectrum of chemicals.
Organic waste recycling to Land	Diffuse	N, P, Pathogens.
Agricultural Fertilizers	Diffuse	N, P.
Soil Cultivation	Diffuse	Soil, N, P.
Power Generation Facilities	Diffuse	N, Sulphur, Mercury, POPs, Temperature (thermal) pollution.
Farm Wastes and Silage	Point/Diffuse	N, P, Oxygen depleting substances, Pathogens, suspended and settled solids.
Contaminated Land	Point/Diffuse	Hydrocarbons, organic chemicals, heavy metals, Oxygen depleting substances.
Mining	Point/Diffuse	Heavy metals, Acid mine drainages, suspended and settled solids.
Leaking Pipelines	Point/Diffuse	Oil, Sewage,

		Hydrocarbons.
Domestic Plumbing Misconnections	Point source – Connection of domestic appliances and toilets to rain water drains	P, Oxygen depleting substances, Pathogens, suspended andsettled solids, N.

Source: Patrick, P.K. (1980).Glossary on Solid Wastes, WHO Regional Office for Europe, Copenhagen.

4.0 CONCLUSION

Human activities are the largest sources of pollution in the world. Since the industrial revolution in Europe in the early parts of the 20th century, environmental media (soil, air and water) have never been the same. Production activities, mining, transportation, agriculture etc have been responsible for the defilement of water, soil and our natural air. Most of the sources of pollution are either point or diffused involving pollutants like Phosphorus, ammonia, Hydrocarbons, Oxygen depleting substances, oil, heavy metals Suspended and settled solids,etc.

5.0 SUMMARY

In this unit you have seen how human activities have been responsible for various forms of pollution and the pollutants that are incriminated. In the next unit we shall be looking at the natural sources of pollution in our environment.

6.0 TUTOR-MARKED ASSIGNMENT

1. List five human activities that contribute to environmental pollution.
2. Explain five potential pollutants to air media.

7.0 REFERENCES/FURTHER READING

Bassett, H. W. & Davies, F. G. (1981).*Clay's Handbook of Environmental Health (15th ed.).* London: H. K. Lewis and Co. Ltd. pp. 513-535.

Patrick, P. K. (1980). Glossary on Solid Wastes, WHO Regional Office for Europe, Copenhagen.

UNIT 2 NATURAL SOURCES OF POLLUTION

CONTENTS

1.0 INTRODUCTION

The problems facing the environment are vast and diverse. Human activities range from agriculture, mining, industries to construction and poor state of waste management. All these activities affect the atmosphere, and cause destruction of the world's rain forests that many scientists believe will reach critical proportions in the coming decades. All of these problems will be directly affected by the size of the human population.In this unit we shall be looking at the sources of environmental pollution such as air pollution and water pollution.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- list the various sources of pollution
- differentiate between air and water pollution
- describe Trophic States.

3.0 MAIN CONTENT

3.1 Natural Sources of Pollution

The natural sources of pollution are water and air. Pollution may reach natural waters at spots we can easily identify, known as point sources, such as waste pipes or mine shafts. Nonpoint sources are more difficult to recognise. Pollutants from these sources may appear a little at a time from large areas, carried along by rainfall or snowmelt. For instance, the small oil leaks from automobiles that produce discolored spots on the asphalt of parking lots become nonpoint sources of water pollution when rain carries the oil into local waters.

Most agricultural pollution is nonpoint since it typically originates from many fields

3.1.1 Air Pollution

Air pollution is among the biggest threats to our environment. Harmful pollutants can come from human industry in the form of smog or acid rain, but air pollution also occurs as a result of natural processes that introduce foreign matter into the air. Wind erosion, volcanic eruptions and plant decay are the three major natural causes of air pollution.

Wind Erosion

Wind erosion affects crop productivity, water quality and air quality. According to the US department of Agriculture, wind erosion acts by picking up loose particles of dirt and soil, mostly where plants are too sparse to hold the soil together. The stray particles of dirt can fall into water, and we can inadvertently breathe them. In the 1930, during the great depression,the Midwestern United States suffered drought and windstorms that created wind erosion. This gave the area the nickname ‘’the dust bowl’’.

Volcanic Eruption

In addition to Lava, Volcanic eruptions send thousands of tons of ash, soot, sulphur dioxide, carbon dioxide, carbon monoxide and other gases into the atmosphere. According to the US geological survey, sulphur dioxide combines with water vapour in the air to produce sulphuric acid, or acid rain. Carbon dioxide from volcanic eruptions poses a threat to areas located in a depression. Carbon dioxide is naturally heavier than the surrounding air. So it sinks and collects in depressions.

Decomposition

The decomposition of organic matter, like plants and animals, is the largest and most constant natural cause of air pollution.According to the Wisconsin Department of Health, breakdown of organic matter produces methane. It is especially common in areas of high moisture that allow saprophytic bacteria – bacteria that feed on decaying organic matter – to thrive. As the bacteria and fungi feed, the hydrogen-carbon bonds break down, allowing carbondioxide (CO_2) and methane (CH_4) to be released into the air.

Radioactive Material

The earth's crust contains Uranium, a radioactive element. Uranium decays into radium, which in turn decays into radon. Radon is a gas that forms in trace amounts in the bedrock and topsoil of the earth's crust. Ground water and evaporation release this radon into the atmosphere.

3.1.2 Water Pollution

Eutrophication

Eutrophication is, in the simplest terms, too much of a good thing. It occurs when too many nutrients are deposited into a body of water, throwing off the established balance of production and consumption of organic matter. Eutrophication can take place in ponds, lakes, rivers, and oceans. At first, the overload of nutrients in the body of water encourages plant growth. However, soon this excess of organic material uses up most of the available oxygen in the water, taking it away from the other plants and animals. These other organisms can no longer survive with such depleted oxygen levels and die off; creating what is referred to sometimes as a "dead zone", devoid of life. Table 2.1 shows the different trophic states, or levels of organic matter in relation to available oxygen, that a body of water traverses on its way to becoming a "dead zone".

Table 2.1: Shows the Different Trophic States

TROPHIC STATES	
Oligotrophic	Clear waters with little organic matter or sediment and minimum biological activity.
Mesotrophic	Waters with more nutrients, and therefore, more biological productivity.
Eutrophic	Waters extremely rich in nutrients, with high biological productivity. Some species may be choked out.
Hypereutrophic	Murky, highly productive waters, closest to the wetland status. Many clearwater species cannot survive.
Dystrophic	Low in nutrients highly coloured with dissolved humic organic material. (Not necessarily a part of the natural trophic progression).

What causes Eutrophication?

Eutrophication of bodies of water is a naturally occurring phenomenon. However, the process has been aggravated by the human population. Such man-made eutrophication is caused by excessive discharge of nutrients, especially phosphorous (P) in the form PO_4, nitrogen (N) in the form NO_3, and silicate. Pictured is a diagram of how nutrients, such as phosphorous, in runoff lead to plant and animal die offs. In this diagram, phosphorous in the surface runoff fertilizes small floating aquatic plants. As these aquatic plants proliferate, sunlight penetration is reduced. Submerged aquatic vegetation can no longer survive, and as they die and decompose, oxygen levels in the water are also depleted. Eventually, animals die too, due to lack of oxygen. Some probable causes of this excessive nutrient runoff include sewage treatment plant leakage, septic tank leakage, urban runoff, agricultural runoff, channel dredging, and loss of wetlands.

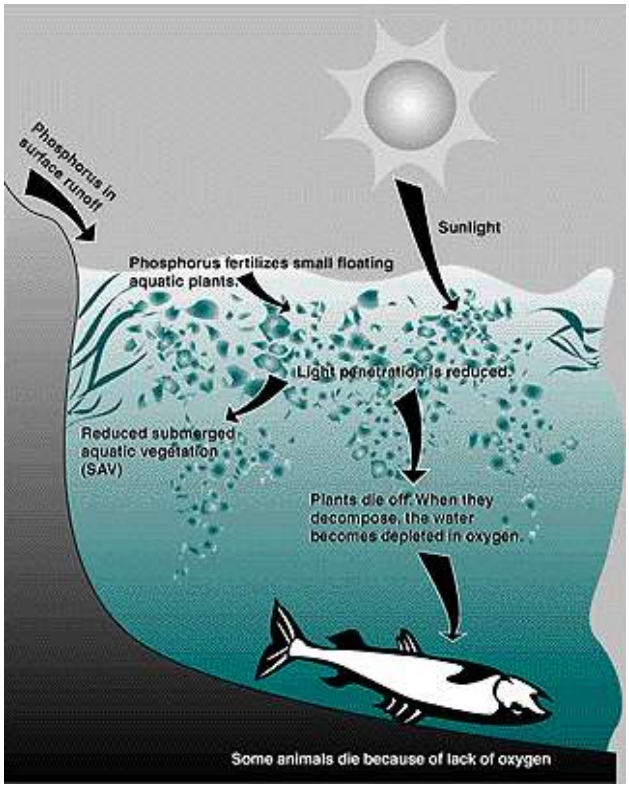


Fig. 2.1: C**auses of Eutrophication.**

4.0 CONCLUSION

As much as pollution is largely incriminated to human activities, there is obviously the important contribution made by natural events as exemplified in the last sections. Natural events that contribute to pollution are events that can hardly be controlled by man. However,

man has the natural ability to mitigate its effects. In the subsequent units, you will come to learn about those important strategies in the mitigation of pollution.

5.0 SUMMARY

You have learnt the various sources of natural pollutionof both water and air. These sources include eutrophication, wind erosion, decomposition and volcanic eruption. Eutrophication in particular involves five important stages, i.e., oligotrophic, mesotrophic, eutrophic, hypereutrophic and dystrophic.

6.0 TUTOR-MARKED ASSIGNMENT

4.0 Explain how decomposition contributes to air pollution.
4.0 List in order, the important stages of eutrophication (trophic states).
4.0 Distinguish between natural and anthropogenic sources of pollution.

7.0 REFERENCES/FURTHER READING

Asogwa, S. E. (1992). *A Guide to Occupational Health Practice in Developing Countries.* Enugu: Fourth Dimension publication.

Kibourne, E.M.&Weiner, J. (1990). Occupational and Environmental Medicine: The Internist's Role.

UNIT 3 NOISE POLLUTION IN NIGERIA

CONTENTS

1.0 INTRODUCTION

In Nigeria and most developing countries, noise pollution is on the increase because of industrialisation, increasing traffic, population and urbanisation. Many city centres of urban areas are characterised with excessive noise above tolerable threshold levels. Most of these noises emanate from products promotions, motor vehicles, sales of electronics, and the use of electric power generators due incessant power failure from public supplies. Unknown to many, this noise could have a negative health impact on the population exposed to it. In this unit we will examine noise as a factor of pollution and the effects it has on human health.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state the threshold of noise in safety concerns
- describe the health effects of noise pollution
- explain the control strategies of noise pollution in Nigeria
- enumerate the various sources of noise pollution in Nigeria.

3.0 MAIN CONTENT

3.1 Concept of Noise Pollution

Sound is a form of energy and a sensory perception evoked by a physiological process in the auditory brain, which may be noise, music or speech, etc. noise may therefore, be defined as an unwanted/disturbing sound or the wrong sound in the wrong place at the wrong timea barking dog, loud music, passing traffic, a power plant or generator (EPA/QPW, 2005; WHO F.S., 2001; D.C). It is a non-harmonious or discordant sound wave often harsh, discomforting and unpleasant to the ear (Okereke, 2006).

Noise impacts directly on the environment, causing annoyance or illness, but can be reduced/controlled by appropriate engine, and silencers (Quantify, 2007).

A quiet environment is a restful place that promotes relaxation, good health and happiness and a happier and healthier community. Noise on the other hand, is a disturbance (pollution) to the human environment by disrupting normal domestic activity like reading or watching television. It can disturb work, concentration, relaxation and sleep, amongst other things, and causes stress, which impacts adversely on human health (EPA/VIC, 2006).

The many consequences of elevated sound levels (e.g. Population annoyance, interference with communication and impaired task performance, besides stress, induce health illnesses) constitute one of the most widespread public health threats to human populationin both industrialised and developing countries (wikipedea, 2007; schomer, 2001).

Noise pollution is on the increase in all areas, especially in the urban areas; this is because of increase of population, urbanisation and traffic levels (road, air, and rail). Besides, residential areas are encroaching into noisy industrial areas, exposing more population to hazardous noise levels. (EPA-NSW, 1997).

According to WHO, governments have a responsibility for the health of their people, which can be fulfilled only by the provision of adequate health and social measures in the form of legislation to control noise generation/abatement. It is therefore, an offence to cause an unreasonable noise from any residential premises and to use some equipment in construction work during prohibited times.

3.2 Sources of Noise

Noise has been categorised into two groups: noise associated with machinery, equipment and general workplace is referred to as occupational or industrial noise. However, the majority of the population is exposed to or tormented by noise from diverse sources outside the industrial workplace, either indoors or outdoors, which is all together, called community, environmental, residential or domestic noise. This by way of definition is noise emitted from all sources, except the industrial workplace (Anne Nadakavukaren, 1995; Ruidos Org/WHO, 1991).

Residential noise is any noise from a house, apartment or flat, commonly neighbours stereos, radios and air conditioners. An unreasonable noise exists when the said item can be heard in a habitable room of a neighbouring house during a prohibited time, whether or not the windows and doors are open, if it goes on for a protracted time. (EPA VIC, 2006).

Outdoor sources of noise include road (motor vehicle noise, horn abuse by drivers, exhaust and tire friction) rail and air traffic, industries, construction and public works, entertainment (Loud music from hotel club, discos and concerts), alarms and sirens, and the neighbourhood. Other sources of noise include shops, rubbish collection, public address systems. It also include pets and leisure activities like shooting, tennis playing, church bell ringing and other religious activities and fireworks (Okereke, 2006). In our case, one will not fail to add the noise from the ubiquitous power generating set as each household in the towns and villages strive to generate its electricity.

The main indoor noise sources are ventilation systems, office machines, house appliances, food blenders, sewing machines, vacuum cleaners, electric can cutters, dishwashers, etc. Thus, there is no escape from noise as modern lifestyles and transportation habits continually generate more noise, worsening the overall noise level and leading to hearing loss and ill-health.

Mechanised industries generate a serious noise problem – indoors as well as outdoors from all sorts of powerful machines that have impulsive and unpleasant disruptive temporal sound patterns (EPA, 1978).

Noise from industries affect nearby communities and be reduced by the use of quieter equipment, zoning of land into industrial and residential areas, sound insulation enclosures, active noise control measures like restriction of operation time (EPA, 1998; IPSC/EHC 12, 1980).

3.3 Effects of Noise on Health

WHO observed that 120 million people have disabling hearing defects world-wide. In developed countries, 12 per cent – 15 per cent employed people are exposed to noise levels of 80db or more. Prolonged or excess exposure to noise can cause permanent medical conditions such as peptic ulcer disease, hypertension, and ischaemia heart disease.

Some prominent noise effects on human health include:

3.3.1 Pain

Aural pain is induced when the tympanic membrane is stretched by large amplitude sound pressure and which may rapture the membrane. At 80db physical discomfort is experienced and pain at 110 – 130db. In an inflamed ear 80 – 90db will cause pain, but no pain is felt in the ear without eardrum at 170db (EPA, 1978).

3.3.2 Hearing Impairment

Hearing impairment generally refers to the hearing level at which individuals begin to experience difficulty understanding speech. In the USA, it approximates 26db or more at 0.5, 1, and 2kHz. In the UK it is 30db or more at 1, 2, and 3kHz. The direct effect of noise is hearing impairment, which is defined as an increase in threshold of hearing. Noise induced hearing impairment occurs mostly in higher frequencies of 3000 – 6000Hz. With increasing levels and exposure time, impairment occurs at frequencies as low as 2000Hz, resulting in the loss of clarity rather than loudness. At 75db or less no impairment is expected to occur.

In developing countries, both occupational and environmental noises constitute increasing risk factors for hearing impairment. Hearing loss occurs gradually, beginning with loss of occasional words in general conversation and difficulty understanding speech heard on the telephone. The main social consequence of hearing impairment is the inability to understand speech in daily living conditions a severe and incurable social handicap resulting in difficulty participating in lectures, meetings, parties, besides listening to TV, radio and telephone.

3.3.3 Sleep Disturbance

Sleep disturbance is a major effect of environmental noise. Uninterrupted sleep is prerequisite for good physiological and mental functioning. Noise induced sleep disturbance will particularly cause difficulty in falling asleep, awakening and alterations of sleep stages or

depth. Effects of noise upon sleep depend on the characteristics of the noise stimulus, the age and the sex of the sleeper, history of previous sleep adaptation and motivation. Noise inhibits increase in esinophils and basophiles that occur during sleep. The sleep of children and younger people are less affected than that of the middle age and older people. Women are more sensitive to noise than men during sleep (EPA, 1978). Noise causes increased blood pressures, heart rate and higher pulse amplitude, vascular constriction, changes in respiration, cardiac arrhythmias and increase body movement during sleep. The probability of being awakened increases with the number of noise event per night. For a good night sleep, equivalent sound level should not exceed 30db

3.3.4 Stress Response

Noise, especially sudden and unexpected, evokes primitive stress response the flight or flight reaction of the autonomic nerve system. If the noise stimulus is sustained, it will cause persistent changes in the neurosensory, circulatory, endocrine, and secretory and digestive systems.

Noise exposure affects the body's physiological function both temporarily and permanently. After prolonged exposure to noise, susceptible individuals develop hypertension and is chaemia heart disease because sound evokes reflex responses that elevate adrenaline levels, triggers narrowing of the blood vessels.

Sound levels of road traffic constrict the arterial blood flow and raises blood flow. High noise level, on its own, produces natural stress reaction resulting in increased frequency of headache, fatigue, stomach ulcers and vertigo (EPA/NSW,1997).

3.3.5 Mental Illness

Exposure to high levels of noise has been associated with the development of neurosis, including disengagement and increased aggressive behaviour. The use or consumption of tranquilisers and sleeping peels is higher in noise exposed persons, besides psychiatric symptoms and admission rates, all suggest effects of noise.

3.4 Noise Control in Nigeria

It is necessary to control noise for the good of everyone. The existing legislation needs to be enforced. For instance, the Federal Environmental Protection Agency (FEPA) guidelines on noise exposure limits provide a limit of 90db for an 8hr period in an industry, violation of which attracts sanctions under the law (Okereke, 2006). The Mineral

Oil Safety Regulation (MOSR) requires operators in the oil industries to provide hearing protection devices for workers exposed to noise levels equal or greater than 85db for 8hr time weighted average, and no unprotected person is to be exposed to noise levels equal to 115db for any length of time. Noise is limited to 50db at night in residential areas. Besides, personnel annual medical check is to include audiometric test.

The use of power generating sets is rift, especially in commercial areas. It follows therefore, that control measures will include the following:

- public enlightenment through the media
- health talk for noise generators
- planning and organising marketing areas for electronics and
- education of itinerant hawkers of musical wares on noise pollution and sales management (Okereke, 2006).

For the general population, noise can be reduced by the following measures:

- provision of adequate and functional amenities and securities
- sanctioning religious and other generators of excessive noise at night and during the day.

4.0 CONCLUSION

In conclusion, noise is a common phenomenon especially in Nigeria where the most desirable legislative control measures are not in place. Noises at excessive levels affect human healthand there is the need for authorities concerned to do something on it.

5.0 SUMMARY

You have learnt that noise is a factor of pollution in Nigeria and the effect of noise pollution has a bearing on human health. Our city centres especially close to market places are exposed to excessive noise above safety limits from motor vehicles, electronics/music marketers, power generators, grinding machines etc. Among the control strategies include – public enlightenment, health talk, planning of marketing areas etc.

6.0 TUTOR-MARKED ASSIGNMENT

1. List five sources of noise pollution in a typical city centre in Nigeria.
2. Explain three measures in the control of noise pollution.
3. Describe two health effects of noise pollution in man.

7.0 REFERENCES/FURTHER READING

Amadi, A. N. (2011).*ABC of Environmental Health*. ReadonPublishers Ltd.

WHO (2001).Occupation and Community Noise, WHO Fact Sheet No. 258.www.who.int/medicentral/factsheets/fs 258/en

AAFP 2005: Hearing: Noise Induced Hearing Loss; American Academy of Family Physicians. File:///E:/Hearing % 20Noise induced%. familydoctors.org.html

MODULE 3

UNIT 1 MONITORING OF POLLUTANTS AND CONTAMINANTS

CONTENTS

1.0 INTRODUCTION

Chemicals, most of which may be described as pollutants, have become a part of our life, sustaining many of our activities, preventing and controlling diseases, and increasing agricultural productivity. However, one cannot ignore that these chemicals may especially if not properly used or the end products or wastes not properly disposed off endanger our health and poison our environment. Contaminants of biological origin can equally infest our environment and pose danger to our health and the environment.

In this unit, you will learn the need for pollutants monitoring and the techniques involved in doingso.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the various types of monitoring of pollutants
- identify the important pollutants to be monitored in different media
- state the procedure of soil monitoring.

3.0 MAIN CONTENT

3.1 Monitoring of Pollutants in Water

Water is described as universal solvent with the potential to receive almost everything that comes its way in suspension or capacity to dissolve varying chemical elements. In its chemical form, water is two molecules of hydrogen and one molecule of oxygen (H_2O), however, it naturally exists with some trace elements often inert and harmless in concentration. Pollutants of all description (chemicals, biological agents, debris and even energy) can be found in water as pollutants depending on the circumstances and the events which the water may have gone through before it is sampled for monitoring purposes. These

circumstances and events can be natural as in weathering of rocks, volcanoes, wind systems etc. or anthropogenic sources as in effluents from industries, solid waste dump in water bodies and radioactive material fallout from nuclear plants.

Monitoring of water quality/pollutants in water involves three principal parameters:

- Physicochemical
- Microbiological and
- Chemicals.

3.1.1 Physicochemical

Physicochemical monitoring involves the temperature, level of suspended solids, total dissolved solids, turbidity, hardness, conductivity, PH, colour, odour, taste, Biochemical Oxygen Demand (BOD) and at times Chemical Oxygen Demand (COD). Pollutants in water and depending on the concentration give negative readings of these physical actors. Colour, taste, odour and level of suspended solids are factors that can be monitored by ordinary observation without the use of equipments. However, other physical monitoring may require the use of equipment or scientific instruments.

3.1.2 Microbiological

Microbiological monitoring looks for microbial pollutants or microbial indicators of pollution. These may be bacteria, viruses, fungi and other microbial life forms. This aspect includes routine sampling and analysis of drinking water to see that it does not contain coliform bacterial indicator of pollution with excreta. Escherichia coliforms, faecal coliforms, aerobacteraerogens are common indicators.

Viruses are not routinely monitored in water except if there is a cause for doing so especially during epidemic outbreaks. However, viruses responsible for hepatitis, poliomyelitis can be found in drinking water as microbial pollutants and may need to be monitored and if found removed for public health reasons.

3.1.3 Chemicals

Chemicals monitoring in water has become so paramount in modern time due to the preponderance of industries and production activities in the urban centres and the emergence of small scale industries and trades in the rural areas which involve the use of chemicals and related pollutants. Dyeing, painting, tanning, etc. are commercial activities in

the rural areas that generate a lot of chemical wastes that deserve constant monitoring. More than a thousand different chemicals are manufactured every year and sent into the market. Some are simple while others could be complex, persistent and also carcinogenic in nature. The heavy metals and other priority pollutants are given special consideration in monitoring activity to prevent massive acute toxicity and destruction to ecosystem. Some chemicals even in trace quantities are carcinogenic, teratogenic, mutagenic and toxic to man and other biological substances of economic importance, hence the need to monitor numerous chemicals to ensure that their permissible levels are not exceeded.

The focus of any monitoring of pollutants in water depends on the suspicion or the use for which the water is intended. For example, water intended for use in irrigation may not necessarily be concerned about some aspects of the physical quality like the temperature, silt content, debris, and suspended solids. However, down- stream water bodies used by local communities for bathing, washing and even drinking need all parameters of monitoring especially where industrial effluents are discharged up-stream with the big question of whether the effluent is properly treated before discharge.

3.2 Monitoring of Pollutants in the Air

Good air quality is essential to our health and well-being. Poor air can have adverse effects on our quality of life and can damage the fabric of buildings and sensitive flora and fauna.

Air monitoring provides raw measurements of air pollutant concentrations and with appropriate analysis and interpretation; these measurements can be transformed into useful information about air quality. In Nigeria we do not possess the appropriate tools and capacity for effective air quality monitoring, however, examples of monitoring and what pollutants are monitored can be drawn from advanced countries thus:

Table 1.1: Active Local Authority Funded Monitoring Sites

Monitoring Site	**Ozone (O_3)**	**Nitrogen Dioxide (NO_2)**	**Sulphur Dioxide (SO_2)**	**Carbon Monoxide (CO)**	**Particulate Matter (PM_{10})**	**Highest Pollution Band**	**Last Updated**
Cambrid	n/m	36 (1	n/m	n/m	12 (1	Low	17/09/2

ge Gonville Place		Low)			Low)	(Index 1)	012 21:00
Cambridge Montague Road	n/m	19 (1 Low)	n/m	n/m	17 (2 Low)	Low (Index 2)	17/09/2012 21:00
Cambridge Newmarket Road	n/m	40 (1 Low)	n/m	n/m	n/m	Low (Index 1)	17/09/2012 09:00
Cambridge Parker Street	n/m	15 (1 Low)	n/a	n/m	13 (1 Low)	Low (Index 1)	17/09/2012 21:00

Overall Pollution Summary	**LOW (Index 2)**
Very High	10
High	9
	8
	7
Moderate	6
	5
	4
Low	3
	2

The outcome of monitoring is summarised as in Table 1.1, which could also be the basis for appropriate actions for control.

3.3 Monitoring of Pollutants in Soil

How to Monitor Soil Pollution
X

Fig. 1.1: Soil Pollution

Landowners need to check if their soil is polluted. Gardeners, farmers, people planning to buy land and golf course managers among others need to know if their soil is polluted. This knowledge lets you know what to plant, what if, any action, is required, and whether you can get organic certification.

Things you will need:

- Distilled water
- Specimen jars
- Small trowel
- Butter knife, surgical gloves.

Instructions:

- Research the area in which your land is located to determine which pollutants are a risk factor to your land. Investigate the agricultural environment and the industries in your areas for at least the past decade to learn if there is anything specific for which you need to test.
- Draw or print a map of your area and mark a grid of one to four acre squares. Assign each a letter or number code. Write the codes on sticky labels that you will affix to the specimen jars.
- Clean your equipment. Contaminated equipment can produce inaccurate results, especially if you are asking for specific, sensitive data. Wash your tools in distilled water.
- Collect a sample from each grid square. Scrape off any leaves and use a trowel to collect a sample from about six inches down. Take the same amount of soil each time. The butter knife helps with getting the soil into the jar. Rinse your equipment between samplings.

- Complete the paperwork required by the laboratory and send your samples for testing. For ongoing monitoring of pollutant levels, repeat this process at regular intervals. If you discover one sample was exceptionally high in pollutants then retest that square using a finer grid.

  Source: Siemens Water Treatmentwww.siemens.co.za/Water Tips &Warnings

- Don't collect your samples after a heavy rainfall. The water will wash some pollutants away and make the soil wet and difficult to work with.
- Wear gloves at all times. This prevents contamination of samples and protects you if there are dangerous pollutants at the site.

3.4 Monitoring of Pollutants in Food

Now, more than ever, all food chain stakeholders are required to demonstrate their commitment to food safety and quality. In the recent past, there had been outbreaks of food-related events (infection or poisoning) which claimed lives or inflicted morbidity among Nigerians.

The Federal Ministry of Health and the States took steps to controlling the incidences through education and enforcement of standards, inspections, and adequate hygiene of food premises.

The Goal of Pollutants Monitoring in Food:

The Primary goal is to find pathogens in the environment before they contaminate food products.
Secondary is to find spoilage microorganisms in the environment before they affect products andlastly to assess effectiveness of cleaning, sanitation and maintenance of quality standards of food products.

Some of the indicators of pollutants in food are the signs of their spoilage and at the same time the monitoring guide of their standard. These include the following:

1. bulging of canned foods
2. change in colour
3. production of odour
4. physical changes in texture
5. change in taste
6. laboratory confirmation of toxins, chemicals and pathogens etc.

4.0 CONCLUSION

Food is an indispensable aspect of our life. It is a major contributor to diseases and illnesses in man if polluted. There is the need for continuous monitoring of the food we eat by public health officers. It is also worth noting that poultry, beef and fish are essential aspects of our food in which antibiotics and drugs are administered in the course of their production. These drugs could have some effects on our health and body immunity, depending on what drugs are involved and their concentration in the food animal.Food pollution monitoring is very important in the prevention and control of food borne illnesses.

5.0 SUMMARY

You have learnt about food pollution monitoring and the indices that are important in the monitoring process. Our foods deserve constant monitoring in order to protect us from food borne illnesses.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the goal of food pollution monitoring.
2. State the indicators of food contamination/pollution.

7.0 REFERENCES/FURTHER READING

Brauer, M. et al. (2002).“Air Pollution from Traffic and the Development of Respiratory Infections and Asthmatic and Allergic Symptoms in Children.”*American Journal of Respiratory Critical Care Medicine*, 166, 1092–1098.

Raaschou-Nielsen, O. et al. (2000). “An Air Pollution Model for Use in Epidemiological Studies: Evaluation With Measured Levels of Nitrogen Dioxide and Benzene.”*Journal of Exp. Anal.Environmental Epidemiology.* 10, 4–14.

Raaschou-Nielsen, O. et al. (2001). “Air Pollution from Traffic at the Residence of Children with Cancer.”*American Journal of Epidemiology,* 153(5), 433–443.

Zmirou, D. et al. (2002). “Five Epidemiological Studies on Transport and Asthma: Objectives, Design and Descriptive Results.”*Journal of Exp Anal Environmental Epidemiology*, 12, 186–196.

UNIT 2 ASSESSMENT OF POLLUTANTS

CONTENTS

1.0 INTRODUCTION

In this unit you will learn about the assessment of pollutants. Pollutants in a given medium are present in both quantity and quality and the space and time they are present all determine the risk factor they may represent. Assessment of pollutants is a highly technical issue and our attempt in this unit is to provide necessary information on the subject matter and a guide to the conduct of assessment.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the concept of pollution assessment
- define risk assessment
- describe three steps involved in public health risk assessment.

3.0 MAIN CONTENT

3.1 Assessment of Pollutants

A pollutant is a waste material that pollutes air, water or soil. Three factors determine the severity of a pollutant: its chemical nature, the concentration and the persistence.

When we discuss the assessment of pollutants, we are either considering assessment to personal exposure or the level of impact on environmental media.

For example high levels of air pollution are associated with adverse effects on public health. Pollutants concentrations are typically subject

to a high spatial and temporal variability. To investigate and quantify potential relations between pollutant concentrations and health effects, e.g. cases of respiratory diseases, sophisticated geospatial tools and methods are required.

Air pollutants are ubiquitous and a certain level of exposure is inevitable. For risk assessments and public health advice, however, it is necessary to quantify human exposure to specific pollutants of concern. This is a challenging task as individual daily mobility patterns substantially influence exposure to air pollutants over time and in space. But it is not only peoples activities making the quantification difficult, also air chemistry, microclimatic and meteorological influences are changing over space and time, resulting in high spatial and temporal variation of ambient pollutant concentrations.

To analyse personal exposure the actual ambient concentration levels of the pollutant of concern are needed with sufficient temporal and spatial resolution. Recent development in GPS technology allows monitoring a person's individual activity patterns, and thus exposure to a specific pollutant, while moving in space and time. The advantage of personal exposure profiles is that the actual concentration levels are measured. This is a highly localised approach which is suitable to assess short term effects of air pollution. For further analysis this monitoring data needs to be integrated with temporal and spatially aggregated concentration data as well as with land use data to derive conclusions above associations between concentration levels, the environment the person is moving in and potential health impacts.

3.2 Risk Assessment

Risk Assessment is a step in a risk management procedure. Risk assessment is the determination of quantitative or qualitative value of risk related to a concrete situation and a recognised threat (also called hazard). *Quantitative risk assessment* requires calculations of two components of risk*(R)*, the magnitude of the potential loss *(L)*, and the probability *(p)* that the loss will occur. In all types of engineering of complex systems sophisticated risk assessments are often made within Safety engineering and Reliability engineering when it concerns threats to life, environment or machine functioning. The nuclear, aerospace, oil, rail and military industries have a long history of dealing with risk assessment. Also, medical, hospital, and food industries control risks and perform risk assessments on a continual basis. Methods for assessment of risk may differ between industries and whether it pertains to general financial decisions or environmental, ecological, or public health risk assessment.

3.3 Risk Assessment in Public Health

In the context of public health, risk assessment is the process of quantifying the probability of a harmful effect to individuals or populations from certain human activities. In most countries the use of specific chemicals or the operations of specific facilities (e.g. power plants, manufacturing plants) is not allowed unless it can be shown that they do not increase the risk of death or illness above a specific threshold. For example, the American Food and Drug Administration (FDA) regulates food safety through risk assessment.[1] The FDA required in 1973 that cancer-causing compounds must not be present in meat at concentrations that would cause a cancer risk greater than 1 in a million lifetimes. The US Environmental Protection Agency provides basic information about environmental risk assessments for the public via its risk assessment portal.[2]

In the estimation of risks, three or more steps are involved that require the inputs of different disciplines:

1. *Hazard Identification*is determining the qualitative nature of the potential adverse consequences of the contaminant (chemical, radiation, noise, etc.) and the strength of the evidence it can have that effect. This is done, for chemical hazards, by drawing from the results of the sciences of toxicology and epidemiology. For other kinds of hazard, engineering or other disciplines are involved.
2. *Dose-Response Analysis* is determining the relationship between dose and the probability or the incidence of effect (dose-response assessment). The complexity of this step in many contexts derives mainly from the need to extrapolate results from experimental animals (e.g. mouse, rat) to humans, and/or from high to lower doses. In addition, the differences between individuals due to genetics or other factors mean that the hazard may be higher for particular groups, called susceptible populations. An alternative to dose-response estimation is to determine an effect unlikely to yield observable effects, that is, a no effect concentration. In developing such a dose, to account for the largely unknown effects of animal to human extrapolations, increased variability in humans, or missing data, a prudent approach is often adopted by including safety factors in the estimate of the "safe" dose, typically a factor of 10 for each unknown step.
3. *Exposure Quantification*is determining the amount of a contaminant (dose) that individuals and populations will receive. This is done by examining the results of the discipline of exposure assessment. As different location, lifestyles and other

factors likely influence the amount of contaminant that is received, a range or distribution of possible values is generated in this step. Particular care is taken to determine the exposure of the susceptible population(s).

Finally, the results of the three steps above are then combined to produce an estimate of risk. Because of the different susceptibilities and exposures, this risk will vary within a population.

4.0 CONCLUSION

Assessment of pollutants is a very important activity in pollution control and our efforts to reduce the risk of exposure to dangerous pollutants.

5.0 SUMMARY

In this unit you have learnt that pollution assessment involves highly technical skills and inputs by other professionals to determine the values of pollutants in any given situation. You have also learnt the important steps involved in pollution assessment. In the next unit we shall consider exposure patterns to pollutants.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the concept of pollutants assessment.
2. List three important steps involved in risk assessment.
3. Define Risk assessment.

7.0 REFERENCES/ FURTHER READING

Merrill, R. A. (1997). "Food Safety Regulation: Reforming the Delaney Clause" *Annual Review of Public Health*, 18, 313-40.

^EPA.gov

^SIS.nlm.nih.gov

^Toxnet.nlm.nih.gov

^HPD.nlm.nih.gov

UNIT 3 EXPOSURE PATTERNS

CONTENTS

1.0 INTRODUCTION

When we are predisposed to situations of pollution certain traits or factors in us and the period of time and concentration of the pollutant in question determine our response. Determination of exposure pattern is a highly technical issue which involve complex processesin which the result varying from one individual to the other. However, there are certaingenerally acceptable responses of exposure to specific pollutants. In this unit we are going to learn about the exposure pattern of certain pollutants common to our environment.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the concept of exposure patterns
- state the exposure patterns of at least five pollutants
- describe the modes of exposure to pollutants.

3.4 MAIN CONTENT

3.1 The Concept of Exposure Pattern

Because human activities impact the timing, location, and degree of pollutant exposure, they play a key role in explaining exposure variation. This fact has motivated the collection of activity pattern data

for their specific use in exposure assessments. In the United States (US), the National Human Activity Pattern Survey (NHAPS), a 2-year probability-based telephone survey (*n*=9386) of exposure-related human activities is an effort towards exposure assessment.

The primary purpose of NHAPS was to provide comprehensive and current exposure information over broad geographical and temporal scales, particularly for use in probabilistic population exposure models. NHAPS was conducted on a virtually daily basis from late September 1992 through September 1994 by the University of Maryland's Survey Research Centre using a Computer-Assisted Telephone Interview instrument (CATI) to collect 24-h retrospective diaries and answers to a number of personal and exposure-related questions from each respondent. The resulting diary records contain beginning and ending times for each distinct combination of location and activity occurring on the diary day (i.e., each microenvironment). Between 340 and 1713 respondents of all ages were interviewed in each of the 10 EPA regions across the 48 contiguous states. Interviews were completed in 63 per cent of the households contacted. NHAPS respondents reported spending an average of 87 per cent of their time in enclosed buildings and about six per cent of their time in enclosed vehicles. These proportions are fairly constant across the various regions of the US.

However, the number of people exposed to environmental tobacco smoke (ETS) in California seems to have decreased over the same time period, where exposure is determined by the reported time spent with a smoker. In both California and the entire nation, the most time spent exposed to ETS was reported to take place in residential locations.

National-level exposure assessments are required for major policy decisions. The importance of activity pattern data has increased with the realisation that many types of exposure to environmental pollutants occur indoors and stem, in large part, from indoor pollutant sources such as cigarettes. Exposure monitoring studies have demonstrated how people's locations and activities can explain the variation in exposure to benzene, tetrachloroethylene, and other volatile organic compounds. Human activity data are major inputs to human exposure models.

3.1.1 Sociological Study of Human Activity

The long history of studies on human activities in the sociological literature contains frequent use of the term "time budget" (also known as "zeitbudget" or "budget de temps"). A time budget is conceptually similar to a person's money budget in that it summarises the amount of time an individual spends in each of many activities over some time period (e.g., a day or a week). According toMichelson (1973), a time

budget is a record, presented orally or on paper, of what a person has done during the course of a stated period of time. It usually covers a 24-hour day or multiples thereof. The record is taken down with precision and detail, identifying what people have done with explicit reference to exact amounts of time. It is usually presented chronologically through the day, beginning with the time that a person gets up in the morning.The information that is normally gathered in a time budget consists of the time an activity began, the time it ended, the nature of the activity*per se*, the persons who were present and active in the given activities, and, not the least, the exact location where the activity took place.Early reviews of the historical development of time budget research are provided by Szalai (1966),Converse (1968), Ottensmann (1972), and Chapin (1974). This early research forms the basis for today's human activity pattern surveys (see the review by Ott, 1989).

The earliest documented studies of human activity in America are byLundberg et al. (1934) andSorokin and Berger (1939), with several time budget studies conducted in 1989, Ott "reinterpreted" the codes from the MCTBRP activity pattern data for 44 US cities (Robinson et al., 1972) to estimate the amount of time that people spend in-transit, outdoors, and indoors, and he concluded that employed persons in the US spend only about two per cent of their time outdoors, six per cent of their time in transit, and 92 per cent of their time indoors.

3.1.2 Health and Human Activity

As alluded to above, the critical problem with activity pattern studies found in the sociological literature is that they do not include many aspects of daily life that are important for environmental pollution exposure assessment, such as storing chemicals in the home, driving an automobile on crowded highways, living with a smoker, using gas appliances, visiting a dry cleaner, using solvents in the home, or filling a gas tank. Nor do they provide sufficient detail on the locations that people visit.

Using methods similar to those of the social scientists, researchers in the environmental health sciences in the 1980s began to collect activity pattern data as part of exposure and health research. For example, the following studies appeared in the literature of this period.

(1) Johnson (1983) and Akland et al. (1985) conducted a probability-based personal exposure field study of 1200 persons in Denver and Washington, DC, in which respondents carried personal monitors to measure their personal exposure to carbon monoxide (CO) while keeping diaries to record the activities and microenvironments they visited over 24 h.Schwab

(1988)analysed the activity patterns and CO exposures using the diary data from this study.

(2) Quackenboss et al. (1986) used a recall questionnaire to gather information on the times people spent in various locations, or microenvironments, in a study of personal nitrogen dioxide (NO_2) exposures and indoor and outdoor concentrations for 350 individuals in Portage, WI.

In parallel scientific efforts, environmental health scientists began developing mathematical exposure models based on human activity patterns. Fugas (1975) initially suggested a modelling approach for computing personal exposure to sulphur dioxide (SO_2), lead (Pb), and manganese (Mn) by summing the concentrations in the locations a person visited (home, work, streets, countryside), weighted by the time the person spent in each location. Subsequently, Duan (1982) suggested a formal mathematical approach to compute personal exposure by summing the pollutant concentrations in the "microenvironments" (defined by Duan as locations of homogeneous concentration) that each person visited; weighted by the time they spent in each microenvironment. Ott (1984) then developed a prototypical computerised exposure model based on the concepts of Fugas and Duan, referred to as the "indirect approach" to exposure assessment. A variety of mathematical models based on this approach were subsequently developed (seeQuackenboss et al., 1986;Sexton & Ryan, 1988;Ott et al., 1992, 1998;Behar et al., 1993;Klepeis et al., 1994;MacIntosh et al., 1995;McCurdy, 1995, 1997;Johnson et al., 1996a,b;Miller et al., 1998a,b;Klepeis, 1999).

3.2 Exposure Patterns

Air pollution is a significant risk factor for multiple health conditions including respiratory infections, heart disease, and lung cancer, according to the WHO. The health effects caused by air pollution may include difficulty in breathing, wheezing, coughing and aggravation of existing respiratory and cardiac conditions. These effects can result in increased medication use, increased doctor or emergency room visits, more hospital admissions and premature death. The human health effects of poor air quality are far reaching, but principally affect the body’s respiratory system and the cardiovascular system. Individual reactions to air pollutants depend on the type of pollutant a person is exposed to, the degree of exposure, the individual’s health status and genetics.

Both indoor and outdoor air pollution have caused approximately 3.3 million deaths worldwide. Children aged less than five years that live in

developing countries are the most vulnerable population in terms of total deaths attributable to both indoor and outdoor air pollution.

The WHO states that2.4 million people die each year from causes directly attributable to air pollution, with 1.5 million of these deaths attributable to indoor air pollution. Epidemiological studies suggest that more than 500,000 Americans die each year from cardiopulmonary disease linked to breathing fine particle air pollution. A study by the University of Birmingham has shown a strong correlation between pneumonia related death and air pollution from motor vehicles. Another study suggests that 310,000 Europeans die from air pollution annually. Causes of death include aggravated asthma, emphysema, lung and heart diseases, and respiratory allergies.

The worst short term civilian pollution crisis in India was the 1984 Bhopal Disaster. Leaked industrial vapours from the Union Carbide factory, belonging to the Union Carbide, Inc., U.S.A., killed more than 25,000 people outright and injured anywhere from 150,000 to 600,000. The United Kingdom suffered its worst air pollution event when the December 4 Great Smog of 1952 formed over London. In six days more than 4,000 died, and 8,000 more died within the following months. An accidental leak of anthrax spores from a biological warfare laboratory in the former USSR in 1979 near Sverdlovsk is believed to have been the cause hundreds of civilian deaths.

Diesel Exhaust (DE) is a major contributor to combustion derived particulate matter air pollution. A study from around the years 1999 to 2000, by the University of Washington, showed that patients near and around particulate matter air pollution had an increased risk of pulmonary exacerbations and decrease in lung function. Air pollution is also emerging as a risk factor for stroke, particularly in developing countries where pollutant levels are highest.

3.2.1 Respiratory Tract Mode

Pollutants in the air find their way into human body through exposure/inhalation of polluted air.In an industry for example producing asbestos, the fibres of asbestos released into the air are easily inhaled by the exposed workers which might become responsible for asbestosis condition in the exposed worker. The same exposure pattern goes for gases like carbon monoxide, sulphur and other occupational dusts for example. Indoor pollution by cigarette smokers exposes non-smokers to the dangers of inhaling dangerous air pollutants like tar, nicotine etc. Respiratory tract exposure is one of most common exposures to pollutants in the air. The exposure patterns exhibit in the form of cough,

difficulty in breathing to symptoms like inflamed lungs and cancerous cells in the lungs.

3.2.2 Alimentary Tract Mode

This is by means of ingestion of pollutants and contaminants through the mouth. It happen both through pollutants in the air, water or ingestion of contaminants in food. Toxic gases or solids can be ingested through the mouth. Contaminants such as bacteria, viruses and fungi can also be taken into the body through food. Examples include streptococci, staphylococci, salmonella etc. These bacteria may be toxin producing and present as acute gastro-enteritis like staphylococcus food poisoning or infection like salmonella typhi (typhoid fever).

3.2.3 Skin and the EyesMode

Essentially what happens is that pollutants are absorbed through the skin by contact. Examples include exposure to solvents, acids and bases. Exposure patterns include contact dermatitis, headache, and nausea and also chronic effects may result into permanent injury to the nervous system. Exposure to light pollution (excessive lighting) may present as eye irritation, temporary loss of sight or permanent loss of sight depending on the degree of exposure and other individual resistance factors.

3.2.4 Auditory Mode

Noise pollution from machines, engines and heavy traffic affect the auditory system. Exposure to decibels above the tolerable levels has negative impact on human health. Patterns indicate that exposure to traffic noise could lead to higher risk of having a heart attack. A new study shows a clear relationship between traffic noise and heart attack risk with a 12 per cent higher risk per 10 decibels of noise. (Redorbit 22/6/12)

4.0 CONCLUSION

Exposure pattern is all about trying to ascertain the outcome of exposure to pollutants determined by complex human disposition based on body resistance, time of exposure, period of exposure and the amount of pollutants involved.

5.0 SUMMARY

You have learnt what exposure patterns is all about and the various mode of its expression. These include the respiratory mode, the

alimentary tract mode, the skin and the eye mode and the auditory mode. In the next unit, we shall be considering the global concerns over pollution.

6.0 TUTOR-MARKED ASSIGNMENT

1. What is an exposure pattern of pollutants?
2. State three modes in exposure to pollutants.
3. Describe two patterns each from exposure to air and water based pollutants.

7.0 REFERENCES/FURTHER READING

Adair, J. H.& Spengler, J.D.(1989).“Time Activity and Exposure Assessment: The Six-city Indoor Air Quality Experience.”*Paper No. 89-100.5. Presented at the 82nd Annual Meeting and Exposition of the Air and Waste Management Association, Anaheim, CA.*

Akland, G. G.et al.(1985). “Measuring Human Exposure to Carbon Monoxide in Washington, DC, and Denver, Colorado During the Winter of 1982–1983.”*Environmental Science Technology,*19**,** 911–918

Amadi, A.N. (2011),*The ABC of Environmental Health*.Nigeria: UgoomaPrinting and Publishing Co. Nig.

Behar, J. V.,Blancato, J. N.,Pandian, M. D.& Thomas, J. (1993).“Modeling of Human Exposure/dose to Benzene.” In: N. L. Nagda (Ed.), *Modeling of Indoor Air Quality and Exposure*, STP 1205 ASTM, Philadelphia, PA.

UNIT 4 OVERVIEW OF CURRENT GLOBAL POLLUTION CONCERNS

CONTENTS

1.0 INTRODUCTION

Since the industrial revolution in Europe in the early part of the 19th century, the World has witnessed tremendous growth and development. These growths were mostly of manufacturing and production nature powered by fossil fuel engines. Over the decades pollutants have invaded the air, water and soil of the earth's environment. A threshold has been attained and now the consequences are beginning to unfold in biodiversity loss, acid rain, global warming etc. This is a cause for concern. In this unit we are going to look into these issues with a view to appreciating their magnitude and what to do about them.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- discuss the global concerns of pollution
- list some of the consequences of pollution
- define global warming
- explain climate change.

3.0 MAIN CONTENT

3.1 Pollution Concerns

Because the sea is expected to yield still larger quantities of valuable resources in the future, and because the water itself is now being used on a small scale through desalination, the concern for preserving the integrity of the ocean has grown. The contaminative effect of increasing technological development and industrialisation has been known to disrupt and destroy the fragile coastal ecology by indiscriminate discharge of industrial and municipal waste into the sea. The pollution of the marine environment by petroleum and chemical spillage and sewage disposal has helped focus world attention on the need for controlled use of resources and planned disposal of waste products. Other pollution concerns are the effects of insecticides and pesticides on marine fish and birds, increasing levels of lead in the surface waters, and the disposal of hot water from power plants into the sea with untoward effects on marine life.

3.1.1 Ocean Pollution

Pollution in the ocean is a major problem that is affecting the ocean and the rest of the Earth, too. Pollution in the ocean directly affects ocean organisms and indirectly affects human health and resources. Oil spills, toxic wastes, and dumping of other harmful materials are all major sources of pollution in the ocean. People should learn more about these because if people know more about pollution in the ocean, then they will know more about how to stop pollution.

3.1.2 What are Toxic Wastes?

Toxic wastes are poisonous materials that are being dumped into the ocean. They harm many plants and animals in the ocean and have a huge impact on our health. Toxic waste is the most harmful form of pollution to sea life and humans. When toxic waste harms an organism, it can quickly be passed along the food chain and may eventually end up being our seafood. In the food chain, one toxic organism gets eaten by another

larger animal, which gets eaten by another animal, and can end up being our seafood. Toxic waste gets into seas and oceans by the leaking of landfills, dumps, mines, and farms. Farm chemicals and heavy metals from factories can have a very harmful effect on marine life and humans.

Many fishermen believe that the toxic chemicals in the ocean are killing much of the fish population. One of the most harmful chemicals in the ocean is lead. Lead can cause many health problems. It can damage the brain, kidneys, and reproductive system. Lead can also cause birth defects for people. It has been shown to cause low IQ scores, slow growth, and hearing problems for small children. House and car paint and manufacturing lead batteries, fishing lures, certain parts of bullets, some ceramic ware, water pipes, and fixtures all give off lead.

Many things found in the ocean may cause seafood to be dangerous to human health. The effect on humans from contaminated seafood may include birth defects and nervous system damage. Medical waste found in the ocean is being tested to see if swimmers have a chance of developing Hepatitis or AIDS. Other waste has been known to cause viral and bacterial diseases. This type of pollution can be stopped by watching what pollution we are letting into the ocean. People are trying to decrease the amount of waste in the oceans by recycling as much garbage as they can so there is a smaller amount of very harmful materials in the ocean.

3.1.3 Boating Pollution

Fig. 4.1: Boating Pollution

Whenever someone takes their boat onto the water for a ride, it is creating pollution that can be very harmful to the sea life. Boating pollution is the pollution that comes from the boat's engine when it is running, and it pollutes the water, killing animals with the chemicals in the exhaust from the engine. The engine gives off excess gasoline, which pollutes the waters and ends up killing the animals.

3.1.4 Garbage Dumping

Fig. 4.2: Garbage

Garbage dumping is the dumping of harmful materials into the ocean like human waste, ground-up garbage, water from bathing, and plastics. Most of the waste that has been dumped into the ocean in the early 1990's is still there today. One main cause of garbage dumping occurs when sewage pipes share their space with storm water drains. Rainfall causes the sewage pipes to overflow and the sewage waste mixes with the storm water drain, which flows into another water source such as a lake or river. After that, the garbage pollutes the ocean, kills plants and animals in the water (for example, the plastic rings that are around pop cans can get around an animal's neck, causing it to suffocate), and makes the water dirty.

3.1.5 Wastewater

Wastewater is a disposal problem that needs to be taken care of. Wastewater is run-off from rainwater and usually ends up in rivers, lakes, and oceans. In order to reduce the amount of wastewater, we need to make sure that the water that ends up in the ocean is clean. We can do this by watching how much pollution we put into the ocean. Whenever even a small amount of pollution gets into the ocean, it damages the environment. A lot of people don't realise that this same pollution is going into the ocean every day and all the small amounts add up to a major problem. To decrease the threat to public health, safety, and the environment, we need to watch how much wastewater we produce.

3.1.6 Other Sources of Pollution

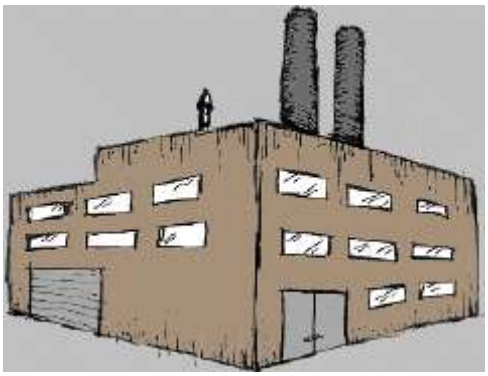


Fig. 4.3: Sources of Pollution (Environment)

Pollution causes a lot of plant and animal deaths in the ocean. In addition to boat pollution, other things that cause water pollution are agriculture (like pesticide run-off), land clearing, and people that pollute the environment without thinking about what harm it can do to animals and humans.

3.1.7 How is Cars Polluting the Oceans?

Fig.4.4: Car Polluting the Ocean.

Cars pollute the ocean a lot. Whenever a car gets driven, you may have noticed a lot of smoke that is coming out from the back of the car. This smoke doesn't go directly into the ocean. It ends up being in acid rain. Acid rain is pollution mixed with regular rain, and when acid rain gets into the ocean, it pollutes the waters and kills many fish over a period of time. Cars are big pollution source. If pollution from cars cannot be stopped or at least cut down, then pretty soon the amount of fish and other creatures in the ocean will decrease.

3.1.8 How is Agriculture Polluting the Oceans?

Chemical pesticides, chemical substances used to kill harmful animals or insects, and fertilizers, chemical or natural substances put on the land to make crops grow better, are another source of pollution. When it rains, the pesticides and fertilizers get taken off of the plants and end up in our oceans, killing ocean plants and animals. They are used by animal and agricultural farms, plantations, industries (especially illegal ones), and believe it or not, our very own gardens. A way to decrease the amount of pesticides and fertilizers polluting rivers, lakes, and oceans is by watching the amount of pesticide spray that you put on the plants in your garden. You can also buy organic products, which are grown with only natural pesticides and fertilisers.

Chemical detergents, batteries, plastics, and sewage are all produced by homes and everyday human activity. Every day humans create and use these things, and every day, people are creating a risk to the plants and animals that live in the oceans and lakes by doing things like driving without carpooling and making sure batteries are not leaking. Some ways that you can protect the oceans are by recycling plastics, disposing of batteries properly, using rechargeable batteries instead of regular batteries, using less water, carpooling, and recycling.

3.1.9 The Ocean Zones

From the shiny, clear sunlight zone to the dark, murky midnight zone, lie facts about the three different zones of the ocean. Even though the very bottom zone is about ninety percent of the ocean, more than ninety percent of the ocean's sea life lives in the top zone, which is why it is important that we do not pollute our oceans.

3.1.10 Sunlight Zone

The sunlight zone is also called the **Euphotic Zone.** This zone is the top zone, and it is also the smallest. The sunlight zone is only about 600 feet deep, but ninety percent of the ocean's sea life lives in the sunlight zone. This zone is home to a wide variety of marine life because plants can grow here. Plants can grow here because sunlight can get to the plants in this zone, so the plants can do photosynthesis and grow. Also, the water temperature is warmer than any other zone in the ocean. The sunlight can reach this zone and warm the ocean water, so it is warm enough for fish and other sea life. Sharks, tunas, mackerels, jellyfish, sea turtles, sea lions, seals, and stingrays are a few of the animals that live in the sunlight zone.

3.1.11 Oil Pollution

Pollution is major problem in the sunlight zone. The main kind of pollution that occurs in this zone is oil pollution. The two main causes of oil pollution in the ocean are big ships leaking oil or ships carrying oil crashing into the ocean.

Global warming is affecting many different parts of the ocean as well. It is causing the water to rise, and when it rises, it covers things such as low land islands with plants, animals, and even some people's homes on them. This can hurt animals in the different layers of the ocean.

One other way ocean layers are affected by global warming is that warm water, caused by global warming, is hurting and even killing algae which are what some fish in the sunlight zone eat. These fish would die because all of their food would have gone. When the fish die, it is a break in our food chain, which would lead to a big problem for all of the animals that rely on the algae-eating fish for their food.

3.1.12 Twilight Zone

The twilight zone is also called the **Disphotic Zone.** In depth, the twilight zone is about 2,400 feet, making it the second largest zone. As the water becomes deeper, the water pressure becomes higher. Almost no sunlight can reach this zone. Therefore, very few plants can grow here. The only animals that can live here are those that can adapt to very little sunlight, really cold temperatures, and very high pressure. The few animals that can live in the twilight zone are lantern fish, hatchet fish, viperfish, mid-water jellyfish, octopus, and squid.

Many animals that live in the twilight zone have bodies that protect them from predators. The viperfish and the ratchet fish have fangs so they can easily protect themselves and help them eat their prey. Other fish are so thin that when a predator looks at them, they do not even see them! Some fish are coloured red and black to blend in with their surroundings.

Some squid and fish can use their bodies to make light with special organs in their bodies called photospheres. These photospheres give off a greenish coloured light, which helps them see. Most fish in this zone don't chase their prey. They wait for their pray to swim by. Then they snatch their prey and eat it.

3.1.13 Toxic Pollution

Some of the pollutants that cause problems for the amazing creatures of the twilight zone are metals and toxic chemicals. These toxic chemicals settle in the sea, and eventually some of the fish eat these chemicals. Other fish eat these fish that ate the chemicals, and these fish, too, will eventually die because they are putting toxic pollution into their bodies.

3.1.14 Midnight Zone

The midnight zone is also called the **Aphhotic Zone.** Ninety percent of the ocean is the midnight zone. This zone happens to be the bottom zone, so it is completely dark. Very few creatures in the ocean live in the midnight zone because the water pressure is extreme and it is near freezing down that far.

Some of the very few creatures that live down in this zone are angler fish, tripod fish, sea cucumbers, snipe eels, opossum shrimp, black swallowers, and the vampire squids.

Because of the lack of plants at this depth, all of the creatures in this zone are predators. They survive by consuming bacteria which grows from the mineral-rich materials and hydrogen sulphide that are given off by underwater cracks in the earth's crust. Since there is no light down in this zone, some fish do not even have eyes.

3.1.15 Anoxic Water

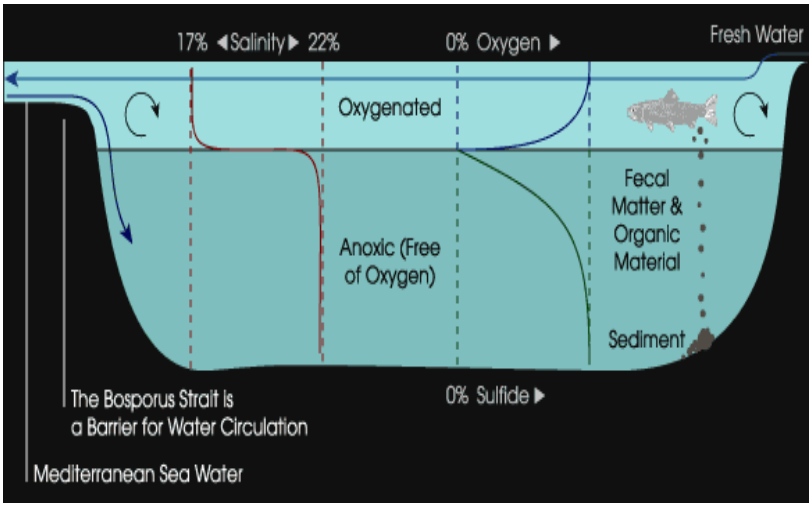


Fig. 4.5: Anoxic Zones

Source: Map at http://daac.gsfc.nasa.gov/CAMPAIGN_POCS/OCDST/dead_zones.html . Used with permission of NASA.

The picture Figure 4.5 is showing the different anoxic zones. One problem caused by pollution that occurs in the midnight zone is called anoxic water. This means that there is no or hardily any dissolved oxygen in the water. When there is no dissolved oxygen, fish and other creatures & nbspcannot breathe and they will quickly die from a lack of oxygen. Some of the creatures that live at this depth might die or migrate to other parts of the ocean. If they do migrate, there is a possibility that there could become a problem in the food chain.

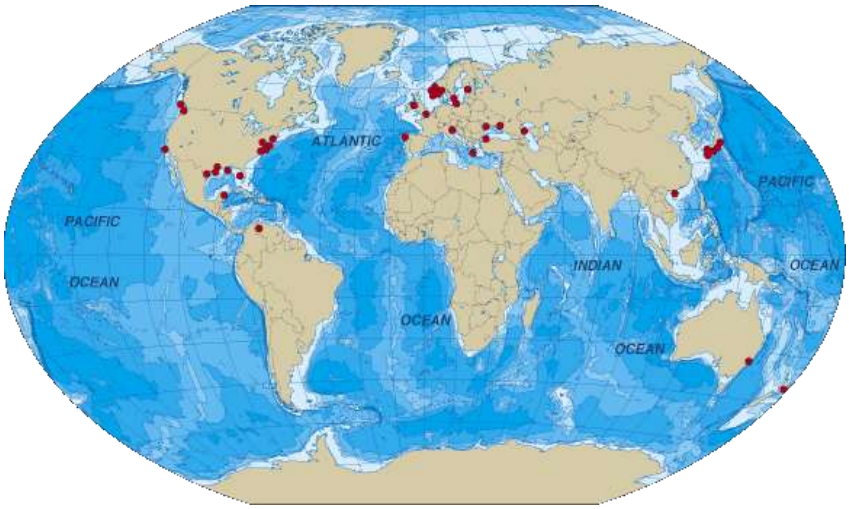


Fig. 4.6: Areas of Anoxic Waters

The red dots show areas where anoxic waters are located. Map at http://daac.gsfc.nasa.gov/CAMPAIGN_POCS/OCDST/dead_zones.html Used with permission of NASA.

It is very important that we address the issues that affect the ocean. Ninety percent of sea creatures live in the sunlight & nbspzone, which is the zone that is most affected by global warming and oil pollution. We must stop these problems because if we don't, we will hurt and maybe even kill our sea life.

3.2 Global Warming

Global warming refers to average temperatures, measured over decades. Temperature measurement obviously varies with location and seasons. Warming simply means that the earth retains more of the sun's heat over time. Heat drives weather and increased heat means increased water and turbulence in the atmosphere. The consequences are determined by the distribution of this extra heat and its effect on ocean and air circulation patterns. We can accept paradoxical weather results as the extra heat makes climate systems more unstable. The most obvious effect of warming is the melting of ice in Arctic, Antarctic and high mountain

glaciers. Ice monitoring has become an important scientific enterprise. Measurements to date reveal accelerating ice melting. The extra fresh water is added to the ocean, raising ocean levels with important changes in ocean circulation patterns. The redistribution of retained heat depends more on the oceans than on the atmosphere.

Fig. 4.7: Greenhouse Gases

Pollution releases greenhouse gases into the atmosphere, resulting in global warming. Air pollution causes global warming through the greenhouse effect, according to the United States Environmental Protection Agency (EPA). The greenhouse effect occurs when greenhouse gases trap heat energy from the sun and prevent it from escaping Earth's atmosphere and entering space. Since the late 1800s, Earth's atmosphere has gotten between 0.4 and 0.8 degrees Celsius warmer, according to NASA.

1. Effects

The first stage of the greenhouse effect is when solar radiation passes through Earth's atmosphere, according to the EPA. The majority of this radiation is absorbed by Earth's surface in the form of heat. Some of this absorbed heat is released back into Earth's atmosphere. Some of this heat escapes into space, while some is contained by greenhouse gases and warms Earth's atmosphere.

2. Considerations

Too many greenhouse gases result in the warming of Earth's atmosphere.

The main greenhouse gases are carbon dioxide, nitrous oxide, methane and water vapour, according to the EPA. Without the presence of greenhouse gases, our atmosphere would be 60 degrees Fahrenheit colder. However, too many greenhouses gases in our atmosphere result in temperature increases worldwide.

3. Prevention/Solution

Fig. 4.8: Car Exhaust Pipes

Cars are a major source of greenhouse gases.Cars emit more than 333 million tons of carbon dioxide into the atmosphere each year, according to the Environmental Defense Fund (EDF). That's one-fifth of the United States' total carbon dioxide emissions. The EDF states that any major solution to global warming would need to include finding a way to cut auto emissions.

Coal burning power plants are another major source of carbon dioxide emissions, according to the United States Department of Energy. Clean coal technology is one way to reduce global warming because it significantly reduces the amount of carbon emissions released into the atmosphere from coal burning power plants.

4. Warning

Fig. 4.9: Melting of Ice Caps

The melting of ice caps is resulting in higher sea levels.One of the main effects of global warming is the melting of ice worldwide, especially at the North and South poles, according to National Geographic. This has resulted in the decline of Adéliepenguins that live in Antarctica over the last 30 years, whose population has dropped from 32,000 to 11,000. Sea levels around the world are also beginning to increase as a result of global warming. Sea levels are expected to rise between 7 and 23 inches by the end of the century, according to National Geographic. In addition, hurricanes are likely to become stronger and occur more frequently, and floods and droughts are predicted to occur more frequently and with increased severity. Also, there will be less fresh water because of global warming.

5. Quick Fact

If the Quelccaya Ice Cap in Peru continues melting at its current rate, it will disappear by 2100, leaving thousands of people without drinking water, according to National Geographic.

3.3 Climate Change

Dramatic weather patterns in the past few years are convincing even determined skeptics that something is happening to global climates. Humans have changed planet earth. One of our accomplishments is to extract and burn much of the fossil fuel deposits on the planet. We have increased the concentrations of greenhouse gases in the atmosphere and are now observing the changes in weather patterns and climate that are a result of our actions.

Complex Systems: The attempt to understand complex systems has taken a quantum leap in recent years. We have gone beyond naïve linear models and now appreciate that if complex systems such as the atmosphere, the oceans, and land ecosystems change, they may become unstable and more unfriendly. Extra heat will cause more turbulence, and weather patterns will change in unpredictable ways. Unfortunately

nature changes in abrupt ways and catastrophes are natural phenomena such as volcanic eruptions, storms, floods, earthquakes, avalanches all represent basic patterns of nature. We have to understand that our actions contribute to weather events.The issues loom large when you consider recent climate changes as adverse consequences of human activities that could be improved if humans agreed on a proper course of action. Of course, human have great difficulty reaching agreements and greater difficulty sustaining agreements they have achieved.

The deepest problem for humans is that we cannot predict the future with any accuracy: Even the best informed scientist with the most recent data cannot know what is going to happen next. When we talk about prudence we refer to our best methods of minimising risk and preparing to deal with events beyond our control which can injure or kill us. Preparation for accidents and illness consumes a large chunk of our resources. Smart humans notice adverse changes and take action to minimise the risk of adverse consequences. But not all human are smart or prudent.

Differential Effects Most Important: Too much attention has been paid to estimating and predicting the average temperature increase of the atmosphere as a whole. Long-term predictions are guesses that may be misleading. The main concern is the effect of extra heat on local climates right now. If you track anomalous and destructive weather over the whole planet, there is already substantial evidence of climate change; there may be some benefits, but, overall, the changes look unpleasant and costly.

So far, increasingly anomalous weather and increasing loss of life and property from greenhouse gas accumulation are occurring with small changes in the average temperature of the planet. You can increase the temperature in some areas and decrease in others and you can alternate - the differential effect will drive storms and precipitation in unusual ways. Increased adverse weather events can be explained as an exaggerated differential effect. We built a greenhouse with gases over much of the Pacific Ocean, for example, and put up heat shields in other areas - smoke, other particles and water vapour. The temperature differences increase, followed by more weather extremes that cause loss of life and property from adverse weather increases. There is no need to wait until 2050 to find out what is going to happen.

Weather: in its simplest form is the expression of heating and cooling effects. When wind blows the roof off a house or a flood carries the house downstream, the energy required was supplied by the sun. The energy may have been stored briefly in the water of a lake or ocean and then expressed through heating of the water and air and evaporation of

water. Air moves when there is a pressure gradient, another result of heating and cooling.

The water vapour content of the atmosphere will increase in a warmer world. With more water vapour in the atmosphere and an increase in sea surface temperatures, there will be increased precipitation at times and more vigorous storms and floods. Water is in constant motion in the oceans. Air and water vapour are in constant motion in the atmosphere. When patterns of distribution change, ecosystems change. Humans experience these changes as threats to their comfort and security and ultimately to their survival.

A model of heat dynamics: that has emerged from a high technology, multidisciplinary study of the planet is complex. Important players in atmospheric dynamics are:

1. The sun supplies all the energy.
2. The atmosphere regulates input and output of the sun's energy
3 Oceans store and distribute heat while supplying water to the atmosphere.
4 The green biomass in the ocean and on land supplies oxygen and consumes carbon dioxide.
5. Ice fields subtract water from the oceans and store it below 0 degrees Celsius ($0^{o}C$).
6. Humans change all the variables except the sun.

Green Developments: in the media made "green" the slogan for action to limit the adverse effects of human degradations of the environment. The media often suggested that this is a relatively new consensus that there is an environmental crisis. They excused people who have ignored the effect of greenhouse gases on climates global warming over the past 30 years. Some know what is really going on out there, but most people do not know or know but deny the obvious for selfish reasons.
Green refers to the colour of chlorophyll in plants. Human action destroys plants and replaces healthy ecosystems with concrete and asphalt. Another slogan that emerged was "save planet earth." Humans will not save the planet. The task for humans is to stop destroying the environments that sustain humans. If we fail, the planet will be fine without us.

Greenhouse Gases: are carbon dioxide, methane, nitrous oxide and chlorofluorocarbons (CFCs). These gases act like the glass covering a greenhouse, letting sunlight in but blocking some of the infrared radiation from the earth's surface that carries heat back into space. The gases act like a blanket wherever their concentration increases. Local concentrations increase local heat and increased differences between

hotter and colder regions drives weather events into more extreme ranges. Over many years, the total amount of greenhouse gases accumulates and the average temperature of the whole planet is increasing. The planet's thermostat had been set at a pleasant average temperature of 59 degrees Fahrenheit (59^{o}F) for the last 10 thousand years or so and is now rising.

UV Radiation: The reduction in forest biomass and reduction of ocean plankton from heat and exposure to increased UV radiation are also concerns. Ocean phytoplankton supplies 70 per cent of the oxygen we breathe and is a major consumer of carbon dioxide. Plankton do best in cold water. If ocean temperatures increase and other problems such as increased UV radiation from ozone holes kill phytoplankton, the problems we are predicting will accelerate.

Ecosystems: are precariously balanced around temperature, pH, oxygen and carbon dioxide concentrations. The adaptive range for many organisms is tight and small changes can have big results. It may be that we can adapt to the changes that have occurred so far but we may have already gone too far and will encounter the big avalanche. The negative consequences of our actions may escalate beyond our control.

Living on the Edge: People in California are specially adapted to the uncertainty of nature - earthquakes have always taken their toll; however when you add the toxicity of air pollution and agricultural chemicals, to soil erosion, floods, fires, failing economy and social unrest you have the formula for an unstable ecosystem that will become less habitable rather than more as the years proceed.

Other comfortable and affluent North Americans are having trouble realising that they are living on an ecological edge. More of them are seeing homes and businesses under water, on-fire, blown away, crushed by heavy snow or deprived of a supportive infrastructure. We will have more water at times dumped on the land and the consequences can be severe and cumulative. At other times in other places, there will be less water and drought and winds will blow away more top soil. More of the forest biomass will be lost and erosion will continue at accelerated rates. Food-growing lands are in jeopardy; it may be difficult to sustain the level of agricultural productivity we enjoyed in the 20th century. New health hazards will emerge - some predicable; others will be unpleasant surprises. After hurricanes, fires and floods - things are never really the same again.

Insurance Companies: are either increasing, out of business, worried, or refusing coverage for properties at risk. Hurricane Andrew was the worst weather disaster in US history causing 16.5 billion dollars in

insured losses and bankrupting some smaller insurance companies. The UN panel on climate change has estimated that windstorm damage increased from $500 million in the 60's to over $11 billion in the 90's and the annual bill in the 21st century may be hundreds of billions of dollars per year. Before 1987, storms had never caused insured losses exceeding $1 billion. Hurricane Andrew destroyed over 28,000 homes. Hurricanes Jeanne, Ivan, Frances and Charley in 2004 destroyed 27,500 housing units. The Southern US was attacked by 17 major storms during the 2005 hurricane season. Hurricane Katrina did extensive damage on 19thSeptember, 2005 to the Gulf coast of the US.Early damage cost was estimated at $200 billion, the worst natural disaster in US history. Hurricane Rita soon followed on 24thSeptember and became the most intense hurricane in the Gulf of Mexico but caused less damage, because it made landfall in less populated areas - no consolation to the people in Texas and Louisiana who suffered a direct hit. Damage estimate was $10 billion.

Political Action: should swift and definitive, but of course, it is not. Politicians are short-term administrators who tend to be inexperienced and poorly informed. In all fairness to politicians, some of them began their careers with high hopes of improving the world, but discovered as they matured in politics that they could only court the favour of those with vested interests, power, money and influence. The realist might say that the politician can only do what is political expedient and this usually means what is in his or her best interest in the next two to four years. The task of leading fellow Homo sapiens from a self-destructive path requires an intelligent consensus and leadership from compassionate superheroes who think in terms of centuries, even millennia.

According to Maurice Strong who headed the **1992 Rio Earth Summit** stated; "Overall we haven't made the fundamental course of change promised in Rio. The process of deterioration has continued and the forces that drive that deterioration have continued ". At that summit 153 nations signed treaties to reduce global warming, save endangered species and foster sustainable development.

Kyoto 1997: The Kyoto meeting to determine emissions policy for the countries of the world has been a great disappointment and only confirmed our basic understanding that governments are not going to act responsibly.Man-made climate problems are going to be with us for decades to come. Disruptions in ecosystems, economic systems, and political systems are inevitable.

ICC Dec. 2007 NUSA DUA, Indonesia. At the international climate conference, the world’s nations committed to negotiating a new accord

by 2009 that cut in half emissions of heat-trapping gases by 2050. While the commitment is welcome, humans remain critical of each other, disputatious and focused on self interest. The negotiations that might lead to an accord will not be a smooth path and even if an accord is achieved, compliance with its terms will not be enforceable.

The climate talks in **Copenhagen in December 2009** involved 200 nations who failed to achieve enforceable agreements to reduce carbon emissions. If you were an optimist you might value the Accord that was achieved, a five-page document that represented another tentative step toward global action to reduce atmospheric pollution and climate change. A realist would restate our understanding of human nature – that local interests always trump global concerns and local interests are divergent and divisive. US President Obama stated: "I think that people are justified in being disappointed about the outcome in Copenhagen. The science says that we've got to significantly reduce emissions over the next 40 years. There's nothing in the Copenhagen agreement that ensures that will happen."

Limitations of Human Nature

Changes in human behaviour must come from all people who sense danger, seek to understand their options and change spontaneously. The same issues come up in personal and public health concerns - constructive change is required. Ignorance and denial obstruct constructive change; wishful thinking and fantasy solutions become more popular. Self-interest and greed dominate the political process. Mother earth shudders and complains looks like we are staying on the edge.

4.0 CONCLUSION

In a book written by Fred Guterl titled ''the fate of the species": I quote: The sixth ''Mass extinction event'' in the history of the planet Earth is currently underway, with over two hundred species dying off every day. The cause of this seismic event is also the same of the single biggest threat to human life: Our own inventions. But for all our talk about sea levels and biotechnology, do we really know what our future will actually look like? Will our immune systems be attacked by so-called superbugs, always evolving and more easily spread than ever? Will the disappearance of numerous species cripple the biosphere? And if it does, what happens then?

Above quote summarises mankind's ever concern about the current trend of pollution in the only planet we know to support life – the Earth.

5.0 SUMMARY

The world is concerned about the current trends in pollution and the obvious consequences expressed in global warming, climate change and the loss of biodiversity. Human health is also another serious consequence which cannot be quantified. In an event the planet earth losses all its support capacities for the sojourn of man, where does man go? The solution to this problem lies with our efforts in sustainable development.

6.0 TUTOR-MARKED ASSIGNMENT

1. List three major concerns in global pollution.
2. Explain two consequences of ocean pollution.
3. What is global warming?
4. Define climate change.

7.0 REFERENCES/FURTHER READING

http://www.learner.org/exhibits/sewage.html. Last Visited: 2/18/02.

Castilleja School (USA). Ocean Pollution.http://www.jp.kids-commons.net/vc96/ocean_pollution/ocean1.html.Last Visited: 2/8/02.

Castilleja School (USA). Oil Pollution. www.JP.Kids-commons.net/vc96/vc-13ocean_pollution/ocean1.html Last Visited: February 28, 2002.

National Geographic: Effects of Global Warming.

United States Department of Energy: Clean Coal Technology.

Environmental Defense Fund: Cars and Global Warming.

United States Environmental Protection Agency: Greenhouse.

NASA: Global Warming.

MODULE 4

UNIT 1 IMPACT OF POLLUTANTS ON HUMAN HEALTH

CONTENTS

1.0 INTRODUCTION

Pollution has negative impact on human health. The impacts represent the aggregate of concerns in all the types of pollution affecting human societies in their environment. These could be air, water, soil or noise. In this unit you will learn the negative effects of pollution on human health.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- list the various health effects of pollution on man
- identify some of the pollutants involved
- explain their route into the human body.

3.0 MAIN CONTENT

3.1 Air Borne Pollution

Pollutants in the air cause health defects ranging from unnoticeable chemical and biological changes to trouble breathing and coughing. The ill effects of air pollution primarily attack the cardiovascular and respiratory systems. The severity of a person's reaction to pollution depends on a number of factors, including the composition of the pollution, degree and length of exposure and genetics.

1. Individuals at Risk

While everyone can potentially suffer from air pollution, there are individuals who are more susceptible than others. In general, living in an urban setting where there are lots of cars and buildings releasing pollutants increases a person's risk of health problems. Joggers and bikers who exercise on smoggy days expose their bodies to vast amounts of pollution each time they go out. Both the elderly and children seem to be especially sensitive to pollutants in the air.

The respiratory system is responsible for bringing large amounts of air into the body, and then transporting oxygen from that air into the blood system. Eventually the oxygen is carried to the heart, where it then becomes part of the cardiovascular system. However, polluted air that works its way through the respiratory and cardiovascular systems can cause problems.

2. Respiratory Effects

The respiratory system is extremely susceptible to pollutants. Ozone, metals, and other pollutants from the air enter the lungs and can cause damage. Ozone has been known to attack the alveoli, an integral piece of the respiratory system responsible for filtering in oxygen and filtering out carbon dioxide. Pollutants are also able to cause secondary damage to lung tissue by reacting with airway enzymes. Inflammation or infection of the lungs may occur.

3. Cardiovascular Effects

Once toxic substances reach the cardiovascular system, a number of reactions can occur. These include physical changes, degeneration, and inflammation of the heart and other areas of the cardiovascular system. Pollutants can also cause heart arrhythmias, which if severe enough can prove fatal.

4. Asthma

Perhaps the most well-known health defect caused by air pollution is asthma, a disease that can be both chronic and incapacitating. Traffic fumes were responsible for at least 500,000 asthma attacks and more than 25,000 new cases of chronic bronchitis each year in the United States.

There is concern that the threat to public health posed by city's air pollution is more important than smoking.

Ozone, sulphur dioxide, particulate matter like dust and ash, and nitrogen oxide have all been known to exacerbate or even trigger asthma. According to the Natural Resources Defense Council's website, about 30 per cent of asthma cases in children are a direct result of environmental pollution.

3.2 Water Borne Pollution

It is a well-known fact that clean water is absolutely essential for healthy living. Adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth, yet it has been observed that millions of people worldwide are deprived of this.

Freshwater resources all over the world are threatened not only by over exploitation and poor management but also by ecological degradation. The main source of freshwater pollution can be attributed to discharge of untreated waste, dumping of industrial effluent, and run-off from agricultural fields. Industrial growth, urbanisation and the increasing use of synthetic organic substances have serious and adverse impacts on freshwater bodies. It is a generally accepted fact that the developed countries suffer from problems of chemical discharge into the water sources mainly groundwater, while developing countries face problems of agricultural run-off in water sources. Polluted water like chemicals in drinking water causes problem to health and leads to water-borne diseases which can be prevented by taking measures. Measures can be taken even at the household level.

Groundwater and its Contamination

Fig. 1.1: Water Pump

Many areas of groundwater and surface water are now contaminated with heavy metals, POPs (Persistent Organic Pollutants), and nutrients that have an adverse effect on health. Water-borne diseases and water-caused health problems are mostly due to inadequate and incompetent management of water resources. Safe water for all can only be assured when access, sustainability, and equity can be guaranteed. Access can be defined as the number of people who are guaranteed safe drinking water and sufficient quantities of it. There has to be an effort to sustain it, and there has to be a fair and equal distribution of water to all segments of the society. Urban areas generally have a higher coverage of safe water than the rural areas. Even within an area there is variation: areas that can pay for the services have access to safe water whereas areas that cannot pay for the services have to make do with water from hand pumps and other sources.

In the urban areas water gets contaminated in many different ways, some of the most common reasons being leaky water pipe joints in areas where the water pipe and sewage line pass close together. Sometimes the water gets polluted at source due to various reasons and mainly due to inflow of sewage into the source.

Ground water can be contaminated through various sources and some of these are mentioned below.

Pesticides

Run-off from farms, backyards, and golf courses contain pesticides such as DDT that in turn contaminate the water. Leachate from landfill sites is another major contaminating source. Its effects on the ecosystems and health are endocrine and reproductive damage in wildlife. Groundwater is susceptible to contamination, as pesticides are mobile in the soil. It is a matter of concern as these chemicals are persistent in the soil and water.

Sewage

Untreated or inadequately treated municipal sewage is a major source of groundwater and surface water pollution in the developing countries. The organic material that is discharged with municipal waste into the watercourses uses substantial oxygen for biological degradation thereby upsetting the ecological balance of rivers and lakes. Sewage also carries microbial pathogens that are the cause of the spread of disease.

Nutrients

Domestic waste water, agricultural run-off, and industrial effluents contain phosphorus and nitrogen, fertilizer run-off, manure from livestock operations, which increase the level of nutrients in water bodies and can cause eutrophication in the lakes and rivers and continue on to the coastal areas. The nitrates come mainly from the fertilizer that is added to the fields. Excessive use of fertilizers causes nitrate contamination of groundwater, with the result that nitrate levels in drinking water is far above the safety levels recommended. Good agricultural practices can help in reducing the amount of nitrates in the soil and thereby lower its content in the water.

Synthetic organics

Many of the 100 000 synthetic compounds in use today are found in the aquatic environment and accumulate in the food chain. POPs represent the most harmful element for the ecosystem and for human health, for example, industrial chemicals and agricultural pesticides. These chemicals can accumulate in fish and cause serious damage to human health. Where pesticides are used on a large-scale, groundwater gets contaminated and this leads to the chemical contamination of drinking water.

Acidification

Acidification of surface water, mainly lakes and reservoirs, is one of the major environmental impacts of transport over long distance of air pollutants such as sulphur dioxide from power plants, other heavy industry such as steel plants, and motor vehicles. This problem is more severe in the US and in parts of Europe.

Chemicals in Drinking Water

Chemicals in water can be both naturally occurring or introduced by human interference and can have serious health effects.

Fluoride

Fluoride in the water is essential for protection against dental caries and weakening of the bones, but higher levels can have an adverse effect on health. In India, high fluoride content is found naturally in the waters in Rajasthan.

Arsenic

Arsenic occurs naturally or is possibly aggravated by over powering aquifers and by phosphorus from fertilizers. High concentrations of arsenic in water can have an adverse effect on health. A few years back, high concentrations of this element was found in drinking water in six districts in West Bengal. A majority of people in the area was found suffering from arsenic skin lesions. It was felt that arsenic contamination in the groundwater was due to natural causes. The government is trying to provide an alternative drinking water source and a method through which the arsenic content from water can be removed.
Lead. Pipes, fittings, solder, and the service connections of some household plumbing systems contain lead that contaminates the drinking water source.

Recreational use of water

Untreated sewage, industrial effluents, and agricultural waste are often discharged into the water bodies such as the lakes, coastal areas and rivers endangering their use for recreational purposes such as swimming and canoeing.

Petrochemicals

Petrochemicals contaminate the groundwater from underground petroleum storage tanks.

Other heavy metals

These contaminants come from mining waste and tailings, landfills, or hazardous waste dumps.

Chlorinated solvents

Metal and plastic effluents, fabric cleaning, electronic and aircraft manufacturing are often discharged and contaminate groundwater.

Diseases

Table 1.1: Water-Borne Diseases and their Causes

Cause	Water-Borne Diseases
Bacterialinfections	Typhoid
CholeraParatyphoid	fever
Bacillary dysentery	Viral infections
Infectious Hepatitis	(Jaundice)
Poliomyelitis	Protozoal infections
Amoebic	dysentery

Water-borne diseases are infectious diseases spread primarily through contaminated water. Though these diseases are spread either directly or through flies or filth, water is the chief medium for spread of these diseases and hence they are termed as water-borne diseases.

Most intestinal (enteric) diseases are infectious and are transmitted through faecal waste. Pathogens – which include virus, bacteria, protozoa, and parasitic worms – are disease-producing agents found in the faeces of infected persons. These diseases are more prevalent in areas with poor sanitary conditions. These pathogens travel through water sources and interfere directly through persons handling food and water. Since these diseases are highly infectious, extreme care and hygiene should be maintained by people looking after an infected patient. Hepatitis, cholera, dysentery, and typhoid are the more common water-borne diseases that affect large populations in the tropical regions. A large number of chemicals that either exist naturally in the land or are added due to human activity dissolve in the water, thereby contaminating it and leading to various diseases.

Pesticides

The organophosphates and the carbonates present in pesticides affect and damage the nervous system and can cause cancer. Some of the pesticides contain carcinogens that exceed recommended levels. They contain chlorides that cause reproductive and endocrinal damage.

Lead

Lead is hazardous to health as it accumulates in the body and affects the central nervous system. Children and pregnant women are most at risk.

Fluoride

Excess fluorides can cause yellowing of the teeth and damage to the spinal cord and other crippling diseases.

Nitrates

Drinking water that gets contaminated with nitrates can prove fatal especially to infants that drink formula milk as it restricts the amount of oxygen that reaches the brain causing the 'blue baby' syndrome. It is also linked to digestive tract cancers. It causes algae to bloom resulting in eutrophication in surface water.

Petrochemicals

Benzene and other petrochemicals can cause cancer even at low exposure levels.
Chlorinated solvents

These are linked to reproduction disorders and to some cancers.

Arsenic

Arsenic poisoning through water can cause liver and nervous system damage, vascular diseases and also skin cancer.

Other heavy metals

Heavy metals cause damage to the nervous system and the kidney, and other metabolic disruptions.

Salts

It makes the fresh water unusable for drinking and irrigation purposes.
Exposure to polluted water can cause diarrhoea, skin irritation, respiratory problems, and other diseases, depending on the pollutant that is in the water body. Stagnant water and other untreated water provide a habitat for the mosquito and a host of other parasites and insects that cause a large number of diseases especially in the tropical regions. Among these, malaria is undoubtedly the most widely distributed and causes most damage to human health.

Preventive Measures

Water-borne epidemics and health hazards in the aquatic environment are mainly due to improper management of water resources. Proper management of water resources has become the need of the hour as this would ultimately lead to a cleaner and healthier environment.

In order to prevent the spread of water-borne infectious diseases, people should take adequate precautions. The city water supply should be properly checked and necessary steps taken to disinfect it. Water pipes should be regularly checked for leaks and cracks. At home, the water should be boiled, filtered, or other methods and necessary steps taken to ensure that it is free from infection.

Minamata: Environmental Contamination with Methyl Mercury

In Minamata, Japan, inorganic mercury was used in the industrial production of acetaldehyde. It was discharged into the nearby bay as waste water and was ingested by organisms in the bottom sediments. Fish and other creatures in the sea were soon contaminated and eventually residents of this area who consumed the fish suffered from MeHg (methyl mercury) intoxication, later known as the Minamata disease. The disease was first detected in 1956 but the mercury emissions continued until 1968. But even after the emission of mercury stopped, the bottom sediment of the polluted water contained high levels of this mercury.

Various measures were taken to deal with this disease. Environmental pollution control, which included cessation of the mercury process; industrial effluent control, environmental restoration of the bay; and restrictions on the intake of fish from the bay. The research and investigative activities were promoted assiduously, and compensation and help was offered by the Japanese Government to all those affected by the disease.

The Minamata disease proved a turning point, towards progress in environment protection measures. This experience clearly showed that health and environment considerations must be integrated into the process of economic and industrial development from an early stage.

3.3 Soil Borne Pollution

Soil fertility: Soil pollution reduces soil fertility. This can be harmful to agriculture and lead to inadequate food-crop production, which can negatively affect human health.

Acidification: Many chemicals and salts can increase soil acidity according to World Health Organisation. Acid loving soils tend to be toxic to human health.
Ground water: Soil pollution can leach into the ground water and end up in drinking supplies, according to the World Health Organisation. Directly consuming the contaminated water can cause health effects associated with the type of chemical that are in the water.

Direct contact: Human health can be severely affected by direct contact with contaminated soil. For example building a playground on a contaminated site can be disastrous since the children will tend to come into heavy contact with the contaminated soil and their development will be drastically harmed. Chromium has been linked to cancer. Lead has been linked to kidney and brain damage. Mercury can lead to both kidney and liver damage.

Children are at a higher risk than adults, since soil pollution can get ingested into their bodies at much higher relative quantities.

3.4 Noise Pollution

Noise pollution affects everyone, yet this problem is largely ignored by most people. Upon hearing loud noises and sounds, we might be irritated but feel at a loss to do anything about it. Noise pollution comes from various sources including traffic, airports, industries, factories and highly populated urban areas. However, these are not the only ways we can be affected by noise pollution. A loud musical event such as a rock concert, occupational noises, and large crowds are just as detrimental to humans, especially with repeated exposure.

The effects of noise pollution on humans are being studied all over the world. The US Environmental Protection Agency (EPA) recommends a "safe noise level" of no more than 55 decibels. Decibels are units that help to express how loud sounds are. For example, sounds that are inaudible range from 0 to 10 decibels; noises that are loud enough to damage your hearing are 150 decibels.

Noise pollution affects sleep, eating habits, mood, concentration and body functions such as respiration and heart rate. When humans are unable to sleep due to noise, they get insomnia. Insomnia causes mood swings and can affect performance in all areas of your life, as well as negatively affect your health. Loud noises cause stress, increasing respiration and heart rate. Then your body begins to secrete hormones such as adrenaline, which prepare us for fight or flight. This response puts unnecessary stress on the body. As a result, your blood pressure

increases, leaving you vulnerable to heart disease. Stress also contributes to lowered immunity, which can lead to infection and illness. Some scientists are now suggesting that psychiatric disorders are related to noise. This theory is still under investigation and is highly controversial.

The most significant way that people are affected by noise is through hearing loss. This is easy to measure and widely studied. It is known that young people today experience hearing loss at early ages because of the loud music they listen to while wearing headphones and attending concerts. Therefore, teenagers are likely to hear 25 per cent less than their parents or grandparents do.

The effects of noise pollution are also relevant to each individual. Some people are not bothered by particular sounds as much as others might be. This is because some are more sensitive to auditory stimulation. It is not understood why certain people become more aggressive when exposed to loud noises, but it probably has to do with how much noise you are used to hearing. For example, a rural dweller who is used to the quiet sounds of nature would probably be agitated if he to spend the night in a city.

The EPA regulates businesses and areas for noise pollution. However, there are ways that you can control your environment. Noise-blocking devices such as earplugs and headphones cut out sounds that may affect your sleep, work or personal time. You can also buy CDs that play monotone- or nature-type sounds and use this as soothing background music. Another way to reduce noise is to get involved with local organisations that shape new business development and regulate present industries and noise problems in your area.

4.0 CONCLUSION

Environmental pollution threatens human health. Air pollution in cities causes a shorter lifespan for city dwellers. The major factor contributing to air pollution is vehicle emissions. Air pollution is thought to be the cause for 1 in 10 deaths due to lung cancer and is responsible for 24,000 premature deaths in the UK every year.
The effect of pollution generally on heath is overwhelming and everything needs to be done to control it.

5.0 SUMMARY

In this unit you have learnt of the effects of pollution on human health which include various diseases condition like asthma, poisoning, brain damage, damage to the liver, cancers and even communicable diseases

like cholera, typhoid, dysentery etc. Other physical trauma especially to do with noise pollution include – hearing loss, irritation, sleeplessness etc.

6.0 TUTOR-MARKED ASSIGNMENT

1. List five (5) health problems associated with exposure to polluted water.
2. Explain the effects of noise pollution on human health.
3. What was the pollutant involved in the popular Miamata incidence of water pollution?

7.0 REFERENCES/FURTHER READING

Wexler, P. (2000). *Information Resources in Toxicology, (3rd ed.).* San Diego: Academic Press; 178-199

Hodgson, E. (2004). *A Text Book of Modern Toxicology. (3rd ed.).* NJ: Willey-interscience Publisher.

Hodgson, E. & Smart, R. C. (2001). *Introduction to Biochemical Toxicology, (3rd ed.).* NY: Willey.

UNIT 2 IMPACT OF POLLUTANTS ON THE ECOSYSTEM

CONTENTS

1.0 INTRODUCTION

An ecosystem is a specialised community, including all the component organisms, that forms an interacting system, for example, a marsh. An environment is the totality of conditions surrounding an organism. There is the concern that pollution is having a serious negative impact and destabilising the natural equilibrium thereby threatening species existence. In this unit you will learn how pollution affects the ecosystem.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the concept of ecosystem
- describe the effects of pollution on the ecosystem.

3.0 MAIN CONTENT

3.1 Concept of Ecosystem

An ecosystem is a self-contained, dynamic system made of a population of species in its physical environment. This concept is used to study the complex interactions between the organisms - plants, animals, bacteria, and fungi - that make up the community. There are many different ways in which the community of organisms interacts.

There is the food chain where each organism is in a producer, consumer, predator, and prey relationship; there is the oxygen cycle and the water cycle that sustains the organisms. When an ecosystem gets polluted, the natural balance in the system is disturbed and this affects the organisms in different ways. It is important to know how a simple act like introducing sewage water or toxic waste into a lake can threaten several life species and plants in the area.
Man-made air pollutants such as Volatile Organic Compounds (VOCs),

carbon monoxide and sulphur dioxide are generated in densely-populated metro areas, and then carried by the wind to mountain and forest ecosystems such as the Sierra Nevada, where the toxic gases threaten plant, bird and animal species.

3.2 Pollution and the Ecosystem

Pollutants like oil, detergents, nitrogen and phosphate from fertilizers and lead can have a tremendous impact on the ecosystem, especially if the water gets polluted. In a lake, for example, it can wreak havoc on the ecological balance by stimulating plant growth and causing the death of fish due to suffocation resulting from lack of oxygen. The oxygen cycle will stop, and the polluted water will also affect the animals that are depending on the lake water.

Pollution from human population expansion, improper hazardous waste disposal, soil erosion and runoff from sewage and agricultural areas, as well as from man-made debris that ends up in marine ecosystems, pose a danger to coral reefs, according to the National Oceanic and Atmospheric Administration.

3.2.1 Oceans

It is no secret that humans are affecting the ocean ecosystem. What most people may not know is just how heavy the impact truly is. In fact 40 per cent of the planet's oceans have been severely affected by human activities. The majority of the damage comes from things like shipping; coastal development and fishing. As a result, marine life such as fish and shellfish are rapidly disappearing. In turn this upsets the balance of the oceans, because they are not as easily able to provide food or clean water. Also a declining marine population affects the fishing industries making it difficult for fishermen to make a living.

3.2.2 Lakes

Considering the heavy human population around lakes, it is no surprise that human impact has been substantial. Things like agriculture, industry and sewage treatment have caused a great deal of harm to the stability of lakes everywhere. Pollution from fertilizers has been known to increase aquatic plant growth, starving the lakes of oxygen. With a lack of oxygen, death of marine life, such as fish, is inevitable. Additionally dirty substances resulting from the pollution make lakes undesirable to fish or swim in.

3.2.3 Rivers

Rivers are heavily affected by pollution. Wastes from fertilizers affect rivers by speeding up algae growth making the water green. When the algae die, bacteria break them down and consume a lot of oxygen. The loss of oxygen causes death among various marine life forms. Industrial waste is also highly toxic. The chemicals emitted into rivers from industry can instantly kill fish.

3.2.4 Mountains

Mountain ecosystems are a primary source of water for the world's populations. Pollution and other factors such as deforestation and global climate change are threatening mountain ecosystems, according to the United Nations News Service. Effects include catastrophic flooding in places such as Bhutan.
Forests are declining in the Carpathian Mountains of Eastern Europe due to air pollution, according to the United States Forest Service. Air pollutants can penetrate soil and contaminate water in all ecosystems.

3.2.5 Plants

Pollution affects the natural balance of the world's ecosystems, which threatens the life cycles of a plethora of plant and animal species found within such ecosystems as coral reefs, wetlands, mountains and forests. The effects of pollution on ecosystems also pose a threat to future generations of mankind.

4.0 CONCLUSION

According to the United States Climate Change Science Program, ecosystems affect the climate system and sustain human life. "Ecosystems shape our societies and nations by providing essential renewable resources and other benefits," states USCCSP. It is therefore imperative to reduce all forms of pollution.

5.0 SUMMARY

You have learnt about the concept of ecosystem which is a self contained, dynamic system made of a population of species in its physical environment. There are also hard evidences proving the impact of pollution on different ecosystems such as oceans, lakes, rivers, mountains etc.

In the next unit we shall consider the economic impact of pollution on human populations.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the concept of ecosystem.
2. State four types of ecosystem and how pollution affect them.

7.0 REFERENCES/FURTHER READING

American Petroleum Institute (API) (1990). *Management of Water Discharges: Design and Operations of Oil-Water Separators* (1st ed.). American Petroleum Institute.

Gershon, C. (2006). "The 'Solution' to Pollution Is Still 'Dilution'". Earth Island Institute. http://www.earthisland.org/eijournal/new_articles.cfm?articleID=299&journalID=49. Retrieved 2006-02-14.[*dead link*]

"What is required". Clean Ocean Foundation. 2001. http://www.cleanocean.org/index_general.asp?menuid=240.010. Retrieved 2006-02-14.

"The Mixture Rule under the Resource Conservation and Recovery Act". U.S. Dept. of Energy. 1999. http://homer.ornl.gov/sesa/environment/guidance/rcra/mixture.pdf. Retrieved 2012-04-10.

World Carbon Dioxide Emissions (Table 1, Report DOE/EIA-0573, 2004, Energy Information Administration).

Carbon dioxide Emissions Chart (Graph on Mongabay website page based on Energy Information Administration's Tabulated Data).

UNIT 3 ECONOMIC IMPACT OF POLLUTION

CONTENTS

1.0 INTRODUCTION

Economic impacts studies of pollution are very valuable instruments in policy decisions making in the control of pollution. Since there are no available data on local economic effect of pollution in any situation in Nigeria we will in this unit share the China experience as listed in the main content. The research was undertaken by the Policy Research Centre of the National Environmental Protection Agency, 100035, Beijing. Most of the formulae used to arrive at results were not captured. However, the information will give you an insight to what economic cost/impact of pollutants/pollution is all about.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- describe the economic impact of pollution
- explain the parameters for measurement of cost
- state the importance of economic impact assessment of pollution.

3.0 MAIN CONTENT

3.1 Economic Losses Resulting from the Impact of Water

Pollution on Human Health

Water pollution may affect people indirectly through the aquatic food chain and through the use of waste water for crop irrigation. Water pollution can also have a direct affect on human health as a result of polluting drinking water, often causing infections and chronic or acute poisoning. In many parts of China, especially in suburban areas, waste water is used to irrigate crops. The advantages of using waste water in this way include its greater availability, its fertilizing properties, and the limited purification required. However, the long term costs of waste water irrigation outweigh the benefits. Waste water irrigation pollutes and damages both the agricultural environment and human health.

According to the *1993 Bulletin of China's Environmental Status*, waste water irrigation polluted 3.3 million ha (Mha) of farmland and affected a population of 40 million.

A 1980s study on irrigation conducted in Shenyang and Fushun in Liaoning province discovered the incidence of cancer in regions that irrigate with waste water was twice that of regions that relied on fresh water. In regions that irrigated with waters contaminated by petroleum, the incidence of certain major diseases was 1.5 to 20 times higher than in areas that relied on fresh water irrigation. Furthermore, the incidence of stomach cancer in areas irrigated with waste water was found to be 18 per 100,000, far higher than the 12 per 100,000 found in areas that irrigated with fresh water. In addition, the incidence of enteric disease was 5 per cent higher in regions that rely on waste water irrigation, and the incidence of hepatitis was 3.6 per cent higher.

The human capital formula is best suited to calculating economic losses resulting from the impact of water pollution on human health. According to data produced by public health departments, the average medical expenses per patient per year were: 5,595 yuan for cancer patients, 280 yuan for hepatitis patients and 93 yuan for patients with enteric disease. China's health system is unique in that the family of a sick person is responsible for his or her care, even while the sick person is residing in hospital. As a result, economic losses resulting from sickness and hospitalisation must also account for time lost by family members. The average number of days a family spends accompanying and caring for a family member is 36 days for cancer patients, 25 days for patients with hepatitis, and 10 days for patients with enteric disease. To summarise, the economic losses resulting from the impact of water pollution on human health is approximately 20 billion yuan.
In Nigeria for example, when rain falls, and surface runoffs fill the rivers and dams, the water bodies become heavily polluted. It becomes more expensive when the same water is to be treated for municipal supply for drinking. The additional cost of chlorine and other coagulants to be used runs into millions of Naira.

3.2 Economic Losses Resulting from the Impact of Water Pollution on Farm Yields

In the mid-1980s the Agricultural Environmental Protection Institute conducted a study of 380,000 hectares (ha) of farmland in 37 regions that depended on sewage water for irrigation. According to the study, farmland irrigated with sewage water yielded 80 million kg of grain less than farmland irrigated with clean water, a difference of 210 kg/ha in yields. Since 3.3 Mha of farmland were irrigated with sewage water in 1992, we estimate the resultant loss of grain yields was 690,000 tonnes.

It has been suggested that plants be used as indicators for harmful contaminants because of their greater sensitivity to certain specific contaminants. Hydrogen fluoride, sulphur dioxide, smog, ozone, and ethylene are among the compounds that can harm plants. Assessment of damage shows that the loss can be significant, although other factors such as soil fertility, temperature, light, and humidity also affect production. In May, 1970 it was reported in Czechoslovakia that more than 300 square miles of evergreen forests were severely damaged by sulphur dioxide fumes. Sulphur dioxide injury shows up as bleached and necrotic areas between the veins, growth suppression, and reduction in yield. Hydrogen fluoride injury shows as plant leaf tip and margin burn, chlorosis, dwarfing, abrupt growth cessation, and lowered yield.

3.3 Economic Losses Resulting from the Impact of Water Pollution on Livestock and Fisheries

It is estimated that 320,000 large animals were lost as a result of water pollution. The market value per head of cattle in 1985 was 1,000 yuan. Since we know that the 1992 purchase price was 179.3 per cent above the 1985 figure, we calculate that the average market price of livestock in 1992 was 1,793 yuan per head. Implementing the Market value formula, we estimate the loss of livestock to water pollution in the cities of Beijing and Tianjin, and the province of Liaoning at 580 million yuan. By adding 20 per cent to this figure, we arrive at 700 million yuan, reflecting the economic loss for the entire country.

Water pollution also caused the loss of 45,500 tonnes of fish in the country's 327,000 ha fresh water aquatic industry. Implementing the market value formula, we estimate the economic loss arising from an incremental decrease in aquatic yields at 64.61 million yuan. We then add the 400 million yuan lost to fisheries as a result of pollution accidents to this figure, arriving at the approximate total economic loss to fisheries of 460 million yuan. By combining the total economic loss resulting from the impact of water pollution on both the livestock and fisheries industries, we arrive at a total of 1.16 billion yuan.

Fluorides have caused crippling skeletal damage to cattle in areas where fluorides absorbed by vegetation are ingested. Animal laboratory studies show deleterious effects from exposure to low levels of ozone, photochemical oxidants, and peroxyacyl nitrates (PAN). Lead and arsenic have also been implicated in the poisoning of sheep, horses, and cattle. Likewise, some incidences of large cattle or animal mortality especially in the grazing fields of Northern Nigeria are largely due to soil pollution with dangerous chemicals or pesticides.

3.4 Economic Losses Resulting from the Impact of Air Pollution on Human Health

The main economic impact of air pollution on human health is the rising incidence of respiratory disease among people, resulting in a loss of human capital. There are three major respiratory illnesses focused; chronic bronchitis, pulmonary heart disease, and lung cancer. The economic loss resulting from the impact of air pollution on human health, in 1992, is approximately 20.16 billion yuan.

3.5 Economic Losses Resulting from the Impact of Air Pollution on Materials

Air pollution causes damage to materials, increasing the amount of time that must be devoted to household upkeep, laundering, and car washing. Due to its corrosive effect, air pollution also shortens the life span of structures, urban facilities, and factory equipment.

Pollutants cause damage to property, equipment, and facilities, in addition to increased medical costs, lost wages and crop damage. Sulphur pollution attacks copper roofs and zinc coatings; steel corrodes two to four times faster in urban and industrial areas; the usual electrical equipment contacts become unreliable unless serviced frequently; clothing fabric and leather are weakened; paint pigments are destroyed; and building surfaces, materials, and works of art are corroded. In addition particulates (including smoke) in polluted air cause erosion, accelerate corrosion, and soil clothes, buildings, cars, and other property, making more frequent cleaning and use of air –filtering equipment necessary. Ozone reduces the useful life of rubber, discolours dyes, and damages textiles.

Air pollutants interrupt part of the light from the sun, thereby increasing the use of electricity in daytime. Unburned fuel coming out of the chimney or auto exhaust pipe as black smoke is wasted energy. A study conducted by the United States Environmental Protection Agency (USEPA) reported that air pollution was costing the residents of big cities as much as $6 billion a year in property and health damage. Crop and ornamental plant losses were estimated at $160 million. Damage to buildings, clothing, and other property add $12.3 billion. Sickness alone from air pollution was estimated to cost Americans about $4.6 billion yearly in medical treatment, loss wages for sick workers, and lost work. The American Lung Association estimates pollution related losses in medical costs, lost wages, disability, and premature deaths to be more than $10 billion year.

Air pollution increases dust fall, adding to the time required for household upkeep. The life-span of clothes is shortened by the frequent laundering necessitated by air pollution. Frequent laundering also creates increased demand for water, electricity, and detergent. A 1990 study suggested that, as a result of air pollution, for every hour per day a person is exposed to the open air, he or she will be required to spend an additional 1.11 yuan on clothes laundering each year.

Acid rain is a particularly damaging component of air pollution. The corrosive impact of acid rain on steel shortens its effective life span from 44.4 years under normal conditions, to only 19 years under polluted conditions.

3.6 Economic Losses Resulting from Solid Waste

Solid waste contributes to soil and underground water pollution, and occupies land previously earmarked for other uses. According to a report issued by the National Environmental Protection Agency, 5.919 billion tonnes of industrial waste have accumulated over the past few years, occupying 54.5 thousand ha of land. This is equivalent to 100 million tonnes of waste for every 920 ha of occupied land. Statistics also confirm that in 1992 there were 618 million tonnes of solid waste, of which 256 million tonnes were reused, and 126 million tonnes were discharged. The remaining 336 million tonnes accumulated on approximately 3,100 ha of land.

The majority of solid waste accumulates around cities on land previously earmarked for vegetables and grain cultivation. The economic loss from land used for solid waste is 5.12 billion yuan (120 million x 42.67).
Economic losses resulting from environmental pollution in 1992 equalled approximately 98.61 billion yuan. This amount can be disaggregated as follows:

- water pollution contributed 35.6 billion yuan, accounting for 36.1 per cent of total losses
- air pollution contributed 57.89 billion yuan, accounting for 58.7 per cent of total losses
- solid waste contributed 5.12 billion yuan, accounting for 5.2 per cent of total losses.

These results are presented in Table 3.2.

Table 3.1: Losses Resulting from Pollution in 1992		
Environmental Factor	**Value of Economic Loss (billion yuan)**	**% of Total Loss**

Water Pollution	**35.60**	**36.10**
Human Health	19.28	
Industry	13.78	
Crop Yields	1.38	
Livestock	0.70	
Fisheries	0.46	
Air Pollution	**57.89**	**58.70**
Human Health	20.16	
Agriculture	7.20	
Household Upkeep	13.44	
Clothing	1.06	
Vehicles	1.07	
Buildings	0.96	
Acid Rain	14.00	
Solid Waste	**5.12**	**5.20**
Total	**98.61 (4.04% of GNP)**	**100.00**

The regional distribution of economic losses has been estimated to correspond with the industrial income of economic regions.

Table 3.2: Regional Distribution of Economic Losses

Region	**Total Value of Industrial Production (billion yuan)**	**Regional Share of Industrial Production (%)**	**Total Losses Resulting From Pollution (billion yuan)**	**Losses Resulting from Water Pollution (billion yuan)**	**Losses Resulting From Air Pollution (billion yuan)**	**Losses Resulting From Solid Waste (billion yuan)**
Countrywide	2894.165	100	98.61	35.6	57.89	5.12
North	367.457	12.67	12.51	4.52	7.35	0.65
North-East	356.617	12.33	12.16	4.39	7.14	0.63
East	1170.233	40.44	39.87	14.39	23.41	2.06
South-Central	650.87	22.49	22.17	8.01	13.02	1.15
South-West	220.144	7.61	7.50	2.71	4.41	0.39

North-West	128.844	4.45	4.39	1.58	2.56	0.22

Source*: The Figures for Regional Industrial Income are Derived from *A Statistical Survey of China, 1993.

China's Gross National Product (GNP) in 1992 was 2,437.89 billion yuan. The economic loss resulting from environmental pollution was 98.61 billion yuan, equivalent to 4.04 per cent of GNP. The results of this study are as follows: In 1992, environmental pollution in China resulted in 98.6 billion yuan in economic losses. These losses can be attributed as follows:

- water pollution accounted for 37.6 per cent of total losses, equivalent to 36.1 billion yuan
- air pollution accounted for 58.7 per cent of total losses, equivalent to 57.89 billion yuan
- solid waste accounted for 5.2 per cent of total losses, equivalent to 5.12 billion yuan.

  As a percentage of GNP, environmental pollution caused economic losses equivalent to 4.04 per cent of China's 1992 GNP.

4.0 CONCLUSION

As noted, economic losses resulting from environmental pollution are closely related to such factors as economic activities, population, and geographic conditions. Of these various factors, we consider economic activities to be the major contributor to economic losses resulting from environmental pollution.

5.0 SUMMARY

You have learnt how economic values have been attached to various scenarios of pollution in china and the estimated financial losses to the country. In Nigeria too even though such studies have not been carried out, it is obvious that the country is incurring huge losses from the ever increasing incidences of pollution in the country. What we need to do is to organise and enforce our pollution control strategies in order to reduce the economic burden it is imposing on us.

6.0 TUTOR-MARKED ASSIGNMENT

1. Explain the concept of economic impact of pollution.

2. Describe three parameters of pollution that can be economically evaluated
3. State two significance of economic costing of pollution.

7.0 REFERENCES/FURTHER READING

Guo Yongwen & Yu Guozheng (1983). "Analysis on Economic Return of Environmental Protection and Assessment on Pollution Hazard," *On Environment Economics --Colloquia of the National Symposium on Environment Economics (1981)* (Nanjing: Jiangsu Science and Technology Publishing House, pp. 130-143.

Zhu Jicheng & Wang Baibin (1983). "Research on Economic Loss Caused by Water Pollution," *On Environment Economics* (Nanjing: 1981 Colloquia of the National Symposium on Environment and Economics, Jiangsu Science and Technology Publishing House, pp. 230-339.

Zeng Beiwei (1985). "Study on Calculation Method on Economic Losses Caused by Environmental Pollution in Xiangjiang River Domain," *Environmental Pollution, Prevention and Control* (Vol. 7).

National Environmental Protection Agency [NEPA], (1990). *Environment Forecast and Countermeasure Research in China in 2000* (Beijing: Qinghua University Publishing House, pp. 273-290.

Research Institute of Environmental Protection Science of Liaoning Province, (1990). *Theoretical Method and Quantitative Research on Economic Losses Caused by Environmental Pollution* (keynote report, unpublished.

Research Institute of Environmental Protection Science of Yantai City, *Cost-Benefit Analysis on Assessment of Economic Losses Caused by Environmental Pollution.*

MODULE 5

UNIT 1 DEFINITION AND CONCEPT OF POLLUTION ABATEMENT AND CONTROL

CONTENTS

1.0 INTRODUCTION

It was the industrial revolution that gave birth to environmental pollution as we know it today. The emergence of great factories and consumption of immense quantities of coal and other fossil fuels gave rise to unprecedented air pollution and the large volume of industrial chemical discharges added to the growing load of untreated human waste. The emergence of big towns/cities and population explosion have contributed immensely to the problems of pollution in most developing countries. In this unit we shall be talking about the concept of pollution abatement and control.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- define pollution abatement
- state the methods of pollution abatement
- identify pollution sources and causes.

3.0 MAIN CONTENT

3.1 Concept of Pollution Control and Abatement

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat or light. Pollutants, the components of pollution, can be either foreign substances/energies or naturally occurring contaminants. Pollution is often classed as point source or nonpoint source pollution. The Blacksmith Institute issues an annual list of the world's worst polluted places. In the 2007 issues the ten top nominees are located in Azerbaijan, China, India, Peru, Russia, Ukraine and Zambia.

Pollution abatement refers to technology applied or measure taken to reduce pollution and/or its impacts on the environment. The most commonly used technologies are scrubbers, noise mufflers, filters, incinerators, waste—water treatment facilities and composting of wastes.

The cost of substantially reducing industrial pollution is high; how to finance it without undue economic burden remains a question. Some experts hold that since population growth automatically increases waste production, pollution can best be combated by population control. Another view is that worldwide proliferation of industry and technology is the chief culprit, posing the threat of global warming and requiring curtailment if pollution is to be conquered. The early 1990s brought discussion of more effective means to calculate the true costs of pollution in terms of its effects on health, productivity, and quality of life. There is considerable agreement, nonetheless, on the need for revised technology to diminish industrial and automotive emissions, to produce degradable wastes, and to dispose of all wastes in ways less damaging to the environment—for example, by returning sewage to the farm as fertilizer and by recycling glass and metal materials. Finally, improvement is required in techniques for preventing pollution by especially hazardous wastes. The difficulty of finding adequate permanent storage locations has been increased by opposition from residents of potential sites, who are concerned about health hazards. In

1997 more than 1.3 million people in the United States were employed in environmental industries related to pollution control.

Air pollution has always accompanied civilisations. Pollution started from the prehistoric times when man created the first fires. According to a 1983 article in the journal Science, "soot found on ceilings of prehistoric caves provides ample evidence of the high levels of pollution that was associated with inadequate ventilation of open fires. The forging of metals appears to be a key turning point in the creation of significant air pollution levels outside the home. Core samples of glaciers in Greenland indicate increases in pollution associated with Greek, Roman and Chinese metal production, but at that time the pollution was comparatively less and could be handled by nature.

Historical perspective – King Edward 1 of England banned the burning of sea-coal by proclamation in London in 1272, after its smoke became a problem. But the fuel was so common in England that this earliest of names for it was acquired because it could be carted away from some shores by the wheelbarrow. Air pollution would continue to be a problem in England, especially later during the industrial revolution, and extending into the recent past with the Great Smog of 1952. London also recorded one of the earlier extreme cases of water quality problems with the Great Stink on the Thames of 1858, which led to construction of the London sewerage system soon afterward.

Chicago and Cincinnati were the first two American cities to enact laws ensuring cleaner air in 1881. Other cities followed around the country until early in the 20th century, when the short lived Office of Air Pollution was created under the Department of the Interior. Extreme smog events were experienced by the cities of Los Angeles and Donora, Pennsylvania in the late 1940s, serving as another public reminder.

Later Development - Pollution became a popular issue after World War II, due to radioactive fallout from atomic warfare and testing. Then a non-nuclear event, The Great Smog of 1952 in London, killed at least 4000 people. This prompted some of the first major modern environmental legislation, The Clean Air Act of 1956.

Pollution began to draw major public attention in the United States between the mid-1950s and early 1970s, when Congress passed the Noise Control Act, the Clean Air Act, the Clean water Act and the National Environmental Policy Act.

Fig. 1.1: Smog Pollution in Taiwan

Incidences: Severe incidents of pollution helped increase consciousness. PCB dumping in the Hudson River resulted in a ban by the EPA on consumption of its fish in 1974. Long-term dioxin contamination at Love Canal starting in 1947 became a national news story in 1978 and led to the Superfund legislation of 1980. Legal proceedings in the 1990s helped bring to light hexavalent chromium releases in California--the champions of whose victims became famous. The pollution of industrial land gave rise to the name brown-field, a term now common in city planning.

Nuclear science: The development of nuclear science introduced radioactive contamination, which can remain lethally radioactive for hundreds of thousands of years. Lake karachay, named by the World-watch Institute as the "most polluted spot" on earth, served as a disposal site for the Soviet Union throughout the 1950s and 1960s. Second place may go to the area of Chelyabinsk U.S.S.R. (see reference below) as the "Most polluted place on the planet.

Nuclear weapons continued to be tested in the Cold War, sometimes near inhabited areas, especially, in the earlier stages of their development. The toll on the worst-affected populations and the growth since then in understanding about the critical threat to human health posed by radioactivity has also been a prohibitive complication associated with nuclear power. Though extreme care is practiced in that industry, the potential for disaster suggested by incidents such as those at Three Mile Island and Chernobyl pose a lingering specter of public mistrust. One legacy of nuclear testing before most forms were banned has been significantly raised levels of background radiation.

Catastrophes: International catastrophes such as the wreck of the Amoco Cadiz oil tanker off the coast of Brittany in 1978 and the Bhopal disaster in 1984 have demonstrated the universality of such events and

the scale on which efforts to address them needed to engage. The borderless nature of atmosphere and oceans inevitably resulted in the implication of pollution on a planetary level with the issue of global warming. Most recently the term Persistent Organic Pollutants (POP) has come to describe a group of chemicals such as PBDEs and PFCs among others. Though their effects remain somewhat less well understood owing to a lack of experimental data, they have been detected in various ecological habitats far removed from industrial activity such as the Arctic, demonstrating diffusion and bioaccumulation after only a relatively brief period of widespread use.

Growing evidences - Growing evidence of local and global pollution and an increasingly informed public over time have given rise to environmentalism and the environmental movement, which generally seek to limit human impact on the environment.

3.2 Forms of Pollution

The major forms of pollution are listed below along with the particular contaminant relevant to each of them:

Air pollution: the release of chemicals and particulates into the atmosphere. Common gaseous pollutants include carbon monoxide, sulphur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides produced by industry and motor vehicles. Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight. Particulate matter, or fine dust is characterised by their micrometre size PM10 to PM2.5.

Light pollution: includes light trespass, over-illumination and astronomical interference.

Littering: the criminal throwing of inappropriate man-made objects, onto public and private properties.

Noise pollution: which encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar.

Soil contamination: occurs when chemicals are released by spill or underground leakage. Among the most significant soil contaminants are hydrocarbons, heavy metals, MTBE, herbicides, pesticides and chlorinated hydrocarbons.

Radioactive contamination, resulting from 20th century activities in atomic physics, such as nuclear power generation and nuclear weapons

research, manufacture and deployment. (See alpha emitters and actinides in the environment).
Thermal pollution: is a temperature change in natural water bodies caused by human influence, such as use of water as coolant in a power plant.

Visual pollution: which can refer to the presence of overhead power lines, motorway billboards, scarred landforms (as from strip mining), open storage of trash, municipal solid waste or space debris.

Water pollution: by the discharge of wastewater from commercial and industrial waste (intentionally or through spills) into surface waters; discharges of untreated domestic sewage, and chemical contaminants, such as chlorine, from treated sewage; release of waste and contaminants into surface runoff flowing to surface waters (including urban runoff and agricultural runoff, which may contain chemical fertilizers and pesticides); waste disposal and leaching into groundwater; eutrophication and littering.

3.3 Sources and Causes

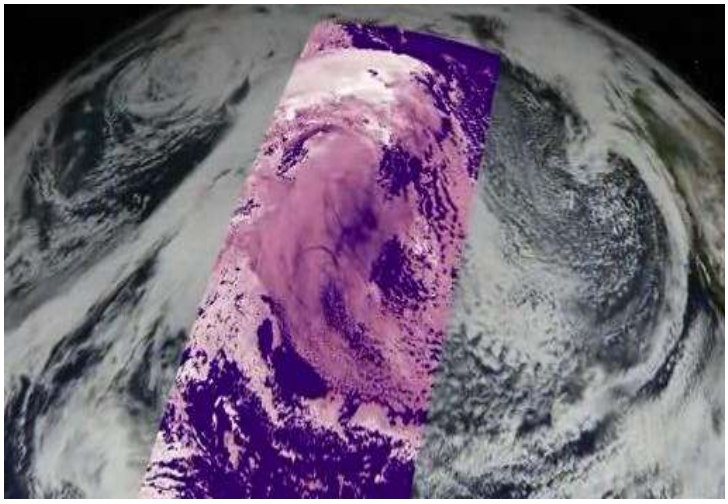


Fig. 1.2: Air Pollution Produced by Ships

Air pollution produced by ships may alter clouds, affecting global temperatures (Figure 1.2). Air pollution comes from both natural and human-made (anthropogenic) sources. However, globally human-made pollutants from combustion, construction, mining, agriculture and warfare are increasingly significant in the air pollution equation.
Motor vehicle emissions are one of the leading causes of air pollution.China, United States, Russia, Mexico, and Japan are the world leaders in air pollution emissions. Principal stationary pollution sources include chemical plants, coal-fired power plants, oil refineries,

petrochemical plants, nuclear waste disposal activity, incinerators, large livestock farms (dairy cows, pigs, poultry, etc.), PVC factories, metals production factories, plastics factories, and other heavy industry. Agricultural air pollution comes from contemporary practices which include clear felling and burning of natural vegetation as well as spraying of pesticides and herbicides.

About 400 million metric tons of hazardous wastes are generated each year. The United States alone produces about 250 million metric tons. Americans constitute less than five per cent of the world's population, but produce roughly 25 per cent of the world's CO2, and generate approximately 30 per cent of world's waste. In 2007, China has overtaken the United States as the world's biggest producer of CO2, while still far behind based on per capita pollution - ranked 78th among the world's nations.

In February 2007, a report by the Intergovernmental Panel on Climate Change (IPCC), representing the work of 2,500 scientists, economists, and policymakers from more than 120 countries, said that humans have been the primary cause of global warming since 1950. Humans have ways to cut greenhouse gas emissions and avoid the consequences of global warming, a major climate report concluded. But to change the climate, the transition from fossil fuels like coal and oil needs to occur within decades, according to the final report this year from the UN's Intergovernmental Panel on Climate Change (IPCC).

Some of the more common soil contaminants are chlorinated hydrocarbons (CFH), heavy metals (such as chromium, cadmium–found in rechargeable batteries, and lead–found in lead paint, aviation fuel and still in some countries, gasoline), MTBE, zinc, arsenic and benzene. In 2001 a series of press reports culminating in a book called Fateful Harvest unveiled a widespread practice of recycling industrial by-products into fertilizer, resulting in the contamination of the soil with various metals. Ordinary municipal landfills are the source of many chemical substances entering the soil environment (and often groundwater), emanating from the wide variety of refuse accepted, especially substances illegally discarded there, or from pre-1970 landfills that may have been subject to little control in the US or EU. There have also been some unusual releases of polychlorinated dibenzodioxins, commonly called dioxins for simplicity, such as TCDD. Pollution can also be the consequence of a natural disaster. For example, hurricanes often involve water contamination from sewage, and petrochemical spills from ruptured boats or automobiles. Larger scale and environmental damage is not uncommon when coastal oil rigs or refineries are involved. Some sources of pollution, such as nuclear

power plants or oil tankers, can produce widespread and potentially hazardous releases when accidents occur.

In the case of noise pollution the dominant source class is the motor vehicle, producing about ninety per cent of all unwanted noise worldwide.

3.4 Effects

3.4.1 Human Health

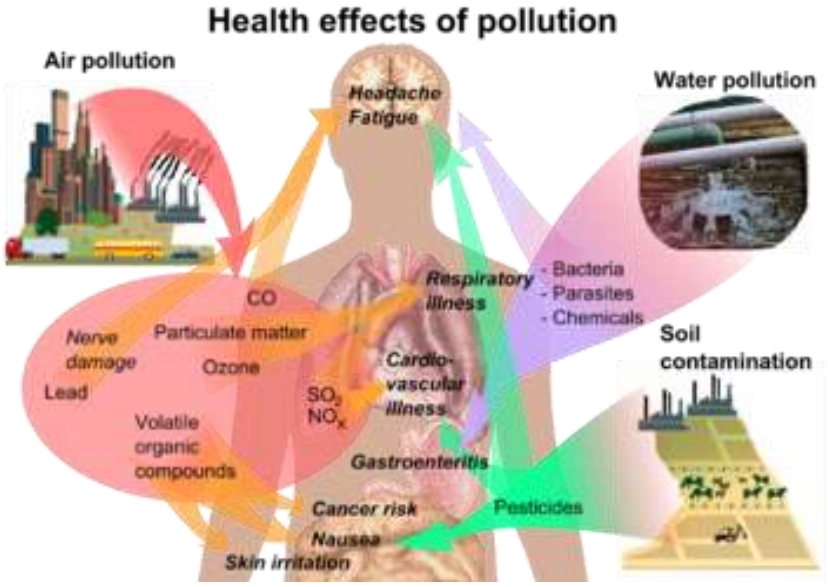


Fig. 1.3: Health Effects of Pollution

Overview of main health effects on humans from some common types of pollution.Adverse air quality can kill many organisms including humans. Ozone pollution can cause respiratory disease, cardiovascular disease, throat inflammation, chest pain, and congestion. Water pollution causes approximately 14,000 deaths per day, mostly due to contamination of drinking water by untreated sewage in developing countries. An estimated 700 million Indians have no access to a proper toilet, and 1,000 Indian children die of diarrhoeal sickness every day. Nearly 500 million Chinese lack access to safe drinking water. 656,000 people die prematurely each year in China because of air pollution. In India, air pollution is believed to cause 527,700 fatalities a year. Studies have estimated that the number of people killed annually in the US could be over 50,000.

Oil spills can cause skin irritations and rashes. Noise pollution induces hearing loss, high blood pressure, stress, and sleep disturbance. Mercury

has been linked to developmental deficits in children and neurologic symptoms. Older people are majorly exposed to diseases induced by air pollution. Those with heart or lung disorders are under additional risk. Children and infants are also at serious risk. Lead and other heavy metals have been shown to cause neurological problems. Chemical and radioactive substances can causecancer and as well asbirth defects.

3.4.2 Environment

Pollution has been found to be present widely in the environment. There are a number of effects of this:

Biomagnification describes situations where toxins (such as heavy metals) may pass through trophic levels, becoming exponentially more concentrated in the process.

Carbon dioxide emissions cause ocean acidification, the ongoing decrease in the pH of the Earth's oceans as CO2 becomes dissolved.
The emission of greenhouse gases leads to global warming which affects ecosystems in many ways.

Invasive species can compete with native species and reduce biodiversity. Invasive plants can contribute debris and biomolecules (allelopathy) that can alter soil and chemical compositions of an environment, often reducing native species competitiveness.

Nitrogen oxides are removed from the air by rain and fertilise land which can change the species composition of ecosystems.

Smog and haze can reduce the amount of sunlight received by plants to carry out photosynthesis and leads to the production of tropospheric ozone which damages plants.

Soil can become infertile and unsuitable for plants. This will affect other organisms in the food web.

Sulphur dioxide and nitrogen oxides can cause acid rain which lowers the pH value of soil.

3.5 Methods and Equipment of Pollution Abatement and Control

Pollution Control

Pollution control is the term used in environmental management. It means the control of emission and effluents into air, water or soil.

Without pollution control the waste product from consumption, heating, agriculture, mining, manufacturing, transportation and other human activities, whether they accumulate or disperse, will degrade the environment in the hierarchy of controls, pollution prevention and land development, low impact development is a similar technique for the prevention of urban runoff.

Pollution control devices
Dust collection systems
Baghouses
Cyclones
Electrostatic precipitators
Scrubbers
Baffle spray scrubber
Cyclonic spray scrubber
Ejector venturi scrubber
Mechanically aided scrubber
Spray tower
Wet scrubber
Sewage treatment
Sedimentation (Primary treatment)
Activated sludge biotreaters (Secondary treatment; also used for industrial wastewater)
Aerated lagoons
Constructed wetlands (also used for urban runoff)
Industrial wastewater treatment
API oil-water separators [15][35]
Biofilters
Dissolved air flotation (DAF)
Powdered activated carbon treatment
Ultrafiltration
Vapour recovery systems
Phytoremediation

Air Pollution Abatement Equipment

Equipment used to reduce or eliminate airborne pollutants, including particulate matter (dust, smoke, fly, ash, dirt, etc.), sulphur oxides, nitrogen oxides (NOx), carbon monoxide, hydrocarbons, odours, and other pollutants. Examples of air pollution abatement structures and equipment include flue-gas particulate collectors, flue-gas desulfurisation units and nitrogen oxide control devices.

Water Pollution Abatement Equipment

Equipment used to reduce or eliminate waterborne pollutants, including chlorine, phosphates, acids, bases, hydrocarbons, sewage, and other pollutants. Examples of water pollution abatement structures and equipment include those used to treat thermal pollution; cooling, boiler, and cooling tower blow down water; coal pile runoff; and fly ash waste water. Water pollution abatement excludes expenditures for treatment of water prior to use at the plant. (DOE5)

Practices
Recycling
Reusing
Reducing
Mitigating
Preventing
Compost.
Pollution Control Devises
Dust collection systems
Bag-houses
Cyclones
Electrostatic precipitator.

3.6 Regulation and Monitoring

To protect the environment from the adverse effects of pollution, many nations worldwide have enacted legislation to regulate various types of pollution as well as to mitigate the adverse effects of pollution. Much of legislation and policy issues on the abatement of pollution will be discussed in unit 3.

3.7 Taking on Pollution: A Global Attempt

While artificial chemical have improved the quality of life around the world, they have also posed a threat to the health of people and wildlife. In late 2000, in an effort to control the effect of toxic global pollutants, the United Nations Environmental Programme (UNEP) organised a meeting to draft a treaty to restrict the production and use of twelve persistent organic pollutants (POPs), especially those used as pesticides. The twelve toxic chemicals cited, which environmentalists have called the ‘’dirty dozen’’, include eight pesticides (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene), two types of industrial chemicals (hexachlorobenzene and polychlorinated biphynyls or PCBs), and two types of industrial by-products (dioxins and furans). These toxic pollutants were chosen not because they are the most dangerous, but because they are the most widely studied. Since it is still widely used in Africa to control malaria, DDT was given a special exemption: it can be used in those countries until replacement chemical

or strategies can be developed and put into place. One hundred and twenty-two nations (including the US) agreed to the treaty. Before it can take effect, however, at least fifty of those nations must also ratify it.

4.0 CONCLUSION

The earliest precursor of pollution generated by life forms would have been a natural function of their existence. The attendant consequences on viability and population levels fell within the sphere of natural selection. For humankind, the factor of technology is a distinguishing and critical consideration, both as an enabler and an additional source of by-products. Short of survival, human concerns include the range from quality of life to health hazards. Since science holds experimental demonstration to be definitive, modern treatment of toxicity or environmental harm involves defining a level at which an effect is observable. However, the combinations of both equipment and methodologies have assisted in the abatement of pollution everywhere in the world.

5.0 SUMMARY

"The solution to pollution is dilution", is a dictum which summarizes a traditional approach to pollution management whereby sufficiently diluted pollution is not harmful. It is well-suited to some other modern, locally scoped applications such as laboratory safety procedure and hazardous material release emergency management. The use of devices in the abatement of pollution in on the increase and as we advance we continue to explore more of such methods and devices for the effective control and abatement of pollution.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define pollution abatement.
2. List five pollution abatement equipment.
3. Describe two effects of pollution on human health.

7.0 REFERENCES/FURTHER READING

"Pollution - Definition from the Merriam-Webster Online Dictionary". Merriam-webster.com. 2010-08-13.http://www.merriam-webster.com/dictionary/pollution. Retrieved 2010-08-26.

The World's most polluted places, Blacksmith Institute - September 2007

Spengler, J. D. & Sexton, K. A. (1983). "Indoor Air Pollution: A Public Health Perspective" Science (New Series) 221 (4605), 9–17.

Hong, Sungmin et al. (1996). "History of Ancient Copper Smelting Pollution During Roman and Medieval Times Recorded in Greenland Ice" Science (New Series) 272 (5259), 246–249.

David Urbinato (1994). "London's Historic "Pea-Soupers"".United States Environmental Protection Agency. http://www.epa.gov/history/topics/perspect/london.htm. Retrieved 2006-08-02.

"Deadly Smog".PBS.2003-01-17. http://www.pbs.org/now/science/smog.html.Retrieved 2006-08-02.

James, R. F.& Bethany, R. K. (2006). "History of the Clean Air Act".American Meteorological Society.http://www.ametsoc.org/sloan/cleanair/. Retrieved 2006-02-14.

UNIT 2 INSTITUTIONAL ARRANGEMENT FOR POLLUTION CONTROL

CONTENTS

1.0 INTRODUCTION

Institutions established to cater for the control of pollution in the environment are very useful instruments for the prevention and control of pollution. In Nigeria and most developing countries these institutions are basically set up to provide services like water supply, garbage collection etc.; however, they yet have pollution control as mandate without the necessary instrumentation, data and expertise to function effectively. In this unit we shall examine the roles of these institutions in pollution control.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- state key institutions responsible for pollution control in your country
- identify some other countries arrangement for pollution control
- list some international organisations involved in pollution control activities
- list the objectives of pollution control Agencies.

3.0 MAIN CONTENT

3.1 Water Pollution Control

Water pollution control is typically one of the responsibilities of a government as it aims to protect the environment for the good of the general public. Governments undertake to do this by establishing an appropriate set of organisations and launching programmes. These interventions aim at achieving national, or regional, objectives that include, for example enhanced economic productivity, public health and well-being (all of which should, ideally, form part of a sustainable development strategy).

Water pollution control comprises four main functions: water quality management, regulation and standard setting, on site sanitation and collection and treatment of domestic and industrial waste water. Each function needs appropriate institutional arrangement in order to make the whole sub-sector work effectively. In many instances the regulatory function has proved to be a comparatively easy part of the overall task.
The types of institutional arrangements for water pollution control often differ, but not always from those for water supply. The ‘’optimal’’ arrangement depend on the political and institutional environment, the economic policy, the roles and values of water in the country, the local topography and hydrogeology, and the natural environment.

Many types of arrangement exist and could fulfill the necessary requirements, No ‘’ideal’’ type exists that could be prescribed to any country at any moment in the world. A prerequisite is that an appropriate match between the organisational mandates and structure and the institutional environment. Depending on local conditions, the preferred organisations may have a particular scale and scope. Typically, however, water pollution control requires a relationship with water management and hence large scale (10-100km, covering a river or drainage basin or an agglomeration of municipalities). Usually single municipalities are unable to generate the required vision, finance and technical knowledge. Where it is possible to enhance particular function, mergers with other sub-sectors or utilities may be advisable.

As water infrastructure is so expensive, the generation of finance is a key consideration for investment, and for operation and maintenance. Consequently, institutions must be designed to allow cost recovery. This necessitates devolution of decision making and operation maintenance to lower administrative levels, i.e. closer to the consumer and citizen.

In order to render the organisations flexible, task and performance oriented, and financially well managed, they require a large degree of autonomy. For this purpose, the conventional command and control must be deregulated and replaced by measures that ensure self-regulation. This may include arrangement for competition (for service

contracts, for example) avoidance or control of monopolies, or the prevention of executives organisations from regulating themselves. Delegated management and privatisation may be useful components in a deregulation strategy. However, the institutional environment must be equally developed to ensure adequate control of the private partners and to avoid monopoly and cartel formation.

In Nigeria for example some of the institutional arrangements for water pollution control include the Federal Ministry of Water Resources, Environment and Health. At the state levels, institutions like the State Ministries of Water Resources, Environment, Health and the Water Boards, Environmental Protection Agencies etc. exist.

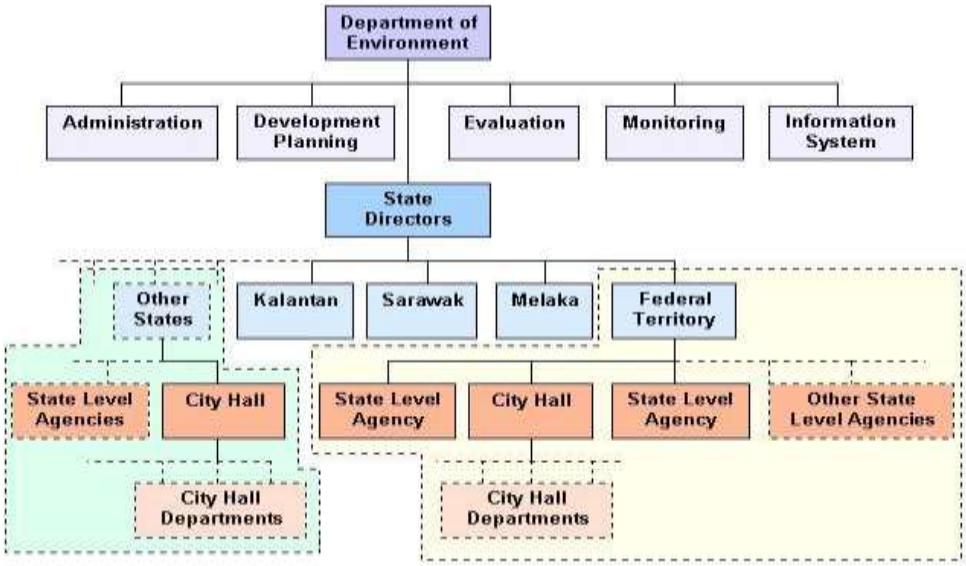
At the international level, United Nations Agencies like the UNEP, FAO are relevant institutions that have stake in water pollution.

3.2 Role of Public and Private Agencies and Water Users

A wide range of public and private sector agencies are involved in drainage water management and they deal with issues of regulation, conservation and communication (NESPAK and Mott MacDonald, 1992). In developed countries, drainage water management is usually the responsibility of both the individual farmer and some type of collective organisation, such as an irrigation or drainage district, water user group or a municipal-type authority. The collective organisationmay monitor the performance of on-farm drainage systems and ensure compliance with federal and local water quantity and quality regulations and standards. In much of the developing world, however, drainage development is at a low level and heavily dependent on government initiatives. Individual farmers are responsible for on-farm drainage, but enforcement of regulations is difficult due to a lack of formal water quality standards, the absence of organised user groups, or weak enforcement capacity on the part of governmental institutions. It is, therefore, important to redefine public (both central and local) and private sector roles in water management and to strengthen technical and management capacities for setting, monitoring and enforcing workable standards, and for promoting water conservation measures. Such standards and measures are usually formulated within a framework of overall water and environmental policy at various levels in a country or region. For example, in France, drainage improvement plans are expected to be in line with the regional water management master plan proposed by the country's 1992 Water Law (Zimmer et al., 1996).

3.3 Air Pollution Control

In Nigeria, there are no specific institutions for the control of air pollution as such, like is the case with water, however, certain institutions like the states environmental protection Agencies and the Ministries of Environment both at the States and Federal have mandate of air pollution control. For most developing countries that is the case. Example of what obtains in Malaysia is illustrated in Figure 1.1



Malaysia: Institutional Arrangement for Environmental Management
Fig. 2.1: Central Environmental Authority Responsibilities

The Department of Environment (DoE) is the primary authority with regard to the environment in Malaysia.

It comprises of five Divisions;

1) Administration Division,
2) Control Division,
3) Development Planning Division,
4) Assessment Division, and
5) Information Technology Division. It also includes 13 other State offices, one of which is the Federal Territory of Kuala Lumpur.

State-level Authority: Department of Environment - Federal Territory Responsibilities Federal Territory of Kuala Lumpur has its own State-level agency to handle its environmental problems and regulations. Its main function is to monitor sources of pollution from smoke and noise pollution from vehicles and works closely with City Hall of Kuala Lumpur in its environmental monitoring and enforcement.

Local Authority/Government - City Hall Responsibilities City Hall of Kuala Lumpur has eight departments that deal with planning, impacts

resulting from development, management or monitoring of environmental pollution and other directly or indirectly related aspects in the Federal Territory of Kuala Lumpur.

Work Share between City Hall and DoE

Pollution monitoring under the City Hall of Kuala Lumpur is very wide in scope, where as the DoE focuses on more specific areas, previously mentioned above - smoke and noise pollution from vehicles.

With regard to enforcement, City Hall considers that enforcement concerning premises and factories should be turned over to DoE, along with enforcement of specific noise pollution control measures.

3.4 Food and Soil Pollution Control

The National Agency for Food and Drugs Administration and Control (NAFDAC), the Environmental Health Officers Registration Council of Nigeria (EHORECON), and the Environment and Health authorities at the local Government levels have responsibility for food pollution or soil pollution control as the case may be in their various areas of jurisdiction in Nigeria.

The main objectives of these institutions are to:

- ensure the wholesomeness of food meant for human consumption
- prevent the adulteration of food
- prevent the pollution of food with harmful substances
- control the sale of counterfeit food products
- also to prevent/control the pollution/degradation of soil
- control the transfer of harmful substances from the soil into human food etc.

4.0 CONCLUSION

Institutional arrangement for the control of pollution is very important for the control of pollution everywhere in the world. Governments and authorities must be encouraged and supported to control all aspects of pollution as a global initiative for sustainable development.

5.0 SUMMARY

The various media of pollution; water, air, soil and food could have their institutional arrangements for pollution control in accordance with various national policies. In Nigeria, the important institutions include the Ministries of water Resources, Environment, Health, Agriculture and

the various Agencies and authorities at the states and local Government councils respectively.

6.0 TUTOR-MARKED ASSIGNMENT

List four objectives of pollution control institutions.
Identify three key National institutions for the control of pollution in Nigeria.

7.0 REFERENCES/FURTHER READING

http://www.theenvironmentalblog.org/environmental-issues/. Retrieved 2011-12-10.

Concerns about MTBE from U.S. EPA website

Declaration of the United Nations Conference on the Human Environment, 1972

Environmental Performance Report 2001 (Transport, Canada website page)

State of the Environment, Issue: Air Quality (Australian Government website page)

Pollution and Society Marisa Buchanan and Carl Horwitz, University of Michigan7.http://www.unescap.org/drpad/publication/integra/volume2/malaysia/2my03b01.ht^1952: London fog clears after days of chaos

UNIT 3 POLICY AND LEGISTILATION MEASURES ON POLLUTION CONTROL

CONTENTS

1.0 INTRODUCTION

Policy and legislation are the backbone of any project implementation in the society. Policies will usually give the direction and the main thrust of a project while legislation will provide the necessary legal authority to enforce the goals of a policy. Pollution in Nigeria has only in the recent past enjoyed the benefits of National policies and legislations compared to some advanced countries that have experienced the need for a very long time. In this unit we are going to examine issues of policy and legislation in historical perspective and the development in both Nigeria and outside.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- give a brief history of pollution related policies and legislation in Nigeria
- state the goals of pollution policies
- list certain policies and legislations on pollution control.

3.0 MAIN CONTENT

3.1 Historical Perspectives

It was the industrial revolution that gave birth to environmental pollution as we know it today. The emergence of great factories and consumption of immense quantities of coal and other fossil fuels gave rise to unprecedented air pollution and the large volume of industrial chemical discharges added to the growing load of untreated human

waste. Chicago and Cincinnati were the first two American cities to enact laws ensuring cleaner air in 1881. Other cities followed around the country until early in the 20th century, when the short lived Office of Air Pollution was created under the Department of the Interior. Extreme smog events were experienced by the cities of Los Angeles and Donora, Pennsylvania in the late 1940s, serving as another public reminder.

King Edward I of England banned the burning of sea-coal by proclamation in London in 1272, after its smoke became a problem. Air pollution would continue to be a problem in England, especially later during the industrial revolution, and extending into the recent past with the Great Smog of 1952. London also recorded one of the earlier extreme cases of water quality problems with the Great Stink on the Thames of 1858, which led to construction of the London sewerage system soon afterward.

Modern Awareness

Pollution became a popular issue after World War II, due to radioactive fallout from atomic warfare and testing. Then a non-nuclear event, The Great Smog of 1952 in London, killed at least 4000 people. This prompted some of the first major modern environmental legislation, The Clean Air Act of 1956.

Pollution began to draw major public attention in the United States between the mid-1950s and early 1970s, when Congress passed the Noise Control Act, the Clean Air Act, the Clean Water Act and the National Environmental Policy Act.

Smog Pollution in Taiwan

Severe incidents of pollution helped increase consciousness. PCB dumping in the Hudson River resulted in a ban by the EPA on consumption of its fish in 1974. Long-term dioxin contamination at Love Canal starting in 1947 became a national news story in 1978 and led to the Superfund legislation of 1980. Legal proceedings in the 1990s helped bring to light hexavalent chromium releases in California.

The development of nuclear science introduced radioactive contamination, which can remain lethally radioactive for hundreds of thousands of years. Lake Karachay, named by the World-watch Institute as the "most polluted spot" on earth, served as a disposal site for the Soviet Union throughout the 1950s and 1960s.

Nuclear weapons continued to be tested in the Cold War, sometimes near inhabited areas, especially in the earlier stages of their

development. The toll on the worst-affected populations and the growth since then in understanding about the critical threat to human health posed by radioactivity has also been a prohibitive complication associated with nuclear power.

International catastrophes such as the wreck of the Amoco Cadiz oil tanker off the coast of Brittany in 1978 and the Bhopal disaster in 1984 have demonstrated the universality of such events and the scale on which efforts to address them needed to engage. The borderless nature of atmosphere and oceans inevitably resulted in the implication of pollution on a planetary level with the issue of global warming. Most recently the term Persistent Organic Pollutant (POP) has come to describe a group of chemicals such as PBDEs and PFCs among others. Though their effects remain somewhat less well understood owing to a lack of experimental data, they have been detected in various ecological habitats far removed from industrial activity such as the Arctic, demonstrating diffusion and bioaccumulation after only a relatively brief period of widespread use. Growing evidence of local and global pollution and an increasingly informed public over time have given rise to environmentalism and the environmental movement, which generally seek to limit human impact on the environment.

In Nigeria, right from the British rule in the 1900s, the colonial economic development, policies and plans contain little or no stringent rules to conserve the natural resources or to limit pollution. Thus the formative stage of institutional environmental regulation in Nigeria could be said to have been characterised by the absence of clear scientific criteria and standards on toxic wastes and pollution levels.
In 1988 as part of the emerging coordinated approach to environmental issues, the Federal Environmental Protection Agency (FEPA) was established due to discovery of an Italian ship in May 1988 of some imported toxic wastes.

3.2 National Policy Measures on Pollution Control

The creation of the Federal Environmental Protection Agency in 1988 which later metamorphosed to the Federal Ministry of Environment witnessed the beginning of the consciousness of the environment in Nigeria. This development was greeted by the enactments of environmental control policies and legislations. The S.I 19 and S.I 15 of 1991 were regulations specifically on pollution control, as a fall-out of the 1988 event.

Later developments witnessed the transformation of FEPA into the Federal Ministry of Environment and in 2002 the establishment of the Environmental Health Officers Registration Council of Nigeria

(EHORECON). These were products of policy to putting in place institutions that will not only address the issues of pollution but also to regulate the practice of personnel and manpower involved in pollution control.

In 2005, the Department of Pollution Control in the Federal Ministry of Environment launched the National Environmental Sanitation Policy (NESP), a policy and national strategy aimed at addressing the issues of sanitation and waste management.

EHORECON also launched the National Environmental Health Practice Regulations (NEHPRs) in 2007 to address among other issues the problem of industries inspection and pollution control.

On a similar note the National Environmental Standards Regulations and Enforcement Agency (NESREA) was established in 2007. Since its establishment NESREA has enacted many national regulations and guidelines on the quality of air, water, soil and biodiversity and wildlife management.

The states and local government councils have follow suit of the national legislations and a times have adapted to suit local situations.
3.3 National Legislation on Pollution Control
Some of the common legislative instruments for pollution control in Nigeria include the following:

Environmental Health Officers Registration Council Act; 2002.
NESREA Act; of 2007
S.I. 19 of 1991
S.I. 15 of 1991
Public Health Law of 1958
Factories Act of 1958
Environmental Sanitation Laws/Edicts of the various states and
The LGAs bye Laws on Sanitation.

4.0 CONCLUSION

In conclusion, the goals of policies and legislation on pollution control can be summarised as:

To control the environment from the harmful effects of pollutants
To protect human health and property damage from the effects of pollution
To prescribe standards and limitations for pollutants/effluents discharge
To ensure the conservation of natural resources
To advance the principles of sustainable development

5.0 SUMMARY

The Federal policies and legislation on pollution control provide a policy and legislative instrument for effective control. Legislations vary in scope, depending on the context, specific locality, ecology, customs and traditions. However, the national instrument yet provides the necessary framework for adaptation to local situations.

You have learnt that the colonial masters did not have any sound policy on pollution control for Nigeria until only in the late 80s that the issue of environmental concern began to receive serious attention.

6.0 TUTOR-MARKED ASSIGNMENT

1. State four goals of pollution policy in Nigeria.
2. List five institutions concerned with pollution policies /legislation in Nigeria.
3. Enumerate three legislative instruments on pollution control in Nigeria.

7.0 REFERENCES/FURTHER READING

Handbook of Air Pollution Technology. New York: Wiley, 2001.

Jorgensen, E. P. (Ed.). (1989). The Poisoned Well: New Strategies for Groundwater Protection. Washington, DC: Island Press.

Kenworthy, L. & Schaeffer, E. (1990).A Citizens Guide to Promoting Toxic Waste Reduction. New York: INFORM.

Matthews, J. A., Bridges, E. M. & Christopher, J. C. (2001).The Encyclopaedic Dictionary of Environmental Change. New York: Edward Arnold.

UNIT 4 INDUSTRIAL METHODS FOR POLLUTION CONTROL

CONTENTS

1.0 INTRODUCTION

Industries represent human activities, and they are the most veritable sources of generation of pollutants into the environment. Efforts geared towards the control of pollution at the source of generation are very important in environmental Health. In modern day practice, the use of equipments is more effective and more assuring. In this unit we are going to examine the workings of the different types of pollution control equipment we have.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- list methods of pollution control in the industry
- describe at least two methods
- define pollution control.

3.0 MAIN CONTENT

3.1 Pollution Control

Pollution control is the process of reducing or eliminating the release of pollutants into the environment. It is regulated by various environmental agencies which establish pollutant discharge limits for air, water, and land.

Control of environmental pollution at source is very good attempt resulting in reduction of environmental pollution which not only effect human beings but also the other wonderful creatures living in this

beautiful world. Method of controlling air and water pollution should be given thrust as everybody will get affected by the same. Pollution control board should take necessary action at their end with the full cooperation of the public at large. Pollution has become the biggest problem in today's world. No place is left over on earth without pollution and pollutants.

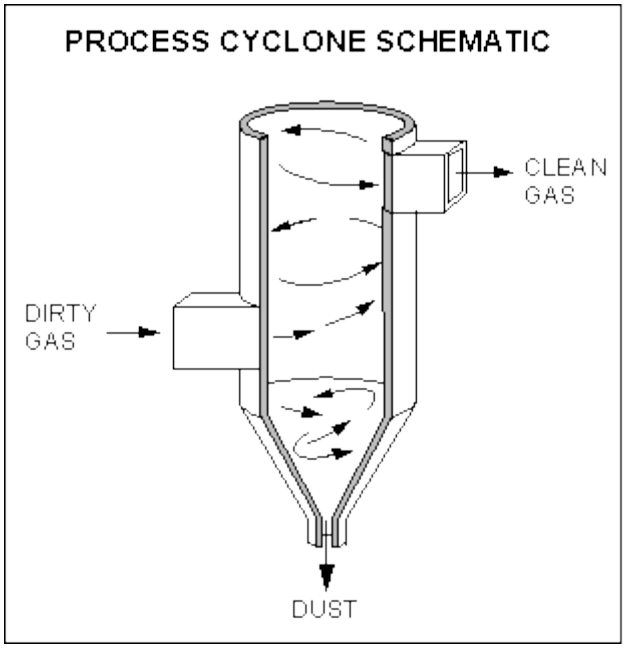
Air pollution control strategies can be divided into two categories, the control of particulate emission and the control of gaseous emissions. There are many kinds of equipment which can be used to reduce particulate emissions. Physical separation of the particulate from the air using settling chambers, cyclone collectors, impingers, wet scrubbers, electrostatic precipitators, and filtration devices, are all processes that are typically employed.

3.2 Control Devices/Methods in Industries

1. Cyclones

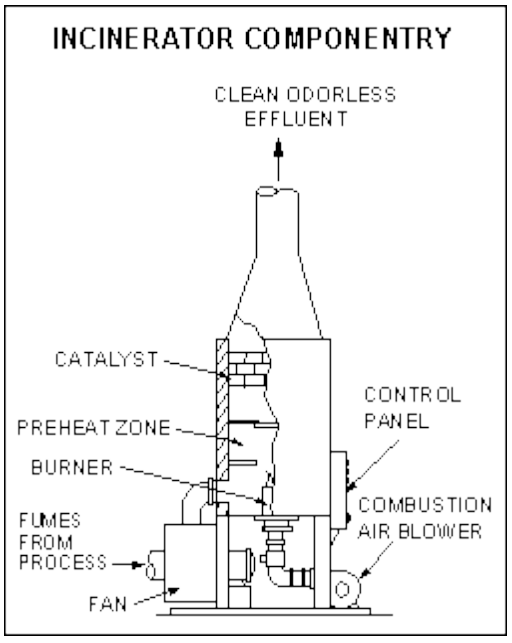
Cyclones operate to collect relatively large size particulate matter from a gaseous stream through the use of centrifugal forces. Dust laden gas is made to rotate in a decreasing diameter pathway forcing solids to the outer edge of the gas stream for deposition into the bottom of the cyclone. 90% efficiency in particle sizes of 10 microns or greater are possible.

Performance & Collection Efficiency
Linear increases with particle density, gas stream velocity, and rotational passes
Linear decrease with fluid viscosity
Exponential increase with particle diameter.
Limitations / Advantages / Problems
Reduces internal access needs
Optimal flow rate difficult to adjust
Prone to internal erosion / corrosion
Operation at elevated temperatures possible
Low efficiency for small diameter material
Hopper recirculation / flow distribution problems
High energy costs for volumetric flow requirements
Dew point agglomeration, bridging, and plugging
Few moving parts, few mechanical / electrical ignition sources.



2. Incinerators

Incineration involves the high efficiency combustion of certain solid, liquid, or gaseous wastes. The reactions may be self sustaining based on the combustibility of the waste or require the addition of fuels. They may be batch operations or continuous as with flares used to burn off methane from landfills; and, they may incorporate secondary control methods and operate at efficiency levels of 99.99%, as with hazardous waste incinerators. Combustion temperatures, contact time, and mass transfer are the major parameters affecting incineration performance.
Performance & Efficiency Parameters



t = V/Q t = residence time
where; V = incinerator volume
Q = gas volumetric flow rate at combustion conditions

Increased residence times mean increased performance

$$\text{hydrocarbon incineration rate} = \frac{d[HC]}{dt} = -k\,[HC]$$

where, [HC] = concentration of hydrocarbon
-k = reaction rate constant

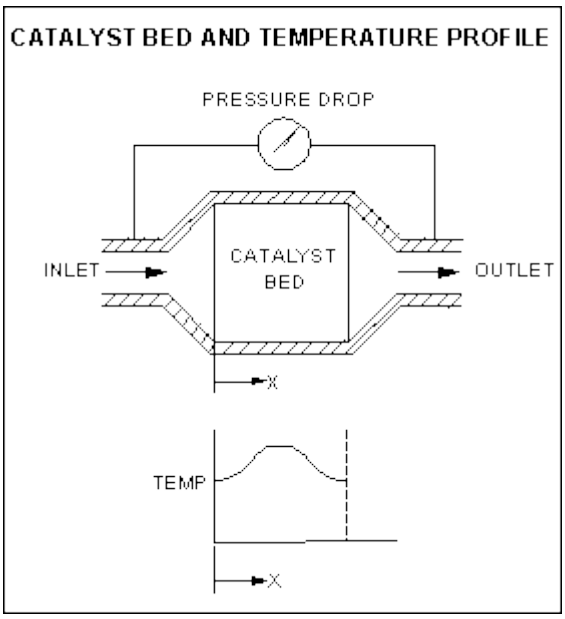
Increased residence times mean increased performance

Increased waste stream concentrations mean increased percentage rates of incineration
Limitations / Advantages / Problems
High destruction efficiencies possible
Variations in fuel content of waste
Transition among wastes require significant control changes
Good for gases, liquids, and solids
High cost of supplementary fuel
High temperatures require good thermal loss control
Hot surfaces, flashback, and explosive conditions.

3. Catalytic Reactors

Catalytic reactors can perform similar thermal destruction functions as incinerators, but for selected waste gases only. They incorporate beds of solid catalytic material that the unwanted gases pass through typically for oxidation or reduction purposes, and have the advantages of lowering the thermal energy requirements and allow small, short-term fluctuations in stoichiometry. Efficiency kevels of 99.99% are possible with reduced energy costs. Increasing pressure drops across the catalyst bed increase energy / operating costs.

Performance & Efficiency Parameters



Pressure drop = $\frac{(L)(uf)(V^2)}{A}$

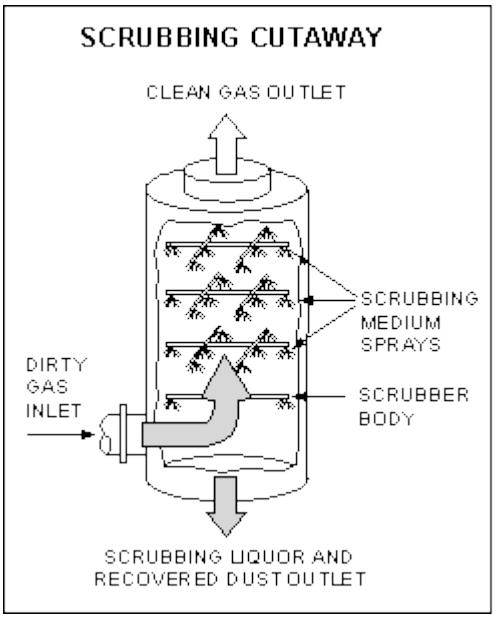
where; L = bed thickness
V = velocity
uf = fluid viscosity
A = cross-sectional area

Limitations / Advantages / Problems
Supplementary fuel savings
Short-circuiting of flow through bed
Excessive oxidation and thermal failure
Breakthrough of emissions as failure mode
Abrasion and thermal shock of catalyst
Poisoning of catalyst and drop in performance
Thick beds cause high pressure drops and increased energy costs.

4. Absorption & Wet Scrubbing Equipment

The goal in absorption and wet scrubbing equipment is the removal of gases and particulate matter from an exhaust stream by causing the gaseous contamination to become dissolved into the liquid stream and the solids to be entrained in the liquid. The rate of gas transfer into the liquid is dependent upon the solubility, mass transfer mechanism, and equilibrium concentration of the gas in solution. Gas collection efficiencies in the range of 99% are possible. The rate of particulate matter collection at constant pressure drops is inversely proportional to

the aerodynamic mean diameter of the particulate matter and scrubber droplets.



where, Hk) is Henry's constant
[Cgas] is the concentration in the gas stream
[Cliquid] is the concentration in the liquid stream

Performance & Efficiency Parameters

For gas collection, the maximum equilibrium concentration in solution is described by Henry's law:

[Cgas] = (Hk) [Cliquid]

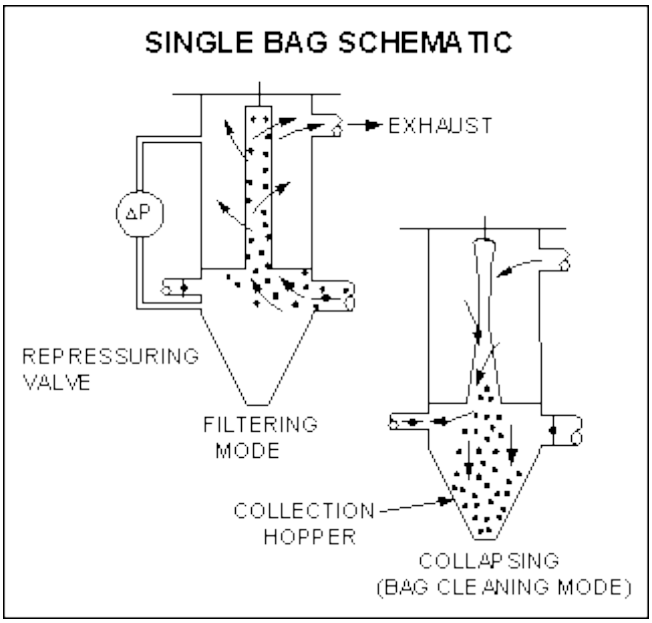
Limitations / Advantages / Problems
High pressure drops required
Internal plugging, corrosion, erosion
Increased need for internal inspection
Formation / precipitation of solids
Few internal moving parts
Reduced opportunity for gas ignition
Gas and liquid chemistry control important
Increased relative velocity between scrubbing the fluid and gas stream, increases efficiency for solids.

5. Baghouses

Bag houses utilise sieving, impaction, agglomeration, and electrostatic filtration principles to remove solids from a gaseous exhaust stream.

Bag houses maximise the filtration area by configuring the fabric filter media into a series of long small-diameter fabric tubes referred to as bags. They are tightly packed into a housing wherein the dust laden air moves across the bag fabric thereby removing it from the gas stream and building up a filter cake which further enhances air cleaning. The filter cake is removed to hoppers by various shaking means. The operating pressure drop across the bags is described by:

Performance & Efficiency Parameters



Pressure drop = dP = SeV + KCV2t

where, Se = drag coefficient
V = velocity
K = filter cake coefficient
C = inlet dust concentration
t = Collection running time

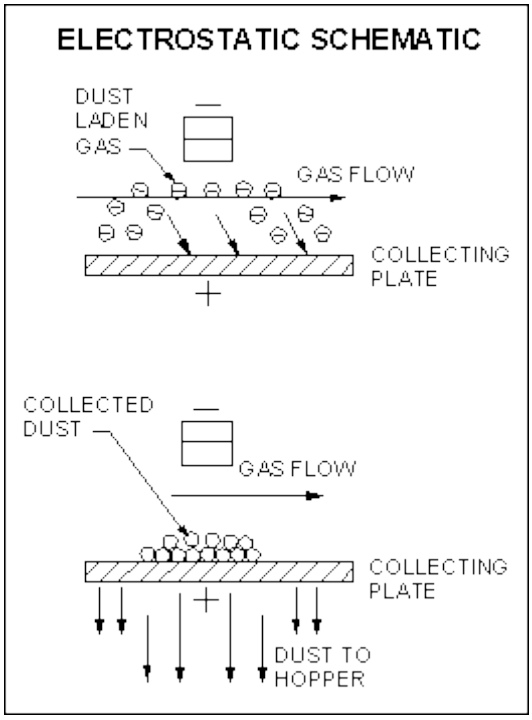
Limitations / Advantages / Problems
High collection efficiencies
Internal condensation / corrosion
Over-temperature limitations
Need for internal inspection / access
Possible to have variable flow rates
Plugging / short-circuiting / break-through/ collection media fouling
Accumulation of flammable gases/ dusts and ignition sources
Unexpected bag failure due to changes in operating parameters.

6. Electrostatic Precipitators

This control device utilises gaseous ions to charge particles which are then moved through an electric field to be deposited onto charged collection plates. Collected particulate material is then removed by rapping or washing of the plates. To produce the free ions and electric field, high internal voltages are required. Since the collection process does not rely on mechanical processes such as sieving or impaction, but rather electrostatic forces, the internal gas passages within a precipitator are relatively open with small pressure drops and lower energy costs to move the gas stream. High collection efficiencies are possible, but collecting efficiency may drastically change with changes in operating parameters.

Performance & Efficiency Parameters

Collection Eff. % = 1 - e -WA/Q



where, A = collecting electrode area
Q = volumetric gas flow rate
W = particle drift velocity

where; Eo = charging field
Ep = collecting field
a = particle radius

C = proportionality constant
n = gas viscosity

and drift vel. = EoEpaC
W (pi) n

Limitations / Advantages / Problems
Large installation space required
High efficiencies for small particles possible
Low pressure drops and air moving costs
High potential for ignition sources
Re-entrainment, spark-over, back corona problems
High temperature operation possible
Susceptible to changes in moisture and resistivity

7. Adsorption

The process of adsorption involves the molecular attraction of gas phase materials onto the surface of certain solids. This attraction may be chemical or physical in nature and is predominantly a surface effect. Certain materials like activated carbon charcoal possess the large internal surface area and the presence of physical attraction forces to adsorb large quantities of certain gases within their structure. The rate of adsorption is affected by the temperature, concentration, atmospheric pressure, and molecular structure of the gas.

Performance & Efficiency Parameters

The following figure shows typical trends for adsorption.

Limitations / Advantages / Problems
Can recover contaminant for reuse
May require multiple units; one in service, one in recycle mode
Few internal parts, controls, and alternating cycler required
Potential for step-function change in efficiency
Normal operation at ambient temperature
Flammable hydrocarbons
Chemical mixture problems.

Other Methods

The method of controlling air pollution at source is complex. It can be controlled by proper use of raw materials, site locations for industries and using the modern technologies to reduce emissions. There is a mass transfer between soluble gas component and a solvent liquid HCl, HF and others can be removed by dissolving them in water. SO2 can be

absorbed in alkaline water. The attraction forces between atoms, molecules and ions which hold a solid together fail at the surface of solids. Hence they cannot hold other materials such as gases and liquids, the absorption capacity of solid increases with its porosity. Activated carbon, silica gets and earth are some of the important absorbents. The absorbents placed in suitable containers capture gaseous or liquid molecules passing through them.

Vapours are usually controlled by condensation and are a suitable measure to combat the emissions of hydrocarbons and organic compounds having low vapour pressure. Gaseous pollutants can be controlled by chemical reactions with other elements. Setting chambers are used to collect the heavy particles from a gas stream. The particles settle out due to gravity action. Electrical precipitators containing charged plates in the air or gas stream settle the particles with opposite charge. The use of natural gas instead of coal can avoid sulphur oxide and fly ash emission from power plants. LPG or CNG can be used instead of petrol and diesel in automobiles.

Settling chambers use gravity separation to reduce particulate emissions. The air stream is directed through a settling chamber, which is relatively long and has a large cross section, causing the velocity of the air stream to be greatly decreased and allowing sufficient time for the settling of solid particles.

Another means of controlling both particulate and gaseous air pollutant emission can be accomplished by modifying the process which generates these pollutants. For example, modifications to process equipment or raw materials can provide effective source reduction. Also, employing fuel cleaning methods such as desulfurisation and increasing fuel-burning efficiency can lessen air emissions.

Water pollution control methods can be subdivided into physical, chemical, and biological treatment systems. Most treatment systems use combinations of any of these three technologies. Additionally, water conservation is a beneficial means to reduce the volume of wastewater generated.

Physical treatment systems are processes that rely on physical forces to aid in the removal of pollutants. Physical processes which find frequent use in water pollution control include screening, filtration, sedimentation, and flotation. Screening and filtration are similar methods used to separate coarse solids from water. Suspended particles are also removed from water with the use of sedimentation processes. Just as in air pollution control, sedimentation devices utilise gravity to remove the heavier particles from the water stream. The wide array of

sedimentation basins in use slow down the water velocity in the unit to allow time for the particles to drop to the bottom. Likewise, flotation uses differences in particle densities, which in this case are lower than water, to effect removal. Fine gas bubbles are often introduced to Equipment for the complete recovery and control of air, acids, and oxide emissions.

Chemical treatment systems in water pollution control are those processes which utilise chemical reactions to remove water pollutants or to form other, less toxic, compounds. Typical chemical treatment processes are chemical precipitation, adsorption, and disinfection reactions. Chemical precipitation processes utilise the addition of chemicals to the water in order to bring about the precipitation of dissolved solids. The solid is then removed by a physical process such as sedimentation or filtration. Chemical precipitation processes are often used for the removal of heavy metals and phosphorus from water streams. Adsorption processes are used to separate soluble substances from the water stream. Like air pollution adsorption processes, activated carbon is the most widely used adsorbent. Water may be passed through beds of Granulated Activated Carbon (GAC), or Powdered Activated Carbon (PAC) may be added in order to facilitate the removal of dissolved pollutants. Disinfection processes selectively destroy disease-causing organisms such as bacteria and viruses. Typical disinfection agents include chlorine, ozone, and ultraviolet radiation.

Biological water pollution control methods are those which utilise biological activity to remove pollutants from water streams. These methods are used for the control of biodegradable organic chemicals, as well as nutrient s such as nitrogen and phosphorus. In these systems, microorganisms consisting mainly of bacteria convert carbonaceous matter as well as cell tissue into gas. There are two main groups of microorganisms which are used in biological treatment, aerobic and anaerobic microorganisms. Each requires unique environmental conditions to do its job. Aerobic processes occur in the absence of oxygen. Both processes may be utilised whether the microorganisms exist in a suspension or are attached to a surface. These processes are termed suspended growth and fixed film processes, respectively.

Solid pollution control methods that are typically used include land filling, composting, and incineration. Sanitary landfills are operated by spreading the solid waste in compact layers separated by a thin layer of soil. Aerobic and anaerobic microorganisms help break down the biodegradable substances in the landfill and produce carbon dioxide and methane gas, which is typically vented to the surface. Landfills also generate a strong wastewater called Leachate that must be collected and treated to avoid groundwater contamination.

Composting of solid wastes is the microbiological biodegradation of organic matter under either aerobic or anaerobic conditions. This process is most applicable for readily biodegradable solids such as sewage sludge, paper, food waste, and household garbage, including garden waste and organic matter. This process can be carried out in static pile, agitated beds, or a variety of reactors.

4.0 CONCLUSION

In conclusion, there are many different types of methods of handling pollution in the industry. Whatever method is chosen the important thing is to ensure that it works and is able to create a barrier between pollutants and the environment or human health on the other hand.

5.0 SUMMARY

In this unit you have learnt about the different methods of handling pollution in the industry. These methods include; baghouses, cyclone, catalytic reactors, incinerators, adsorption, absorption and the use of scrubbers.

Other methods include physical techniques of water treatment involving; screening, sedimentation, aeration, filtration, etc. Landfills and composting are also used in the control of solid wastes.

6.0 TUTOR-MARKED ASSIGNMENT

1. Describe the principles of bag houses in the handling of pollutants in the industry.
2. List four methods of control of industrial air pollution.
3. Explain the term ‘’Composting’’.
4. Define pollution control.

7.0 REFERENCES/FURTHER READING

Fisher, D. E. (1990). Fire and Ice: The Greenhouse Effect, Ozone Depletion, and Nuclear Winter. New York: Harper & Row.

Wentz, C. A. (1989). Hazardous Waste Management. New York: Mc-Graw-Hill.

Mc Connell, Robert, L. & Daniel C. A. (2002). Environmental Issues: Measuring, Analysing, Evaluating. (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

UNIT 5 WASTE MANAGEMENT CONTROL METHODS

CONTENTS

1.0 INTRODUCTION

As a part of human life, solid wastes are generated. The disposal of solid waste should be part of an integrated solid waste management system. The method of collection, transportation, processing, resource recovery and final disposal should be synchronised for effective implementation. This will help in having a clean and healthy environment devoid of diseases. The industries are institutions that generate huge industrial wastes which deserve to be managed at the level of the industry. In this

unit we are also going to examine the industries and their methods of waste management in the control of pollution.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- explain the concept of waste management
- describe some disposal methods of solid wastes in the control of pollution
- explain industrial recycling and the use of waste management machines.

3.0 MAIN CONTENT

3.1 Waste Management

Waste management is the collection, transport, processing, or disposal, managing and monitoring of waste materials. The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources. All wastes materials, whether they are solid, liquid, gaseous, or radioactive fall within the remit of waste management.

Waste management practices can differ for developed and developing nations for urban and rural areas, and for residential and industrial producers. Management for non-hazardous waste residential and institutional waste in metropolitan areas is usually the responsibility of local government authorities, while management for non-hazardous commercial and industrial waste is usually the responsibility of the generator subject to local, national or international controls.

Solid wastes are generated due to human as well as industrial activities. These wastes are to be collected, transported to the site and treated properly. This is very essential as the environments are to be kept clean. The main sources for solid wastes are domestic, commercial, industrial, municipal and agricultural wastes.

The composition of a city waste is as follows:

Paper, wood, cardboard	- 53%
Garbage	– 22%
Ceramics, glass, crockery	– 10%
Metals	– 8%
Rubber, plastics, discarded textiles	- 7%.

3.2 Waste Management Concepts

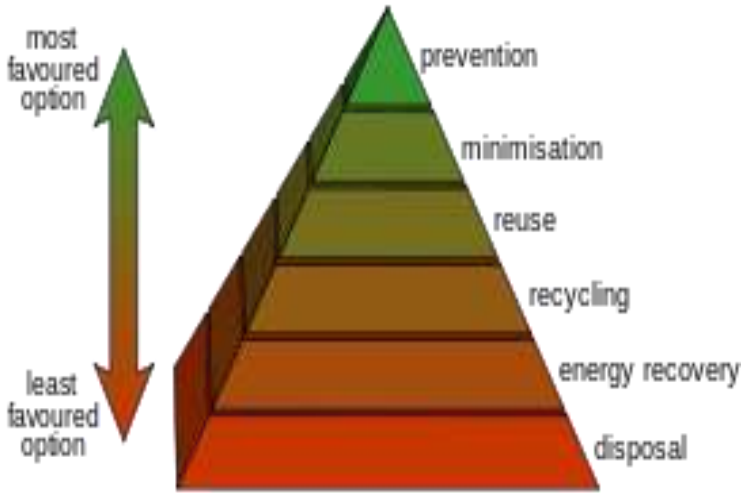


Fig. 5.1: Diagram of the Waste Hierarchy

There are a number of concepts about waste management which vary in their usage between countries or regions. Some of the most general, widely used concepts include:

Waste hierarchy - The waste hierarchy refers to the "3 Rs" reduce, reuse and recycle, which classify waste management strategies according to their desirability in terms of waste minimisation. The waste hierarchy remains the cornerstone of most waste minimisation strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste.

Polluter pays principle - the Polluter Pays Principle is a principle where the polluting party pays for the impact caused to the environment. With respect to waste management, this generally refers to the requirement for a waste generator to pay for appropriate disposal of the unrecoverable material.

3.2.1 Effects of Waste Pollution

Health hazards

If solid wastes are not collected and allowed to accumulate, they may create unsanitary conditions. This may lead to epidemic outbreaks of diseases. Many diseases like cholera, diarrhoea, dysentery, plague, jaundice, or gastrointestinal diseases may spread and cause loss of human lives.

In addition, improper handling of the solid wastes is a health hazard for the workers who come in direct contact with the wastes.

Environmental impact

If the solid wastes are not treated properly, decomposition and putrefaction may take place, causing land and water pollution when the waste products percolate down into the underground resources. The organic solid waste during decomposition may generate obnoxious odour. Stray dogs and birds may sometimes invade garbage heaps and may spread it over the neighbourhood causing unhygienic and unhealthy surroundings.

3.2.2 Control Measures

The main purpose of solid waste management is to minimise the adverse effects on the environment. The steps involved are:

- collection of solid wastes
- disposal of solid wastes
- utilisation of wastes.

3.2.3 Collection of Solid Wastes

Collection of wastes includes gathering the waste, transporting to the centralised location, and then moving it to the site of disposal.

The collected waste is then separated into hazardous and non-hazardous materials. There are a number of waste separation technologies available such as air stripping, stream stripping, carbon absorption and precipitation.

3.2.4 Disposal of Solid Wastes

Before the final disposal of the solid wastes, it is processed to recover the useable resources and to improve the efficiency of the solid waste

disposal system. The main processing technologies are compaction, incineration and manual separation. The appropriate solid waste disposal method has to be selected keeping in view the following objectives:

should be economically viable
should not create a health hazard
should not cause adverse environmental effects
should not result in unpleasant sight, odour and noise.

3.2.5 Utilisation of Wastes

Solid wastes can be properly utilised to reap benefits such as:

- conservation of natural resources
- economic development
- generate many useful products
- employment opportunities
- control of air pollution.

3.3 Methods of Waste Disposal

There are various methods for the waste disposal employed throughout the world. The approach may vary from developed to developing countries or from rural to urban areas. Some of the widely used waste disposal methods are Integrated Waste Management and Landfill.

3.3.1 Integrated Waste Management

This waste disposal method uses LCA life cycle analysis attempts for providing the most caring options for waste management. In case of a mixed municipal solid waste, the waste minimisation includes the separation and collection of waste followed by reuse and recycling of the non-organic fraction. It also includes the production of energy and compost/fertilizer from the organic waste fraction through the anaerobic digestion.

3.3.2 Landfill

Landfill is the widely used method of waste disposal that involves burying the waste in land. Landfills were established usually in deserted or vacant quarries by mining voids or borrowing pits. It proves to be relatively cheap method of disposing of waste materials if it is properly designed and well-managed. The poorly designed or managed landfills can leads to adverse environmental impacts like wind-blown litter, generation of liquid leachate and attraction of vermin. The other common by product of landfills includes gas that is composed of

methane and carbon dioxide. It is produced as organic waste that breaks down anaerobically, kills surface vegetation, and creates odour problems.

Fig. 5.2: Landfill

Fig. 5.3: A Landfill Compaction Vehicle in Action

When all the trucks arrive to the landfills, they first get separated into their proper place; disposing of waste in a landfill involves burying the waste, and this remains a common practice in most countries. Landfills were often established in abandoned or unused quarries, mining and voids or borrow pits. A properly designed and well-managed landfill can be a hygienic and relatively inexpensive method of disposing of waste materials. Older, poorly designed or poorly managed landfills can create a number of adverse environmental impacts such as wind-blown litter, attraction of vermin, and generation of liquid leachate. Another common

product of landfills is gas (mostly composed of methane and carbon dioxide), which is produced as organic waste breaks down anaerobically. This gas can create odour problems, kill surface vegetation, and is a greenhouse gas.

Fig. 5.4: Spittelau Incineration Plant in Vienna

Design characteristics of a modern landfill include methods to contain leachate such as clay or plastic lining material. Deposited waste is normally compacted to increase its density and stability, and covered to prevent attracting vermin (such as mice or rats). Many landfills also have landfill gas extraction systems installed to extract the landfill gas. Gas is pumped out of the landfill using perforated pipes and flared off or burnt in a gas engine to generate electricity.

3.4 Use of Industrial Recycling and Waste Management Machines

Industrial waste management generally refers to a set of strategies and approaches that aim to eliminate, reduce, reprocess or dispose of waste produced in an industrial setting. Industrial waste can be toxic, chemical, solid, liquid, or nonhazardous. Typically, however, industrial waste management is concerned with the proper disposal of industrial by products that could be harmful to the environment. Some of the common approaches to industrial waste management include emphasis on recycling programs, incineration, and landfills.

In industrial production, many materials are employed to manufacture products and because of the scale of that production, a lot of waste is generally produced. As a result of the size of the problem, industrial companies employ waste managers to focus solely on the issue of proper and effective disposal of waste. Most of that focus is in complying with eco-friendly laws which are becoming more common by various governmental bodies. Some of these laws propose penalties in the forms of fines or increased taxes.

There are many different approaches to industrial waste management. Waste may be collected and transported for disposal at another location, or it might be disposed of on site. Recycling or reusing is another solution that industrial companies are implementing. All these solutions can help reduce the amount of industrial waste a company disposes of.
The type of industrial waste produced is an important factor in determining the most effective disposal method. Two of the most common methods of waste disposal are the use of landfills and incineration devices. Depending on the type of waste, it can be disposed of or buried underground at a landfill site. This approach, however, is limited, as there are certain materials which are not dangerous to the environment. Chemical waste or other types of toxic waste are not to be dumped at landfills because it can seep into the groundwater and present a health concern to nearby populations. Incinerators are also used to burn waste materials in appropriate cases. Environmental groups, however, typically do not favour this approach because of the related emission of hazardous gases.

In general, recycling, when possible, is a favoured solution of industrial waste managers and environmentalists. Recycling has two general advantages: it is environmentally-friendly because it converts used products into usable materials, and it can be a source of revenue or reduce costs. A company can convert previously useless waste into a material that they may re-use in their own manufacturing process obviating the need to purchase that material anew, or the company can sell the material for a profit. Some of the most common recycling strategies employed in industrial waste management include biological and physical reprocessing, and energy recovery.

3.4.1 Plasma Gasification

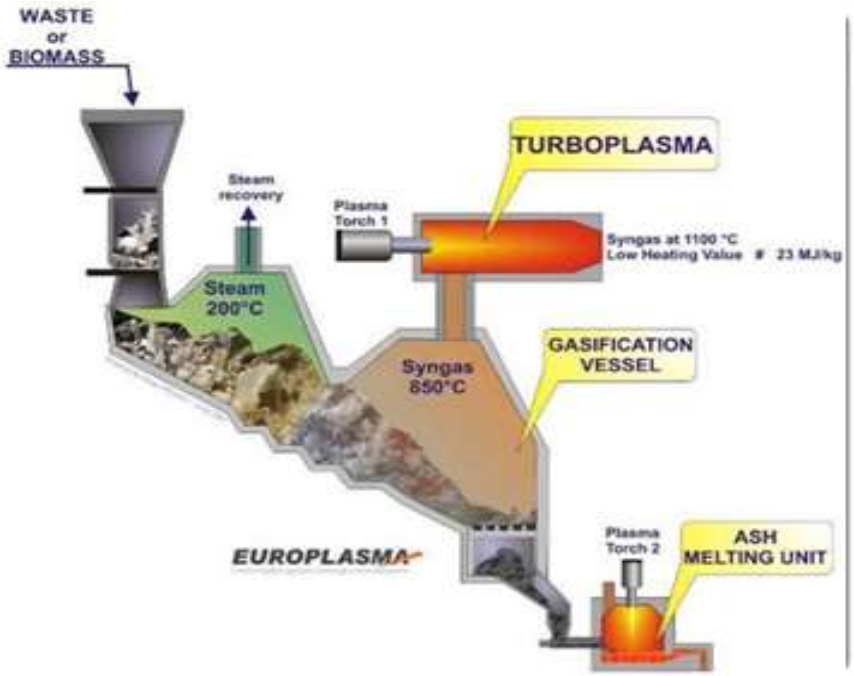


Fig. 5.5: Plasma Gasification

Plasma is a primarily an electrically charged or highly ionised gas. Lighting is an example of plasma which produces temperatures exceeding 12,600 °F (6,980 °C). In this method of waste disposal, a gasifier vessel uses characteristic plasma torches that operates at +10,000 °F (5,540 °C which is equals to the surface temperature of the Sun) for creating a gasification zone till 3,000 °F (1,650 °C) for the conversion of solid or liquid wastes into a syngas. During the treatment of municipal solid waste by this method, the waste's molecular bonds break down due to intense heat in the vessels into elemental components. The process leads to the elemental destruction of waste and dangerous materials. The Plasma gasification provides new opportunities to the countries for the waste disposal, and additionally, it also allows the renewable power generation in an environmentally friendly manner.

With growing environmental awareness and moreover the subsequent demand for innovative methods of minimise carbon footprints, a number of systems like smart recycling equipments are being developed. Because of the availability of advanced recycling machines like shredders, conveyors, balers, plus compactors, you can substantially reduce the amount of matter you discharge as industrial by products or domestic waste materials.

3.4.2 Shredders

Cross-flow Shredder - The cross-flow shredder uses the technique of beating waste down so that it smashes into smaller fragments, or shreds.
Single-shaft Shredder – Essentially, it is the most conventional among best shredder types, the single-shaft shredder utilises traditional blades to rip the waste particles aside.

Multi-shaft Shredder - An advanced version of the single-shaft shredder, it accomplishes its process by forcing waste against blades or between them.

Fig. 5.6: Waste Management in Kathmandu (Nepal)

3.5 Methods of Disposal

3.5.1 Incineration

Incineration is a disposal method in which solid organic wastes are subjected to combustion so as to convert them into residue and gaseous products. This method is useful for disposal of residue of both solid waste management and solid residue from waste water management. This process reduces the volumes of solid waste to 20 - 30 per cent of the original volume. Incineration and other high temperature waste treatment systems are sometimes described as "thermal treatment". Incinerators convert waste materials into heat, gas, steam and ash.

Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous wastes. It is recognised as a practical method of disposing of certain hazardous waste materials (such as biological medical waste).

Incineration is a controversial method of waste disposal, due to issues such as emission of gaseous pollutants.

Incineration is common in countries such as Japan where land is scarce, as these facilities generally do not require as much area as landfills. Waste-to-energy (WtE) and energy-from-waste (EfW) are broad terms for facilities that burn waste in a furnace or boiler to generate heat, steam or electricity. Combustion in an incinerator is not always perfect and there have been concerns about pollutants in gaseous emissions from incinerator stacks. Particular concern has focused on some very persistent organics such as dioxins, furans, PAHs which may be created which may have serious environmental consequences.

3.5.2 Recycling

Fig. 5.7: Steel Crushed and Baled for Recycling

Recycling is a resource recovery practice that refers to the collection and reuse of waste materials such as empty beverage containers. The materials from which the items are made can be reprocessed into new products. Material for recycling may be collected separately from general waste using dedicated bins and collection vehicles are sorted directly from mixed waste streams and are known as kerb-side recycling, it requires the owner of the waste to separate it into various different bins (typically wheelie bins) prior to its collection.

The most common consumer products recycled include aluminium such as beverage cans, copper such as wire, steel food and aerosol cans, old steel furnishings or equipment, polyethylene and PET bottles, glass bottles and jars, paperboardcartons, newspapers, magazines and light paper, and corrugated fibreboard boxes.

PVC, LDPE, PP, and PS (see resin identification code) are also recyclable. These items are usually composed of a single type of material, making them relatively easy to recycle into new products. The recycling of complex products (such as computers and electronic equipment) is more difficult, due to the additional dismantling and separation required.

The type of material accepted for recycling varies by city and country. Each city and country has different recycling programmes in place that can handle the various types of recyclable materials. However, variation in acceptance is reflected in the resale value of the material once it is reprocessed.

3.5.3 Sustainability

The management of waste is a key component in a business' ability to maintaining ISO14001 accreditation. Companies are encouraged to improve their environmental efficiencies each year by eliminating waste through resource recovery practices, which are sustainability-related activities. One way to do this is by shifting away from waste management to resource recovery practices like recycling materials such as glass, food scraps, paper and cardboard, plastic bottles and metal.

3.5.4 Biological Reprocessing

Composting, Home composting, Anaerobic digestion, and Microbial fuel cell

Fig. 5.8: An Active Compost Heap

Recoverable materials that are organic in nature, such as plant material, food scraps, and paper products, can be recovered through composting and digestion processes to decompose the organic matter. The resulting organic material is then recycled as mulch or compost for agricultural or landscaping purposes. In addition, waste gas from the process (such as methane) can be captured and used for generating electricity and heat (CHP/cogeneration) maximising efficiencies. The intention of biological processing in waste management is to control and accelerate the natural process of decomposition of organic matter. (See resource recovery).

3.5.5 Energy Recovery

Fig. 5.9: Anaerobic Digestion Component of Lübeck

Anaerobic Digestion Component of Lübeck Mechanical Biological Treatment plant in Germany, 2007 is shown in Figure 5.9. The energy content of waste products can be harnessed directly by using them as a direct combustion fuel, or indirectly by processing them into another type of fuel. Thermal treatment ranges from using waste as a fuel source for cooking or heating and the use of the gas fuel (see above), to fuel for boilers to generate steam and electricity in a turbine. Pyrolysis and gasification are two related forms of thermal treatment where waste materials are heated to high temperatures with limited oxygen availability. The process usually occurs in a sealed vessel under high pressure. Pyrolysis of solid waste converts the material into solid, liquid and gas products. The liquid and gas can be burnt to produce energy or refined into other chemical products (chemical refinery). The solid residue (char) can be further refined into products such as activated carbon. Gasification and advanced Plasma arc gasification are used to convert organic materials directly into a synthetic gas (syngas) composed of carbon monoxide and hydrogen. The gas is then burnt to

produce electricity and steam. An alternative to pyrolisis is high temperature and pressure supercritical water decomposition (hydrothermal monophasic oxidation).

3.5.6 Resource Recovery

Resource recovery (as opposed to waste management) uses Llife Cycle Analysis (LCA) attempts to offer alternatives to waste management. For mixed Municipal Solid Waste (MSW) a number of broad studies have indicated that administration, source separation and collection followed by reuse and recycling of the non-organic fraction and energy and compost/fertilizer production of the organic material via anaerobic digestion to be the favoured path.

3.5.7 Avoidance and Reduction Methods

Waste Minimisation

An important method of waste management is the prevention of waste material being created, also known as waste reduction. Methods of avoidance include reuse of second-hand products, repairing broken items instead of buying new, designing products to be refillable or reusable (such as cotton instead of plastic shopping bags), encouraging consumers to avoid using disposable products (such as disposable cutlery), removing any food/liquid remains from cans, packaging, and designing products that use less material to achieve the same purpose (for example, light-weighting of beverage cans).

3.6 Waste Handling and Transport

Waste Collection Vehicle, Dustbin, and Waste Sorting

Fig. 5.10: Moulded Plastic Wheeled Waste Bin in Berkshire, England

Waste collection methods vary widely among different countries and regions. Domestic waste collection services are often provided by local government authorities, or by private companies in the industry. Some areas, especially those in less developed countries, do not have a formal waste-collection system. Examples of waste handling systems include:
In Europe and a few other places around the world, a few communities use a proprietary collection system known as Envac, which conveys refuse via underground conduits using a vacuum system. Other vacuum-based solutions include the MetroTaifun single-line and ring-line systems.

In Canadian urban centres curb side collection is the most common method of disposal, whereby the city collects waste and/or recyclables and/or organics on a scheduled basis. In rural areas people often dispose of their waste by hauling it to a transfer station. Waste collected is then transported to a regional landfill.

In Taipei, the city government charges its households and industries for the volume of rubbish they produce. Waste will only be collected by the city council if waste is disposed in government issued rubbish bags. This policy has successfully reduced the amount of waste the city produces and increased the recycling rate.

In Israel, the Arrow Ecology company has developed the Arrow Bio system, which takes trash directly from collection trucks and separates organic and inorganic materials through gravitational settling, screening, and hydro-mechanical shredding. The system is capable of sorting huge volumes of solid waste, salvaging recyclables, and turning the rest into biogas and rich agricultural compost. The system is used in California, Australia, Greece, Mexico, the United Kingdom and in Israel. For example, an Arrow Bio plant that has been operational at the Hiriya landfill site since December 2003 serves the Tel Aviv area, and processes up to 150 tons of garbage a day.

While waste transport within a given country falls under national regulations, trans-boundary movement of waste is often subject to international treaties. A major concern to many countries in the world has been hazardous waste. The Basel Convention, ratified by 172 countries, deprecates movement of hazardous waste from developed to less developed countries. The provisions of the Basel Convention have been integrated into the EU waste shipment regulation. Nuclear waste, although considered hazardous, does not fall under the jurisdiction of the Basel Convention.

3.7 Technologies

Traditionally the waste management industry has been slow to adopt new technologies such as Radio Frequency Identification (RFID) tags, GPS and integrated software packages which enable better quality data to be collected without the use of estimation or manual data entry.
Technologies like RFID tags are now being used to collect data on presentation rates for curb-side pick-ups.

Benefits of GPS tracking is particularly evident when considering the efficiency of ad hoc pick-ups (like skip bins or dumpsters) where the collection is done on a consumer request basis.

Integrated software packages are useful in aggregating this data for use in optimisation of operations for waste collection operations.
Rear vision cameras are commonly used for OH&S reasons and video recording devices are becoming more widely used, particularly concerning residential services.

4.0 CONCLUSION

In conclusion waste management is a core of the control strategies of pollution. All major sources of pollution arise from the wastes that are generated either from the municipalities or the industries.

5.0 SUMMARY

You have learnt about the concept and definition of waste management, which is the collection, transport, processing, or disposal, managing and monitoring of waste materials. Waste generation is an aspect of human living and the challenges to managing it are imperative to any organised human community. A good number of methods and technologies are now available for the management of wastes of any nature and kind we generate. Some of these technologies range from scrubbers, cyclones, incinerators to plasma gasification in the industries and landfills, composts, and recycling technologies in the municipalities. Strategies of waste management usually include; waste minimisation, resource recovery and energy recovery.

6.0 TUTOR-MARKED ASSIGNMENT

1. Define waste management.
2. List four methods of solid waste management.
3. Explain the procedure of composting waste.
4. Describe the composition of a typical city waste.

7.0 REFERENCES/FURTHER READING

"Pollution". Microsoft Encarta Online Encyclopedia 2009.

"Chapter 23 – Solid, Toxic, and Hazardous Waste".

"Waste Watcher" (PDF).http://www.oregon.gov/DAS/FAC/docs/ww092001.pdf. Retrieved 2010-08-26.

"China overtakes US as world's biggest CO2 emitter". Guardian.co.uk. June 19, 2007.

Beychok, M. R. (1967). Aqueous Wastes from Petroleum and Petrochemical Plants (1st ed.). John Wiley & Sons.ISBN0-471-07189-7.LCCN 67019834.