EHS 515
POLLUTION CONTROL

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Introduction

EHS515 – Pollution Control is a course that carries two credit units for students pursuing the B.Sc. Environmental Health. The course consists of 5 modules broken into 21 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
- understanding 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 5 modules in this course broken down into 21 study units. The modules and the study units are:

Module 1

Unit 1   Concept of Pollution
Unit 2   Types and Classification of Pollutants
Unit 3   Environmental Media 1 (Air)
Unit 4   Environmental Media 2 (Water)

Module 2

Unit 1   Environmental Media 3 (Soil)
Unit 2   Environmental Media 4 (Food)
Unit 3   Noise Pollution
Unit 4   Thermal pollution

Module 3

Unit 1   Impacts of Air Pollution on Living Organism and Ecosystem
Unit 2   Impacts of Water Pollution on Living Organism and Ecosystem
Unit 3   Impacts of Soil Pollution on Living Organism and Ecosystem
Unit 4   Impacts of Noise Pollution on Human

Module 4

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

Module 5

Unit 1   Control of Air Pollution
Unit 2   Control of Water Pollution
Unit 3   Control of Soil Pollution
Unit 4   Control of Noise Pollution
Unit 5   Policy and Legislation Measures on Pollution Control

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. In units three and four, you will learn about environmental media of pollution in air and water respectively.

Module 2
Module two contains units 1, 2, 3 and 4. In unit 1 and 2 you will be taken through environmental media of pollution in air and water respectively, while in unit 3 you will go through noise pollution and unit 4 will dwell on thermal pollution.

Module 3
This module is designed to take you through the impacts of air pollution on living organisms and ecosystem in unit 1, the impacts of water pollution on living organisms and ecosystem in unit 2, the impacts of soil pollution on living organisms and ecosystem unit 3 and the impacts of noise pollution on human in unit 4.

Module 4
Unit 1 takes you through monitoring of pollutants, unit 2 assessments of pollutants, unit 3 exposure patterns of air pollutants and unit 3 – overview of current global pollution.

Module 5
In module five, there are five units in which unit 1 takes you through the control of air pollution, unit 2 on control of water pollution, unit 3 on control of soil pollution, unit 4 on control of noise pollution and unit 5 on policy and legislative measures on pollution control.

Text Books and References

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

Pollution prevention: Problems and Solution by Louis Theodore, R. Ryan DuPont and Joseph Reynolds. *Gordon and Breach Science Publishers.*

Pollution, Causes, Effects and Control 4th Edition by Roy M. Harrison, Published by Royal Society of Chemistry.

Environmental Pollution and Control 4th edition by J. Jeffrey Peirce, Ruth. F. Weiner and P. Aarne Vesilind

Environmental Pollution (Air, water, soil, thermal, and noise): causes, effects, and

Controls by   Dr. Yashpal Singh Narwaria pdf.

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 – 4	Four assignments, best three marks of the four count at 10% each–30% of course marks.
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 itemize 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.   Organize 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 you 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 scheduled date (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 endeavor 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 and health impacts of pollution.

We wish you success in this noble endeavour.

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MODULE 1

Unit 1   Concept of Pollution
Unit 2   Types and Classification of Pollutants
Unit 3   Environmental Media 1 (Air)
Unit 4   Environmental Media 2 (Water)

UNIT 1   CONCEPT OF POLLUTION

Unit Structure

1.1   Introduction
1.2   Intended Learning Outcomes
1.3   Main Content
         1.3.1 Concept of Pollution
         1.3.2 Definition of Pollution
         1.3.4 Types of Pollution
1.4   Summary
1.5   References, Further Reading and Web Sources
1.6   Possible Answers to Self-Assessment Exercise(s)

1.1 Introduction

Pollution is one of the most serious problems facing humanity globally as it threatens both human and the ecosystem (water, air, land etc.) that provides the basic and fundamental life existence support. 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.

1.2 Intended Learning Outcomes

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

- Explain the concept of pollution and define pollution
- Explain different types/sources of pollution.

1.3 Main Content

1.3.1 Concept of pollution

When an undesirable substance is found or noticeably present i.e. in excess in the natural environment (water, land and air) such that its affects the value or quality of the environment, pollution has taken place. The phenomena of pollution occur in our environment every day as a result of our daily activities either deliberately e.g. burning of fossil fuel like coal and natural gas or by share coincidence. Pollution also occurs by means of natural events such as bush fires, wind storms, climate change, volcanoes etc. and these activities not only reduce the quality of air, water and land but can also on the long run damage them. Pollution is a global problem. 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.

1.3.2 Definitions of pollution

Various definitions of pollution exist and many have tried to define pollution based on the sources of the pollution. Below are some of definitions of pollution:

1.   The Wikipedia encyclopedia defines pollution as the introduction of <u>contaminants</u> into the natural environment that causes adverse change.

2.   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 also 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).

3.   Pollution is an undesirable change in physical, chemical and biological characteristics of land, air or water caused by excessive accumulation of pollutants (i.e. Substances which cause pollution).

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.

Self-Assessment Exercise 1

What do you understand by the word pollution?

1.3.4 Types of pollution

By convention pollution or environmental pollution are described in accordance with the forms they present. The major forms are as follows:
1. Air pollution: Air pollution is caused by the release of chemicals and particulates into the atmosphere. Air may get polluted by natural causes such as volcanoes, which release ash, dust, sulphur and other gases, or by forest fires that are occasionally naturally caused by lightning. 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.

In-door air pollution
In dwelling places such as in our homes, air pollution occur because of the presence of pollutants. 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. Air pollutants and their sources include the following:

S/N	AIR POLUUTANTS	SOURCES
1.	Asbestos and other fibrous aerosols	Friable asbestos, vinyl floor and Cement products
2.	Carbon monoxide	Vehicular exhausts, kerosene and gas space heaters, gas stoves, wood stoves, fireplaces and smoking
3.	Formaldehyde	Particle board, paneling, plywood carpets, ceiling tile, urea formaldehyde form insulation, other construction material.
4.	Small particulate matter like	Smoking, vacuuming, wood stoves, fireplaces.
5.	Nitrogen dioxide, Sulphur oxides	Burning of fossil fuels, 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
11.	Hydrocarbons	Incomplete burning of fuel such as from generators

2. **Water pollution**: Water pollution is defined as the adding of unwanted substances or the change of physical and chemical characteristics of water in any way which makes it unfit for human consumption. It could also be said to be the contamination of water bodies, usually as a result of human activities. Water bodies include for example lakes, rivers, oceans, aquifers and groundwater.

Figure above is showing the pollution of a water body
Sources of water pollution

Point and non-point sources:
➢   When pollutants are discharged from a specific location such as a drain pipe carrying industrial effluents discharged directly into a water body it represents point source pollution
➢   In contrast, non-point sources include discharge of pollutants from diffused sources or from a larger area such as runoff from agricultural fields, grazing lands, constriction site, abandoned mines and pits, etc.

Water pollution could results from the discharge of waste water (effluents) from commercial and industrial waste into surface waters, discharges of untreated domestic sewage, oil spillage 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 (Aboyeji 2013; *Englande et al., 2013; Ahmed et al., 2021*). This degrades the quality of water. Not only does this spell disaster for aquatic ecosystems, the pollutants also seep through and reach the groundwater, which might end up in our households as contaminated water we use in our daily activities, including drinking.

The causes of water pollution vary and may be both natural and anthropogenic (i.e. from human activities). However, the most common causes of water pollution are the anthropogenic ones.

3**.   Soil pollution**: Soil pollution is the unfavorable alteration of soil by the addition or removal of substances which decrease soil productivity.

"Soil pollution refers to the contamination of soil with anomalous concentrations of toxic substances. It is a serious environmental concern since it harbors many health hazards."

"Soil pollution refers to anything that causes contamination of soil and degrades the soil quality. It occurs when the pollutants causing the pollution reduce the quality of the soil and convert the soil inhabitable for microorganisms and macro organisms living in the soil."

Causes of Soil Pollution:
Soil pollution can be natural or due to human activity. However, it mostly boils down to the activities of the human that causes the majority of soil pollution such as heavy industries, or pesticides in agriculture.

Industrial activities including mining, smelting and manufacturing; domestic, livestock and municipal wastes; pesticides, herbicides, fertilizers used in agriculture; petroleum-derived products that are

released into or break-down in the environment; fumes generated by transportation all contribute to the problem. These include pharmaceuticals, endocrine disruptors, hormones and biological pollutants; "e-waste" from old electronics; and the plastics that are nowadays used in almost every human endeavor.

Self-Assessment Exercise 2

Mention any three industrial activities that can cause soil pollution

4.   Noise pollution: Noise may be defined as an unwanted and unpleasant sound that may have adverse effects on animals and humans. It encompass road-way noise, aircraft noise, industrial noise, as well as high-intensive sonar. The unit of sound level is decibels (db). Noise level above 120 db is considered harmful to human beings.

The different sources associated with noise pollution are industrial machinery, road, rail and air transport, loudspeakers, construction equipment, household appliances, crackers, etc.

5.   Radioactive pollution: The emission of protons, electrons and electromagnetic radiations released by the disintegration of radioactive substances such as radium, thorium, uranium, etc. cause air, water and land pollution.

The ionizing radiations can cause mutations.
•   Strontium-90 accumulates in bones causing bone cancer.
•   Iodine-131 can damage bone marrow, spleen, lymph nodes and can cause leukemia (blood cancer).

6.   **Thermal Pollution:** This is a temperature change in natural water bodies caused by human influence, such as use of water as coolant in a power plant. Thermal pollution is sometimes called "thermal enrichment and can also be defined as the degradation of water quality by any process that changes ambient water temperature. A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. Other causes of thermal pollution include soil erosion.

Self-Assessment Exercise 3

Mention any 5 major types of pollution

Self-Assessment Exercise 4

Attempt these questions. It should not take you more than 5 minutes

1.   Mention three sources each of Water, Soil and Air pollution
2.   Differentiate between point and non-point sources of water pollution

1.4　　Summary

In this 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.

1.5 References/Further Reading/Web Sources

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 (*1sted.*).*Barloz Publishers Inc.

List of Textbooks/Journals

Environmental Pollution (Air, water, soil, thermal, and noise): causes, effects, and Controls by   Dr. Yashpal Singh Narwaria pdf.

Aboyeji, O. O (2013). Freshwater pollution in some Nigerian local communities, causes, consequences and probable solutions*". Academic Journal of Interdisciplinary Studies.*

Englande, A.J.; Krenkel, P. and Shamas, J. (2015), Wastewater treatment and water reclamation*", Reference Module in Earth Systems and Environmental Sciences, Elsevier, pp. B97801240954890950 87, doi:10.1016/b978-0-12-409548-9.09508-7*

Ahmed, J.; Thakur, A and Goyal, A. (2021), Shah, Maulin P (ed.), Chemistry in the Environment, Cambridge: Royal Society of Chemistry, pp. 1–14.

![wrench icon] **1.6   Possible Answers to Self-Assessment Exercise(s)**

Answer 1
Pollution is an undesirable change in physical, chemical and biological characteristics of
land, air or water caused by excessive accumulation of pollutants.
                              or
It can be defined as the introduction of g into the natural environment that cause adverse change.

Answer 2
Mining, smelting and manufacturing

Answer 3
Noise pollution, air pollution, water pollution, soil pollution, radioactive pollution

Other forms of pollution that may exist includes:
➢   **Light pollution** –includes light trespass, over illumination and astronomical interference.
➢   **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.

Answer

1. Sources of Water pollution: Industrial effluents, oil spillage, agricultural runoff
Sources of Air pollution: Aerosol sprays, vehicular exhaust, burning of fossil fuels
Sources of Soil pollution: Pesticides, herbicides, heavy metals

2. When pollutants are discharged from a specific location such as a drain pipe carrying industrial effluents discharged directly into a water body it represents point source pollution

 In contrast, non-point sources include discharge of pollutants from diffused sources or from a larger area such as runoff from agricultural fields, grazing lands, constriction site, abandoned mines and pits, etc.

UNIT 2   TYPES AND CLASSIFICATION OF POLLUTANTS

Unit Structure

2.1   Introduction
2.2   Intended Learning Outcomes
2.3   Main Content
       2.2.1 Types of pollutants
2.4   Classification of Pollutants
       2.4.1 Primary pollutants
       2.4.2 Secondary pollutants
2.5   Classification Based on Ecological Perspective
2.6   Classification on the Basis of State
2.7   Summary
2.8   References, Further Reading and Web Sources
2.9   Possible Answers to Self-assessment Exercise

2.1   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.

2.2   Intended Learning Outcomes

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

* Describe the various types of pollutants and
* Explain the classifications of pollutants.

2.3   Main Content

A pollutant is a substance or energy introduced into the environment that has undesired effects, or adversely affects the usefulness of a resource. A pollutant is a waste material that pollutes air, water or soil. Pollutants can be in the form of solid particles, liquid droplets, or gases present in greater than natural abundance produced due to human activity, which have a detrimental effect on our environment. In addition, they may be natural or man-made. The nature and concentration of a pollutant determines the severity of detrimental effects on human health. 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.

An average human requires about 12 kg of air each day, which is nearly 12 to15 times greater than the amount of food we eat. Thus even a small concentration of pollutants in the air becomes more significant in comparison to the similar levels present in food.
Pollutants that enter water have the ability to spread to distant places especially in the marine ecosystem. Three factors determine the severity of a pollutant: its chemical nature, the concentration and the persistence.

2.3.1   Types of pollutants

1.   Pollutants based on 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). Fund pollutants are not destroyed, but rather converted into less harmful substances, or diluted/dispersed to non- harmful concentrations.

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.

Self-Assessment Exercise

What is a pollutant and mention two types

2.4   Classification of Pollutants

Generally pollutants may be classified into primary and secondary pollutants.

2.4.1 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)**: Sulphur oxides 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 NO2, forms H2SO4, 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)**: Nitrogen oxides 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):** Carbon monoxide 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$_2$):** 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.
- Particulate material such as (soot, ash)
- Toxic metals such as lead, mercury

2.4.1 Secondary pollutants: These are not emitted directly. Rather, they form in the environment when primary pollutants react or interact with themselves or other components of the atmosphere. An important examples of a secondary pollutant are ground level ozone, smog and Persistent Organic Pollutants (POPs). 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.

Self-Assessment Exercise

Differentiate between primary pollutants and secondary pollutants

2.5 Classification Based on Ecological Perspective

2.5.1 Degradable or non-persistent pollutants: These can be rapidly broken down by natural processes therefore will not persist in the environment in the long term e.g. domestic sewage, discarded vegetables etc.

2.5.2 Slowly degradable or persistent pollutants: Pollutants that remain in the environment for many years in an unchanged condition and take decades or longer to degrade e.g. DDT and most plastics.

2.5.3 Non-degradable pollutants: These cannot be degraded by natural processes. Once they are released into the environment they are difficult to eradicate and continue to accumulate e.g. toxic elements like lead or mercury.

2.6   Classification on the Basis of State

2.6.1 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 aluminum, bismuth, bromine and copper.

2.6.3 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 harbor 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.

2.6.3 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.

Self-Assessment Exercise (SAE)

Attempt these questions. It should not take you more than 10 minutes

1. Highlight five classes of pollutants
2. Explain what you understand by degradable and non-degradable pollutants

2.7 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, ecology and controllability. 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.

2.8 References/Further Reading/Web Sources

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.

List of Textbooks/Journals

Environmental Pollution (Air, water, soil, thermal, and noise): causes, effects, and Controls by Dr. Yashpal Singh Narwaria pdf.

Pollution, Causes, Effects and Control 4th Edition by Roy M. Harrison, Published by Royal Society of Chemistry.

2.9 Possible Answers to Self-assessment Exercise

Answer 1
A pollutant can be in the form of solid particles, liquid droplets, or gases present in greater than natural abundance produced due to human activity, which have a detrimental effect on our environment.

The two types of pollutants are fund and stuck pollutants

Answer 2
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 while secondary pollutants are not emitted directly rather they form in the environment when primary pollutants react or interact with themselves or other components of the atmosphere e.g. smog, ground level ozone

Pollutants may also 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
- By ecological perspective pollutants

1.   Highlight five classes of pollutants
Answer
Pollutants may also 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
- By ecological perspective pollutants

2. Explain what you understand by degradable and non-degradable pollutants
Answer
Degradable or non-persistent pollutants: These can be rapidly broken down by natural processes therefore will not persist in the environment in the long term e.g. domestic sewage, discarded vegetables etc.

Non-degradable pollutants: These cannot be degraded by natural processes. Once they are released into the environment they are difficult to eradicate and continue to accumulate e.g. toxic elements like lead or mercury.

UNIT 3   ENVIRONMENTAL MEDIA I (AIR)

Unit Structure

3.1   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.

3.2   Intended Learning Outcomes

By 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

3.3   Main Content

3.3.1 Air media

Air which is also sometimes referred as the atmosphere 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.

Structure of the atmosphere
There are five layers that make up the atmosphere thus; the troposphere, stratosphere, mesosphere, thermosphere and the exosphere. The troposphere is the most important layer of the atmosphere because of its paramount biotic activities. It is characterized 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 6.5°C per kilometer (Lapse rate). That is,' the higher you go, the cooler it becomes'
• pressure decrease with increase in altitude.

The innermost layer the troposphere extends 17 kilometers above sea level at the equator and about 8 kilometers over the poles (Oreyomi, 2005). It contains about 75 percent of the mass of the earth's air. The fragility of this layer is obvious from the fact that if the earth were an apple this particular layer would be no thicker than an apple's skin. The gases present in the troposphere are oxygen, nitrogen, carbon dioxide, noble gases, water vapour, dust particles and some other substances. Temperature declines with altitude in the troposphere. At the top of the troposphere temperatures abruptly begin to rise. This boundary where this temperature reversal occurs is called the tropopause.

The tropopause marks the end of the troposphere and the beginning of the stratosphere, the second layer of the atmosphere. The stratosphere extends from 17 to 48 kilometers above the earth's surface. While the composition of the stratosphere is similar to that of the troposphere it has two major differences. The volume of water vapour here is about 1000 times less while the volume of ozone is about 1000 times greater. The presence of ozone in the stratosphere prevents about 99 percent of the sun's harmful ultraviolet radiation from reaching the earth's surface thus protecting humans from cancer and damage to the immune system. This layer does not have clouds and hence, airplanes fly in this layer as it creates less turbulence. Temperature rises with altitude in the stratosphere until there is another reversal. This point is called the stratopause and it marks the end of the stratosphere and the beginning of the atmosphere's next layer, the mesosphere.

In the mesosphere the temperature decreases with altitude falling up to – 110°C at the top.
Above this is a layer where ionization of the gases is a major phenomenon, thus increasing the temperature. This layer is called the thermosphere. Only the lower troposphere is routinely involved in our weather and hence

air pollution. The other layers are not significant in determining the level of air pollution.

Self-Assessment Exercise

Mention any three structural components of the atmosphere

3.4   Types of 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.

Air pollution occurs due to the presence of undesirable solid or gaseous particles in the air in quantities that are harmful to human health and the environment. Air may get polluted by natural causes such as volcanoes, which release ash, dust, sulphur and other gases, or by forest fires that are occasionally naturally caused by lightning. However, unlike pollutants from human activity, naturally occurring pollutants tend to remain in the atmosphere for a short time and do not lead to permanent atmospheric change.

3.4.1 Types of air pollution 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.

3.4.2 Types of air pollution based on location

This can be out-door or in-door. Pollutants are also found indoors from infiltration of polluted outside air and from various chemicals used or produced inside buildings. 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.

Pollutants that are emitted directly from identifiable sources are produced both by natural events (for example, dust storms and volcanic eruptions) and human activities (emission from vehicles, industries, etc.). These are called primary pollutants. There are five primary pollutants that together contribute about 90 percent of the global air pollution. These are carbon oxides (CO and CO_2), nitrogen oxides, sulfur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter.

There may also be pollutants that are produced in the atmosphere when certain chemical reactions take place among the primary pollutants are called secondary pollutants e.g. sulfuric acid, nitric acid, carbonic acid etc.

Self-Assessment Exercise

Mention five substances that can cause air pollution

3.5   What happens to pollutants in the atmosphere?

Once pollutants enter the troposphere they are transported downwind, diluted by the large volume of air, transformed through either physical or chemical changes or are removed from the atmosphere by rain during which they are attached to water vapour that subsequently forms rain or snow that falls to the earth's surface.

The atmosphere normally disperses pollutants by mixing them in the very large volume of air that covers the earth. This dilutes the pollutants to acceptable levels. The rate of dispersion however varies in relation to topography and metrological conditions.

Self-Assessment Exercise (SAE)

Attempt these questions. It should not take you more than 5 minutes
1.   Highlight the characteristics of the troposphere 2.   What happens to pollutants in the atmosphere

3.6   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.

3.7   References/Further Reading/Web Sources

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Air Pollution 2nd edition edited by Arthur C. Stern. Academic Press New York, London.

Fundamentals of air pollution, 4th edition by Daniel Vallero

3.8 Possible Answers to Self-Assessment Exercise

Answer 1
The troposphere, stratosphere, mesosphere, thermosphere and the exosphere

Answer 2
These are carbon oxides (CO and CO_2), nitrogen oxides, sulfur oxides, volatile organic compounds (mostly hydrocarbons) and suspended particulate matter.

1. Highlight the characteristics of the troposphere
2. What happens to pollutants in the atmosphere?
Answer
1. Characteristics of the troposphere
* 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 6.5°C per kilometer (Lapse rate). That is,' the higher you go, the cooler it becomes'
* pressure decrease with increase in altitude.

2. **What happens to pollutants in the atmosphere?**
Once pollutants enter the troposphere they are transported downwind, diluted by the large volume of air, transformed through either physical or chemical changes or are removed from the atmosphere by rain during which they are attached to water vapour that subsequently forms rain or snow that falls to the earth's surface.

The atmosphere normally disperses pollutants by mixing them in the very large volume of air that covers the earth. This dilutes the pollutants to acceptable levels. The rate of dispersion however varies in relation to topography and metrological conditions.

UNIT 4   ENVIRONMENTAL MEDIA 2 (WATER)

Unit Structure

4.1   Introduction
4.2   Intended Learning Outcomes
4.3   Main Content
       4.3.1 Water Media
4.4   Sources/Causes of Water Pollution
       4.4.1 Disease-causing agents
       4.4.2 Oxygen depleting waste
       4.4.3 Inorganic plant nutrients
       4.4.4 Organic chemicals
       4.4.5 Sediments of suspended matter
       4.4.6 Hot water
       4.4.7 Oil
4.5   Types of Water Pollution
       4.5.1 Precipitation pollution
       4.5.2 Surface water pollution
       4.5.3 Ground water pollution
4.6   Summary
4.7   References, Further Reading and Web Sources
4.8   Possible Answers to Self-assessment Exercise

4.1   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 overemphasized 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.

4.2   Intended Learning Outcomes

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

•   Describe water as a media
•   Define two major sources of water pollution
•   Explain the types of water pollution.

4.3   Main Content

4.3.1 Water as a 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 1.39×109 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.

4.4   Sources/Causes 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. We already discussed these two in unit one of this module. The point sources of water pollution include wastes generated by human settlement, domestic, commercial and industrial activities including those of petroleum related industry, energy utilization activities and the precipitation of atmospheric pollutants. The non-point sources of water pollution include acid rain, run-off from agricultural lands treaded with fertilizers and pesticides, which cause nutrient enrichment and eutrophication of surface water.

Self-Assessment Exercise

List two examples each of point and non-point sources of water pollution

4.4.1 Disease-causing agents

Disease-causing agents (pathogens) which include bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and untreated human and animal wastes. Human wastes contain concentrated populations of coliform bacteria such as *Escherichia coli* and *Streptococcus faecalis*. These bacteria normally grow in the large intestine of humans where they are responsible for some food digestion and for the production of vitamin K. These bacteria are not harmful in low numbers. Large amounts of human waste in water, increases the number of these bacteria which cause gastrointestinal diseases. Other potentially harmful bacteria from human wastes may also be present in smaller numbers. Thus the greater the amount of wastes in the water the greater are the chances of contracting diseases from them.

4.4.2 Oxygen depleting wastes

These are organic wastes that can be decomposed by aerobic (oxygen requiring) bacteria. Large populations of bacteria use up the oxygen present in water to degrade these wastes. In the process this degrades water quality. The amount of oxygen required to break down a certain amount of organic matter is called the biological oxygen demand (BOD). The amount of BOD in the water is an indicator of the level of pollution. If too much organic matter is added to the water all the available oxygen is used up. This causes fish and other forms of oxygen dependent aquatic life to die. Thus anaerobic bacteria (those that do not require oxygen) begin to break down the wastes. Their anaerobic respiration produces chemicals that have a foul odour and an unpleasant taste that is harmful to human health.

4.4.3 Inorganic plant nutrients

These are water soluble nitrates and phosphates that cause excessive growth of algae and other aquatic plants. The excessive growth of algae and aquatic plants due to added nutrients is called eutrophication. They may interfere with the use of the water by clogging water intake pipes, changing the taste and odour of water and cause a buildup of organic matter. As the organic matter decays, oxygen levels decrease and fish and other aquatic species die.

The quantity of fertilizers applied in a field is often many times more than is actually required by the plants. The chemicals in fertilizers and pesticides pollute soil and water. While excess fertilizers cause eutrophication, pesticides cause bioaccumulation and bio magnification. Pesticides which enter water bodies are introduced into the aquatic food chain. They are then absorbed by the phytoplankton and aquatic plants. These plants are eaten by the herbivorous fish which are in turn eaten by the carnivorous fish which are in turn eaten by the water birds. At each link in the food chain these chemicals which do not pass out of the body are accumulated and increasingly concentrated resulting in bio magnification of these harmful substances.

One of the effects of accumulation of high levels of pesticides such as DDT is that birds lay eggs with shells that are much thinner than normal. This results in the premature breaking of these eggs, killing the chicks inside. Birds of prey such as hawks, eagles and other fish eating birds are affected by such pollution.

4.4.4 Organic chemicals

Organic chemicals, which include oil, gasoline, plastics, pesticides, cleaning solvents, detergent and many other chemicals. These are harmful to aquatic life and human health. They get into the water directly from industrial activity either from improper handling of the chemicals in industries and more often from improper and illegal disposal of chemical wastes.

4.4.5 Sediment of suspended matter

Sediment of suspended matter is another class of water pollutants. These are insoluble particles of soil and other solids that become suspended in water. This occurs when soil is eroded from the land. High levels of soil particles suspended in water, interferes with the penetration of sunlight. This reduces the photosynthetic activity of aquatic plants and algae disrupting the ecological balance of the aquatic bodies. When the velocity of water in streams and rivers decreases the suspended particles settle

down at the bottom as sediments. Excessive sediments that settle down destroys feeding and spawning grounds of fish, clogs and fills lakes, artificial reservoirs etc.

4.4.6 Hot water

Hot water let out by power plants and industries that use large volumes of water to cool the plant result in rise in temperature of the local water bodies. Thermal pollution occurs when industry returns the heated water to a water source. Power plants heat water to convert it into steam, to drive the turbines that generate electricity. For efficient functioning of the steam turbines, the steam is condensed into water after it leaves the turbines. This condensation is done by taking water from a water body to absorb the heat. This heated water, which is at least 15°C higher than the normal is discharged back into the water body. The warm water not only decreases the solubility of oxygen but changes the breeding cycles of various aquatic organisms.

4.4.7 Oil

Oil is washed into surface water in runoff from roads and parking lots which also pollutes groundwater. Leakage from underground tanks is another source of pollution. Accidental oil spills from large transport tankers at sea have been causing significant environmental damage.

Self-Assessment Exercise

Name any three categories of water pollutants

Self-Assessment Exercise 1 (SAE 1)

Attempt this question. It should not take you more than 5 minutes
Explain any two causes of water pollution

4.5   Types of Water Pollution

4.5.1 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.

4.5.2 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 mineralized or flow across the surface into streams, lakes and rivers.

4.5.3 Groundwater pollution

While oil spills are highly visible and often get a lot of media attention, a much greater threat to human life comes from our groundwater being polluted which is used for drinking and irrigation. While groundwater is easy to deplete and pollute it gets renewed very slowly and hence must be used judiciously. Groundwater flows are slow and not turbulent hence the contaminants are not effectively diluted and dispersed as compared to surface water. Moreover pumping groundwater and treating it is very slow and costly. Hence it is extremely essential to prevent the pollution of groundwater in the first place.

Ground water is polluted due to:
- Urban run-off of untreated or poorly treated waste water and garbage
- Industrial waste storage located above or near aquifers
- Agricultural practices such as the application of large amounts of fertilizers and pesticides, animal feeding operations, etc. in the rural sector
- Leakage from underground storage tanks containing gasoline and other hazardous substances
- Leachate from landfills
- Poorly designed and inadequately maintained septic tanks
- Mining wastes

Self-Assessment Exercise

List any three activities that can results into groundwater pollution?

Self-Assessment Exercise 2 (SAE 2)

> **Attempt this question. It should not take you more than 10 minutes**
>
> *Discuss any two types of water pollution*

4.6   Summary

In this unit you must have learnt how water as a medium of pollutants can cause water pollution. Water pollutants are of different categories such as disease causing agents, oxygen depleting wastes, oil spillage etc. Water pollution again is of different types and sources. For example precipitation, surface and ground water pollution and anthropogenic and natural sources respectively.

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Controls by   Dr. Yashpal Singh Narwaria pdf.

Pollution, Causes, Effects and Control 4th Edition by Roy M. Harrison, Published by Royal Society of Chemistry.

4.8   Possible Answers to Self-Assessment Exercises

SAE 1
Explain any two causes of water pollution
Answer
(i). Disease-causing agents
Disease-causing agents (pathogens) which include bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and untreated human and animal wastes. Human wastes contain concentrated populations of coliform bacteria such as *Escherichia coli* and *Streptococcus faecalis*. These bacteria normally grow in the large intestine of humans where they are responsible for some food digestion and for the production of vitamin K. These bacteria are not harmful in low numbers. Large amounts of human waste in water, increases the number of these bacteria which cause gastrointestinal diseases. Other potentially harmful bacteria from human wastes may also be present in smaller numbers. Thus the greater the amount of wastes in the water the greater are the chances of contracting diseases from them.

(ii). Oxygen depleting wastes
These are organic wastes that can be decomposed by aerobic (oxygen requiring) bacteria. Large populations of bacteria use up the oxygen present in water to degrade these wastes. In the process this degrades water quality. The amount of oxygen required to break down a certain amount of organic matter is called the biological oxygen demand (BOD). The amount of BOD in the water is an indicator of the level of pollution. If too much organic matter is added to the water all the available oxygen is used up. This causes fish and other forms of oxygen dependent aquatic life to die. Thus anaerobic bacteria (those that do not require oxygen) begin to break down the wastes. Their anaerobic respiration produces chemicals that have a foul odour and an unpleasant taste that is harmful to human health

SAE 2
Discuss any two types of water pollution
Answer
(a). 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.

(b). **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 mineralized or flow across the surface into streams, lakes and rivers.

End of Module Question
1. One of these is not a gaseous pollutant?
(a). carbon monoxide (b) sulphur dioxide (c) nitrogen oxides (d) carbon dioxide

2. Aquifers are not part of water bodies? (**True/False**)

3. Pollutants that are discharged from a specific location are called non-point mutation
 (**True/False**)

4. Natural and human activities are responsible for soil pollution (**True/False**)

5. What level of noise is considered harmful?
(a). 120 db (b). 100 db   (c). 60 db   (d). 80 db

MODULE 2

Unit 1   Environmental Media 3 (Soil)
Unit 2   Environmental Media 4 (Food)
Unit 3   Noise Pollution
Unit 4   Thermal pollution

UNIT 1   ENVIRONMENTAL MEDIA 3 (SOIL)

Unit Structure

1.1   Introduction
1.2   Intended Learning Outcomes
1.3   Main Content
         1.3.1 Soil media
1.4   Properties of Soil
1.5   Soil Atmosphere
1.6   Soil Pollution
         1.6.1 Causes of soil pollution
         1.6.2 Prevention of soil pollution
1.7   Summary
1.8   References/Further Reading/Web Resources
1.9   Possible Answers to Self-Assessment Exercise

1.1   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.

1.2   Intended Learning Outcomes

By the end of this unit, you will be able to:

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

1.3   Main Content

1.3.1 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 emphasized.

Soil is a thin covering over the land consisting of a mixture of minerals, organic material, living organisms, air and water that together support the growth of plant life. Several factors contribute to the formation of soil from the parent material. This includes mechanical weathering of rocks due to temperature changes and abrasion, wind, moving water, glaciers, chemical weathering activities and lichens. Climate and time are also important in the development of soils. Extremely dry or cold climates develop soils very slowly while humid and warm climates develop them more rapidly. Under ideal climatic conditions soft parent material may develop into a centimeter of soil within 15 years. Under poor climatic conditions a hard parent material may require hundreds of years to develop into soil.

Self-Assessment Exercise

State three factors that contributes to soil formation

1.4   Properties of Soil

Mature soils are arranged in a series of zones called soil horizons. Each horizon has a distinct texture and composition that varies with different types of soils. A cross sectional view of the horizons in a soil is called a soil profile.

The top layer or the surface litter layer called the O horizon consists mostly of freshly fallen and partially decomposed leaves, twigs, animal waste, fungi and other organic materials. Normally it is brown or black. The uppermost layer of the soil called the A horizon consists of partially decomposed organic matter (humus) and some inorganic mineral particles. It is usually darker and looser than the deeper layers. The roots of most plants are found in these two upper layers. As long as these layers are anchored by vegetation soil stores water and releases it in a trickle throughout the year instead of in a force like a flood. These two top layers also contain a large amount of bacteria, fungi, earthworms and other small insects that form complex food webs in the soil that help recycle soil nutrients and contribute to soil fertility.

The B horizon often called the subsoil contains less organic material and fewer organisms than the A horizon. The area below the subsoil is called the C horizon and consists of weathered parent material. This parent material does not contain any organic materials. The chemical composition of the C-horizon helps to determine the pH of the soil and also influences the soil's rate of water absorption and retention.

Soils vary in their content of clay (very fine particles), silt (fine particles), sand (medium size particles) and gravel (coarse to very coarse particles). The relative amounts of the different sizes and types of mineral particles determine soil texture. Soils with approximately equal mixtures of clay, sand, silt and humus are called loams.

Self-Assessment Exercise

What do you understand by loams?

1.5   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.

1.6   Soil Pollution

Soil pollution refers to the contamination of soil with anomalous concentrations of toxic substances. It is a serious environmental concern since it harbors many health hazards."

"Soil pollution refers to anything that causes contamination of soil and degrades the soil quality. It occurs when the pollutants causing the pollution reduce the quality of the soil and convert the soil inhabitable for microorganisms and macro organisms living in the soil."

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.

Self-Assessment Exercise 1 (SAE 1)

Attempt this question. It should not take you more than 10 minutes

Describe the nature of the soil

1.6.1 Causes of soil pollution

Soil pollution can be natural or due to human activity. However, it mostly boils down to the activities of the human that causes the majority of soil pollution such as heavy industries, or pesticides in agriculture. Industrial activities including mining, smelting and manufacturing; domestic, livestock and municipal wastes; pesticides, herbicides, fertilizers used in agriculture; petroleum-derived products that are released into or break-down in the environment; fumes generated by transportation all contribute to the problem. These include pharmaceuticals, endocrine disruptors, hormones and biological pollutants; "e-waste" from old electronics; and the plastics that are nowadays used in almost every human endeavor.

Figures above shows soil pollution

Natural Pollution of Soil:
In some extremely rare processes, some pollutants are naturally accumulated in soils. This can occur due to the differential deposition of soil by the atmosphere. Another manner in which this type of soil pollution can occur is via the transportation of soil pollutants with precipitation water.

Anthropogenic Soil Pollution:
Almost all cases of soil pollution are anthropogenic in nature. A variety of human activities can lead to the contamination of soil includes:

- **Pesticides**

Before World War II, the chemical nicotine chemical present in the tobacco plants was used as the pest controlling substance in agricultural practices. However, DDT was found to be extremely useful for malaria control and as pest control of many insects during World War II.

- **Inorganic Fertilizers**

Excessive use of inorganic nitrogen fertilizers leads to acidification of soil and contaminate the agricultural soil.

- **Industrial Pollution**

The incorrect way of chemical waste disposal from different types of industries can cause contamination of soil. Human activities like this have led to acidification of soil and contamination due to the disposal of industrial waste, heavy metals, toxic chemicals, dumping oil and fuel, etc.

- **Heavy Metals**

The presence of heavy metals (such as lead and mercury, in abnormally high concentrations) in soils can cause it to become highly toxic to human beings.

Self-Assessment Exercise 2 (SAE 2)

Attempt this question. It should not take you more than 10 minutes

Discuss the causes of soil pollution

1.6.2 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

1.7   Summary

In our discussion on soil media, we've been able to establish the fact that 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.

📖**1.8   References/Further Reading/Web Resources**

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*

List of Text books/Journals
Environmental Pollution (Air, water, soil, thermal, and noise): causes, effects, and
Controls by Dr. Yashpal Singh Narwaria pdf.

Pollution, Causes, Effects and Control 4th Edition by Roy M. Harrison, Published by Royal Society of Chemistry.

⚒ 1.9   Possible Answer to Self-Assessment Exercises

1. Describe the nature of the soil
Answer
Mature soils are arranged in a series of zones called soil horizons. Each horizon has a distinct texture and composition that varies with different types of soils. A cross sectional view of the horizons in a soil is called a soil profile. The top layer or the surface litter layer called the O horizon consists mostly of freshly fallen and partially decomposed leaves, twigs, animal waste, fungi and other organic materials. Normally it is brown or black.
The uppermost layer of the soil called the A horizon consists of partially decomposed organic matter (humus) and some inorganic mineral particles. It is usually darker and looser than the deeper layers. These two top layers also contain a large amount of bacteria, fungi, earthworms and other small insects that form complex food webs in the soil that help recycle soil nutrients and contribute to soil fertility.

The B horizon often called the subsoil contains less organic material and fewer organisms than the A horizon. The area below the subsoil is called the C horizon and consists of weathered parent material. This parent material does not contain any organic materials. The chemical composition of the C-horizon helps to determine the pH of the soil and also influences the soil's rate of water absorption and retention.

2. Discuss the causes of soil pollution
Answer
Natural Pollution of Soil:
In some extremely rare processes, some pollutants are naturally accumulated in soils. This can occur due to the differential deposition of soil by the atmosphere. Another manner in which this type of soil pollution can occur is via the transportation of soil pollutants with precipitation water.

Anthropogenic Soil Pollution:
Almost all cases of soil pollution are anthropogenic in nature. A variety of human activities can lead to the contamination of soil includes:

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Before World War II, the chemical nicotine chemical present in the tobacco plants was used as the pest controlling substance in agricultural practices. However, DDT was found to be extremely useful for malaria control and as pest control of many insects during World War II.

- **Inorganic Fertilizers**

Excessive use of inorganic nitrogen fertilizers leads to acidification of soil and contaminate the agricultural soil.

- **Industrial Pollution**

The incorrect way of chemical waste disposal from different types of industries can cause contamination of soil. Human activities like this have led to acidification of soil and contamination due to the disposal of industrial waste, heavy metals, toxic chemicals, dumping oil and fuel, etc.

- **Heavy Metals**

The presence of heavy metals (such as lead and mercury, in abnormally high concentrations) in soils can cause it to become highly toxic to human beings.

UNIT 2   ENVIRONMENTAL MEDIA 4 (FOOD)

Unit Structure

2.1   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.

2.2   Intended Learning Outcomes

By the end of this unit, you will 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.

2.3   Main Content

2.3.1 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.

2.4   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 utilized 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.

Self-Assessment Exercise

Mention three (3) ways by which nutrients may be received through the roots

2.5   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 food related illnesses are evolving and becoming anti- biotic resistant.

2.5.1 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.

Self-Assessment Exercise (SAE)

 Attempt this question. It should not take you more than 5 minutes

Enumerate the points of food contamination

2.6   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.

2.7   References/ Further Reading/Web Resources

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.

2.8   Possible Answers to Self-Assessment Exercise

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

Enumerate the points of food contamination
Answer
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.

UNIT 3   NOISE POLLUTION

Unit Structure

3.1   Introduction
3.2   Intended Learning Outcomes
3.3   Man Content
        3.3.1 Concept of noise pollution
3.4   Sources of Noise Pollution
3.5   Summary
3.6   References/Further Reading/Web Resources
3.7   Possible Answers to Self-Assessment Exercise

3.1   Introduction

In Nigeria and most developing countries, noise pollution is on the increase because of industrialization, increasing traffic, population and urbanization. Many city centers of urban areas are characterized 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.

3.2   Intended Learning Outcomes

By the end of this unit, you will 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.

3.3   Main Content

3.3.1 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 time a barking

dog, loud music, passing traffic, a power plant or generator (WHO, 2001; EPA/QPW, 2005). It is a non- harmonious or discordant sound wave often harsh, discomforting and unpleasant to the ear (Okereke, 2006).

Noise may not seem as harmful as the contamination of air or water but it is a pollution problem that affects human health and can contribute to a general deterioration of environmental quality. Noise is undesirable and unwanted sound. Not all sound is noise. What may be considered as music to one person may be noise to another. It is not a substance that can accumulate in the environment like most other pollutants. Sound is measured in a unit called the 'Decibel'.

Decibel levels of common sounds

dB	Environmental Condition
0	Threshold of hearing
10	Rustle of leaves
20	Broadcasting studio
30	Bedroom at night
40	Library
50	Quiet office
60	Conversational speech (at 1m)
70	Average radio
74	Light traffic noise
90	Subway train
100	Symphony orchestra
110	Rock band
120	Aircraft takeoff
146	Threshold of pain

Noise level above 120 db is considered harmful to human beings. 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 population in both industrialized and developing countries (Schomer, 2001).

Noise pollution is on the increase in all areas, especially in the urban areas; this is because of increase of population, urbanization 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.

Self-Assessment Exercise

When noise is considered harmful to human?

3.4 Sources of Noise Pollution

Noise has been categorized into two groups: noise associated with machinery, equipment and general workplace is referred to as occupational or industrial or outdoor 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 (WHO, 1991; Nadakavukaren, 1995).

Residential noise or indoor noise is any noise from a house, apartment or flat, commonly neighbors stereos, radios and air conditioners. An unreasonable noise exists when the said item can be heard in a habitable room of a neighboring 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 neighborhood. 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. Mechanized 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.

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**.** The differences between sound and noise is often subjective and a matter of personal opinion. There are however some very harmful effects caused by exposure to high sound levels. These effects can range in severity from being extremely annoying to being extremely painful and hazardous.

Self-Assessment Exercise

Mention any two sources of indoor noise.

Self-Assessment Exercise (SAE)

Attempt this question. It should not take you more than 5 minutes.

Differentiate between industrial and residential noise.

3.5   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 centers 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.

3.6   References/Further Readings/Web Resources

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

List of Text books/Journals
Environmental Pollution (Air, water, soil, thermal, and noise): causes, effects, and
Controls by   Dr. Yashpal Singh Narwaria pdf.

Pollution, Causes, Effects and Control 4th Edition by Roy M. Harrison, Published by Royal Society of Chemistry.

3.7   Possible Answer to Self-Assessment Exercise

Answer
Noise level above 120 db

Answer
ventilation systems, office machines, house appliances, food blenders, sewing machines, vacuum cleaners

Differentiate between industrial and residential noise
Answer
Noise associated with machinery, equipment and general workplace is referred to as occupational or industrial or outdoor noise while residential noise or indoor noise is any noise from a house, apartment or flat, commonly neighbor's stereos, radios and air conditioners.

UNIT 4   THERMAL POLLUTION

Unit Structure

4.1   Introduction
4.2   Intended Learning Outcomes
4.3   Main Content
        4.3.1 Causes/Sources of thermal pollution
4.4   Summary
4.5   References/Further Reading/Web Resources
4.6   Possible Answers to Self-Assessment Exercise

4.1   Introduction

Thermal pollution, sometimes called "thermal enrichment," is the degradation of water quality by any process that changes ambient water temperature. It occurs when an industry removes water from a source, uses the water for cooling purposes and then returns the heated water to its source. Power plants heat water to convert it into steam, to drive the turbines that generate electricity. For efficient functioning of the steam turbines, the steam is condensed into water after it leaves the turbines. This condensation is done by taking water from a water body to absorb the heat. This heated water, which is at least 15°C higher than the normal is discharged back into the water body.

4.2   Intended Learning Outcomes

By the end of this unit, you will be able to:

•   state the sources or causes of thermal pollution

4.3   Main Content

4.3.1 Causes/Sources of thermal pollution

A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. Other causes of thermal pollution include soil erosion. Many human and natural factors contribute to the problem of thermal pollution. The single biggest cause of thermal pollution is probably cooling for industrial machinery and power plants. Water is an excellent, and free, cooling agent. This is why many industrial

operations pull in relatively cool water to cool their machinery and let the relatively warm water flow back into the river or lake or sea.

Thermal pollution also has some natural causes. Geothermal vents and hot springs introduce excess heat into bodies of water. Soil erosion, deforestation, and runoff from paved areas are other artificial sources of hot water. Deforestation eliminates shade, which exposes the water to sunlight. Water on hot paved surfaces gets hot, then runs off into nearby bodies of water, raising the water temperature. Retention ponds can also be a source of thermal shock because the relatively small and shallow bodies of water can absorb quite a bit of heat energy from the sun. Pumping that water directly into a river, lake, or bay causes a significant temperature increase, just like pouring a hot pitcher of water into a bathtub full of water causes the water to jump a few degrees Fahrenheit.

Self-Assessment Exercise

Mention the common cause of thermal pollution.

Self-Assessment Exercise (SAE)

Attempt these questions. It should not take you more than 10 minutes.

1. Define Thermal pollution.

2. Highlight the causes of thermal pollution.

4.4   Summary

In this unit we have learnt that thermal pollution is the discharge of warm water into a river. The commonest cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. Other causes of thermal pollution may include soil erosion. Both Anthropogenic and natural factors contribute to the problem of thermal pollution. The single biggest cause of thermal pollution is probably cooling for industrial machinery and power plants.

📖 4.5 References/Further Reading/Web Resources

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FEPA (1991). Guidelines and Standards for Environmental Pollution
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List of Textbooks/Journals

Environmental Pollution (Air, water, soil, thermal, and noise): causes,
        effects, and
Controls by   Dr. Yashpal Singh Narwaria pdf.

4.6   Possible Answers to Self-Assessment Exercise

Answer
Use of water as a coolant by water plants and industrial manufacturers

1. *Define Thermal pollution*
Answer
Thermal pollution, sometimes called "thermal enrichment," is the degradation of water quality by any process that changes ambient water temperature. It occurs when an industry removes water from a source, uses the water for cooling purposes and then returns the heated water to its source.

2. *Highlight the causes of thermal pollution*
Answer
i. the use of water as a coolant by power plants and industrial manufacturers
ii. soil erosion
iii. deforestation, and
iv. runoff from paved areas

End of Module Question

1. Which one of these does not contribute to soil formation?
(a). mechanical weathering (b). time (c). climate (d). topography

2. Which of these is a point source of water contamination?
(a). slaughter (b). watering (c). utensils (d). all of the above

3. Which one of these is not an anthropogenic cause of soil pollution
(a). pesticides (b). inorganic fertilizers (c). heavy metals   (d). none of the above

4. Noise associated with the use of machinery and equipment are called outdoor noise (**True/False**)

5. Use of water as a coolant by power plants is a common cause of thermal pollution (**True/False**)

MODULE 3

Unit 1   Impacts of Air Pollution on Living Organism and Ecosystem
Unit 2   Impacts of Water Pollution on Living Organism and Ecosystem
Unit 3   Impacts of Soil Pollution on Living Organism and Ecosystem
Unit 4   Impacts of Noise Pollution on Human

UNIT 1   IMPACTS OF AIR POLLUTION ON LIVING ORGANISM AND ECOSYSTEM

Unit Structure

1.1   Introduction
1.2   Learning Outcomes
1.3   Main Content
1.4   Impacts of Air Pollution on living organism and Ecosystem
    1.4.1 Effects on living organism
    1.4.2 Effects on plants
    1.4.3 Effects on materials
    1.4.4 Effects on stratosphere
1.5   Summary
1.6   References/Further Readings/Web Sources
1.1   Possible Answers to Self-assessment Exercise

1.1   Introduction

Pollution has negative impact on human health and the ecosystem. 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.

1.2   Learning Outcomes

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

- List the various health effects of air pollution on man and ecosystem
- Identify some of the pollutants involved.

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1.3   Main Content

1.4 Impacts of Air Pollution on Living organism and Ecosystem

1.4.1 Effects of air pollution on living organism

Our respiratory system has a number of mechanisms that help in protecting us from air pollution. The hair in our nose filters out large particles. The sticky mucus in the lining of the upper respiratory tract captures smaller particles and dissolves some gaseous pollutants. When the upper respiratory system is irritated by pollutants sneezing and coughing expel contaminated air and mucus. Prolonged smoking or exposure to air pollutants can overload or breakdown these natural defenses causing or contributing to diseases such as lung cancer, asthma, chronic bronchitis and emphysema. Elderly people, infants, pregnant women and people with heart disease, asthma or other respiratory diseases are especially vulnerable to air pollution.

Cigarette smoking is responsible for the greatest exposure to carbon monoxide. Exposure to air containing even 0.001 percent of carbon monoxide for several hours can cause collapse, coma and even death. As carbon monoxide remains attached to hemoglobin in blood for a long time, it accumulates and reduces the oxygen carrying capacity of blood. This impairs perception and thinking, slows reflexes and causes headaches, drowsiness, dizziness and nausea. Carbon monoxide in heavy traffic causes headaches, drowsiness and blurred vision.

Sulfur dioxide irritates respiratory tissues. Chronic exposure causes a condition similar to bronchitis. It also reacts with water, oxygen and other material in the air to form sulfur-containing acids. The acids can become attached to particles which when inhaled are very corrosive to the lung.

Nitrogen oxides especially NO_2 can irritate the lungs, aggravate asthma or chronic bronchitis and also increase susceptibility to respiratory infections such as influenza or common colds.

Suspended particles aggravate bronchitis and asthma. Exposure to these particles over a long period of time damages lung tissue and contributes to the development of chronic respiratory disease and cancer.

Many volatile organic compounds such as (benzene and formaldehyde) and toxic particulates (such as lead, cadmium) can cause mutations, reproductive problems or cancer. Inhaling ozone, a component of photochemical smog causes coughing, chest pain, breathlessness and irritation of the eye, nose and the throat.

1.4.2 Effects on plants

When some gaseous pollutants enter leaf pores they damage the leaves of crop plants. Chronic exposure of the leaves to air pollutants can break down the waxy coating that helps prevent excessive water loss and leads to damage from diseases, pests, drought and frost. Such exposure interferes with photosynthesis and plant growth, reduces nutrient uptake and causes leaves to turn yellow, brown or drop off altogether.

At a higher concentration of sulphur dioxide majority of the flower buds become stiff and hard. They eventually fall from the plants, as they are unable to flower.
Prolonged exposure to high levels of several air pollutants from smelters, coal burning power plants and industrial units as well as from cars and trucks can damage trees and other plants.

Self-Assessment Exercise

Mention the effects of any two air pollutants on man

1.4.3 Effects of on materials

Every year air pollutants cause damage worth billions of rupees. Air pollutants break down exterior paint on cars and houses. All around the world air pollutants have discoloured irreplaceable monuments, historic buildings, marble statues, etc.

1.4.4 Effects on the stratosphere (Ozone Layer)

The upper stratosphere consists of considerable amounts of ozone, which works as an effective screen for ultraviolet light. This region called the ozone layer extends up to 60 km above the surface of the earth. Though the ozone is present up to 60 km its greatest density remains in the region between 20 to 25 km. The ozone layer does not consist of solely ozone but a mixture of other common atmospheric gases. In the densest ozone layer there will be only one ozone molecule in 100,000 gas molecules. Therefore even small changes in the ozone concentration can produce dramatic effects on life on earth.

Ozone is a form of oxygen with three atoms instead of two. It is produced naturally from the photo-dissociation of oxygen gas molecules in the atmosphere. The ozone thus formed is constantly broken down by naturally occurring processes that maintain its balance in the ozone layer. In the absence of pollutants the creation and breakdown of ozone are purely governed by natural forces, but the presence of certain pollutants can accelerate the breakdown of ozone. The release of chlorofluorocarbons (CFC), halons, and hydrochlorofluorocarbons in the

atmosphere is the major cause of depletion of the ozone layer. The depleting ozone layer does not prevent the harmful ultraviolet rays coming from the sun and causes skin diseases and eye problems among individuals.

Changes in the ozone layer have serious implications for mankind.

* **Effects on human health:** Sunburn, cataract, aging of the skin and skin cancer are caused by increased ultra-violet radiation. It weakens the immune system by suppressing the resistance of the whole body to certain infections like measles, chicken pox and other viral diseases that elicit rash and parasitic diseases such as malaria introduced through the skin.

* **Food production:** Ultra violet radiation affects the ability of plants to capture light energy during the process of photosynthesis. This reduces the nutrient content and the growth of plants. This is seen especially in legumes and cabbage. Plant and animal planktons are damaged by ultra- violet radiation. In zooplanktons (microscopic animals) the breeding period is shortened by changes in radiation. As planktons form the basis of the marine food chain a change in their number and species composition influences fish and shell fish production.

* **Effect on materials**: Increased UV radiation damages paints and fabrics, causing them to fade faster.

* **Effect on climate:** Atmospheric changes induced by pollution contribute to global warming, a phenomenon which is caused due to the increase in concentration of certain gases like carbon dioxide, nitrogen oxides, methane and

CFCs. Observations of the earth have shown beyond doubt that atmospheric constituents such as water vapour, carbon dioxide, methane, nitrogen oxides and Chloro Fluro Carbons trap heat in the form of infra-red radiation near the earth's surface. This is known as the **'Greenhouse Effect'.** The phenomenon is similar to what happens in a greenhouse. The glass in a greenhouse allows solar radiation to enter which is absorbed by the objects inside. These objects radiate heat in the form of terrestrial radiation, which does not pass out through the glass. The heat is therefore trapped in the greenhouse increasing the temperature inside and ensuring the luxuriant growth of plants. The rise in temperature will bring about a fall in agricultural produce.

Self-Assessment Exercise (SAE)

Attempt this question. It should not take you more than 5 minutes

Explain the impacts that air pollution have on man

1.5   Summary

In this unit you have learnt about the impacts of air pollutants on both man and the ecosystem. Air pollutants such as carbon monoxide, sulphur dioxide and nitrogen dioxide have detrimental effect on the human body. They can affect the lungs and skin of man which can result in several health issues such as bronchitis cancer etc. Also the air pollutants can deplete the ozone layer of the atmosphere which also affects materials, plants, and man.

1.6   References/Further Reading/Web Sources

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.

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1.7   Possible Answers to Self-Assessment Exercise

Answer

1. Sulfur dioxide can irritates respiratory tissues and can cause a condition similar to bronchitis.

2. Nitrogen oxides especially NO_2 can irritate the lungs, aggravate asthma or chronic bronchitis and also increase susceptibility to respiratory infections such as influenza or common colds.

Explain the impacts that air pollution have on man

Answer

Cigarette smoking is responsible for the greatest exposure to carbon monoxide. Exposure to air containing even 0.001 percent of carbon monoxide for several hours can cause collapse, coma and even death. As carbon monoxide remains attached to hemoglobin in blood for a long time, it accumulates and reduces the oxygen carrying capacity of blood. This impairs perception and thinking, slows reflexes and causes headaches, drowsiness, dizziness and nausea. Carbon monoxide in heavy traffic causes headaches, drowsiness and blurred vision.

Sulfur dioxide irritates respiratory tissues. Chronic exposure causes a condition similar to bronchitis. It also reacts with water, oxygen and other material in the air to form sulfur-containing acids. The acids can become attached to particles which when inhaled are very corrosive to the lung.

Nitrogen oxides especially NO_2 can irritate the lungs, aggravate asthma or chronic bronchitis and also increase susceptibility to respiratory infections such as influenza or common colds.

UNIT 2   IMPACTS OF WATER POLLUTION ON LIVING ORGANISMS AND ECOSYSTEM

Unit Structure

2.1   Introduction
2.2   Learning Outcomes
2.3   Main Content
          2.3.1 Impacts of water pollution on living organism and ecosystem
          2.3.2 Water-borne diseases from water contamination
2.4   Summary
2.5   References/ Further Reading /Web sources
2.6   Answers to Self-assessment Exercise

2.1   Introduction

Water pollution happens when toxic substances enter water bodies such as lakes, rivers, oceans and so on, getting dissolved in them, lying suspended in the water or depositing on the bed. This degrades the quality of water. Not only does this spell disaster for aquatic ecosystems, the pollutants also seep through and reach the groundwater, which might end up in our households as contaminated water we use in our daily activities, including drinking

2.2   Learning Outcomes

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

•   Explain the effects of water pollution.

2.3   Main Content

2.3.1 Impacts of water pollution on living organism and ecosystem

The effects of water pollution are varied. They include poisonous drinking water, poisonous food animals (due to these organisms having bioaccumulated toxins from the environment over their life spans), unbalanced river and lake ecosystems that can no longer support full biological diversity, deforestation from acid rain, and many other effects. These effects are, of course, specific to the various contaminants

1.   Water bodies in the vicinity of urban areas are extremely polluted. This is the result of dumping garbage and toxic chemicals by industrial and commercial establishments.

2.   Water pollution drastically affects aquatic life. It affects their metabolism, behavior, causes illness and eventual death. Dioxin is a chemical that causes a lot of problems from reproduction to uncontrolled cell growth or cancer. This chemical is bioaccumulated in fish, chicken and meat. Chemicals such as this travel up the food chain before entering the human body.

3.   The effect of water pollution can have a huge impact on the food chain. It disrupts the food-chain. Cadmium and lead are some toxic substances, these pollutants upon entering the food chain through animals (fish when consumed by animals, humans) can continue to disrupt at higher levels.

4.   Humans are affected by pollution and can contract diseases such as hepatitis through faucal matter in water sources. Poor drinking water treatment and unfit water can always cause an outbreak of infectious diseases such as cholera etc.

5.   The ecosystem can be critically affected, modified and destructured because of water pollution.

Self-Assessment Exercise

Mention any two impacts of water pollution

2.3.2 Water-borne diseases from water contamination

Pollutants that find their ways into water bodies due to different human activities can results into water-borne diseases. 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

Table 1.1: Water-Borne Diseases and their Causes

Cause	Water-Borne Diseases
Bacterial (*Salmonella typhi*)	Typhoid
Cholera Paratyphoid	Fever
Bacillary dysentery	Viral infections
Infectious Hepatitis	Jaundice
Poliomyelitis	Protozoan infections
Amoebic	Dysentery

A large number of organisms 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

Self-Assessment Exercise

Attempt this question. It should not take you more than 5 minutes
List 3 pathogens that can cause water contamination and their water-borne diseases

2.4   Summary

In this unit you have learnt of the effects of water pollutants on living organisms and ecosystem which includes affecting food chain, and the outbreak of water-borne diseases such as cholera, dysentery etc.

2.5   References/Further Reading/Web Sources

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.

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Environmental Toxicology: Biological and Health Effects of Pollutants 3rd edition by Ming-Ho Yu Masahi Tsunoda and Humio Tsunoda CRC Press.

2.6   Possible Answers to Self-Assessment Exercise

Answer

1. Water pollution drastically affects aquatic life. It affects their metabolism, behavior, causes illness and eventual death. Dioxin causes a lot of problems from reproduction to uncontrolled cell growth or cancer. This chemical is bioaccumulated in fish, chicken and meat. Chemicals such as this travel up the food chain before entering the human body.

2. The effect of water pollution can have a huge impact on the food chain. It disrupts the food-chain. Cadmium and lead are some toxic substances, these pollutants upon entering the food chain through animals (fish when consumed by animals, humans) can continue to disrupt at higher levels

List 3 pathogens that can cause water contamination and their water-borne diseases

Bacteria (*Salmonella typhi*)	Viral infections
Poliomyelitis	Protozoan infections
Amoebic	Dysentery

UNIT 3   IMPACTS OF SOIL POLLUTION ON LIVING ORGANISM AND ECOSYSTEM

Unit Structure

3.1   Introduction
3.2   Learning Outcomes
3.3   Main Content
       3.3.1 Impacts of water pollution on living organism and ecosystem
3.4   Summary
3.5   References/Further Reading/Web Sources
3.6   Possible Answers to Self-Assessment

3.1   Introduction

Soil pollution affects plants, animals and humans. While anyone is susceptible to soil pollution, soil pollution effects may vary based on age, general health status and other factors, such as the type of pollutant or contaminant inhaled or ingested. However, children are usually more susceptible to exposure to contaminants, because they come in close contact with the soil by playing in the ground; combined with lower thresholds for disease, (headaches, nausea, and vomiting, coughing, pain in the chest, and wheezing) this triggers higher risks.

3.2   Learning Outcomes

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

•   Explain the effects of soil pollution on living organism and ecosystem.

3.3   Main Content

3.3.1 Impacts of soil pollution on living organism and ecosystem

•   **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 Organization. Acid loving soils tend to be toxic to human health.

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- • **Ground water contamination:** Soil pollution can leach into the ground water and end up in drinking supplies, according to the World Health Organization. Directly consuming the contaminated water can cause health effects associated with the type of chemical that are in the water.

Health Issues: 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. The hospital waste contains a variety of pathogens that can seriously affect human health.

Self-Assessment Exercise

Enumerate two impacts of soil pollution

3.4   Summary

Soil contamination or soil pollution as part of land degradation is caused by the presence of xenon biotic chemicals or other alteration in the natural soil environment. Soil pollution effects may vary based on age, general health status and other factors, such as the type of pollutant or contaminant inhaled or ingested. However, children are usually more susceptible to exposure to contaminants, because they come in close contact with the soil by playing in the ground; combined with lower thresholds for disease, (headaches, nausea, and vomiting, coughing, pain in the chest, and wheezing) this triggers higher risks.

3.5   References/Further Reading/Web Sources

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

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      CRC Press.

3.6 Possible Answers to Self-Assessment Exercise(s)

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

UNIT 4   IMPACTS OF NOISE POLLUTION ON HUMAN

Unit Structure

4.1   Introduction
4.2   Learning Outcomes
4.3   Main Content
         4.3.1 Impacts of noise pollution on human
4.4   Summary
4.5   References/Further Reading/Web Sources
3.6   Possible Answers to Self-Assessment

4.1   Introduction

Noise pollution affects everyone, yet this problem is largely ignored by most people. Noise pollution affects sleep, eating habits, mood, concentration and body functions such as respiration and heart rate.

4.2   Learning Outcomes

By the end of this unit, you should be able:

•   To explain the effects of noise pollution on human.

4.3   Main Content

4.3.1 Impacts of noise pollution on human

•   **Noise pollution affects the physical health**
The most direct harmful effect of excessive noise is physical damage to the ear and the temporary or permanent hearing loss often called a temporary threshold shift (TTS). People suffering from this condition are unable to detect weak sounds. However hearing ability is usually recovered within a month of exposure. Permanent loss, usually called noise induced permanent threshold shift (NIPTS) represents a loss of hearing ability from which there is no recovery. Below a sound level of 80 dBA haring loss does not occur at all. However temporary effects are noticed at sound levels between 80 and 130 dBA. About 50 percent of the people exposed to 95 dBA sound levels at work will develop NIPTS and most people exposed to more than 105 dBA will experience permanent hearing loss to some degree. A sound level of 150 dBA or more can physically rupture the human eardrum.

The degree of hearing loss depends on the duration as well as the intensity of the noise. For example, 1hour of exposure to a 100 dBA sound level can produce a TTS that may last for about one day. However in factories with noisy machinery workers are subjected to high sound levels for several hours a day. Exposure to 95 dBA for 8 hours every day for over a period of 10 years may cause about 15 dBA of NIPTS.

- **Noise pollution affects mental health**

Noise can also cause emotional or psychological effects such as irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise. It has been observed that the performance of school children is poor in comprehension tasks when schools are situated in busy areas of a city and suffer from noise pollution. As noise interferes with normal auditory communication, it may mask auditory warning signals and hence increases the rate of accidents especially in industries. It can also lead to lowered worker efficiency and productivity and higher accident rates on the job. Thus noise is just more than a mere nuisance or annoyance. It definitely affects the quality of life. It is thus important to ensure mitigation or control of noise pollution.

- 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 life, as well as negatively affect the health.

- It causes harmful effects on the circulatory system by raising blood pressure and altering pulse rates: 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 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.

Self-Assessment Exercise

Attempt this question. It should not take you more than 10 minutes
Explain any two impacts of noise pollution

4.4   Summary

In this unit you have learnt of the effects of noise pollution on human
health which include physical health, mental health, hearing impairment
etc.

4.5   References/Further Reading/Web Sources

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

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        3rd edition by Ming-Ho Yu Masahi Tsunoda and Humio Tsunoda
        CRC Press

4.6   **Possible Answers to Self-Assessment Exercise**

Answer

Explain any two impacts of noise pollution
1. Noise pollution affects mental health: Noise can also cause emotional or psychological effects such as irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise. It has been observed that the performance of school children is poor in comprehension tasks when schools are situated in busy areas of a city and suffer from noise pollution. As noise interferes with normal auditory communication, it may mask auditory warning signals and hence increases the rate of accidents especially in industries. It can also lead to lowered worker efficiency and productivity and higher accident rates on the job. Thus noise is just more than a mere nuisance or annoyance. It definitely affects the quality of life. It is thus important to ensure mitigation or control of noise pollution.

2. 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 life, as well as negatively affect the health.

End of Module Question
1. Which of these air pollutants cause flowers to become stiff and hard
(a). sulphur dioxide (b). nitrogen oxide (c). Nitrogen (d). carbo monoxide
2. One of the implications of changes in the ozone layer on human is skin disease (**True/False**)
3. Dysentery is an example of water contaminated disease (**True/False**)
4. Which one of these is not an impact of soil pollution
(a). acidification (b). ground water contamination (c). reduction in soil fertility (d). none of the above
5. Noise pollution can cause anxiety (**True/False**)

MODULE 4

UNIT 1   MONITORING OF POLLUTANTS

Unit Structure

1.1   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 of 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 doing so.

1.2   Intended Learning Outcomes

By the end of this unit, you will 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.

1.3   Main Content

1.4   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

1.4.1   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 equipment. However, other physical monitoring may require the use of equipment or scientific instruments.

1.4.2   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.

1.4.3 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.

Self-Assessment Exercise

List three principal parameters involved in monitoring water pollutants

1.5   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.

1.6   Monitoring of Pollutants in Soil

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 is 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.
* 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.

Self-Assessment Exercise

Mention four items that may be needed by land owners in monitoring soil pollution of their lands

1.7   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 and lastly 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.

Self-Assessment Exercise

> Attempt this question. It should not take you more than 10 minutes.
>
> Discuss the three principal parameters involved in the monitoring of water pollutants.

1.8   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

1.9   References/Further Reading/Web Resources

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.

List of Text books/Web Resources

Environmental Pollution (Air, water, soil, thermal, and noise): causes, effects, and
Controls by Dr. Yashpal Singh Narwaria pdf.

Pollution, Causes, Effects and Control 4th Edition by Roy M. Harrison, Published by Royal Society of Chemistry

1.10   Possible Answers to Self-Assessment Exercise

Answer
Monitoring of water quality/pollutants in water involves three principal parameters:
- Physicochemical
- Microbiological and
- Chemicals

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

Discuss the three principal parameters involved in the monitoring of water pollutants

Answer

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 equipment. However, other physical monitoring may require the use of equipment or scientific instruments.

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.

Chemicals
Chemicals monitoring in water has become so paramount in modern time due to the preponderance of industries and production activities in the urban centers 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. 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.

UNIT 2   ASSESSMENTS OF POLLUTANTS

Unit Structure

2.1   Introduction
2.2   Intended Learning Outcomes
2.3   Main Content
2.4   Assessment of Pollutants
2.5   Summary
2.6   References/Further Reading/Web Resources
2.7   Possible Answers to Self-Assessment Exercise

2.1   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.

2.2   Intended Learning Outcomes

By the end of this unit, you will be able to:

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

2.3   Main Content

2.4   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 analyze 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 localized 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.

Self-Assessment Exercise

Attempt this question. It should not take you more than 5 minutes. Mention three factors that determine the severity of a pollutant.

2.5   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.

2.6   References/Further Reading/Web Resources

List of Textbooks

Air Pollution by Arthur C. Stern 2nd edition Vol 2: Analysis, Monitoring and Surveying of Pollutants Chapter 16. Academic Press New York London

Environmental Pollution and Control 4th edition by J. Jeffrey Peirce, Ruth. F. Weiner and P. Aarne Vesilind

2.7   Possible Answers to Self-Assessment Exercise

Mention three factors that determine the severity of a pollutant

i. chemical nature,
ii. the concentration and
iii. the persistence of the pollutant

UNIT 3   EXPOSURE PATTERNS TO AIR POLLUTANTS

Unit Structure

3.1   Introduction
3.2   Intended Learning Outcomes
3.3   Main Content
3.4   The Concept of Exposure Pattern
3.5   Exposure Patterns to Air Pollutants
       3.5.1 Respiratory tract exposure
       3.5.2 Alimentary tract exposure
       3.5.3 Skin and the eye exposure
       3.5.4 Auditory exposure
3.6   Summary
3.7   References/Further Reading/Web Resources
3.8   Possible Answers to Self-Assessment Exercise

3.1   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 processes in which the result varying from one individual to the other. However, there are certain generally 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.

3.2   Intended Learning Outcomes

By the end of this unit, you will 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.

3.3   **Main Content**

3.4   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 realization 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.

3.5   Exposure Patterns to Air Pollutants

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 different patterns of exposure to air pollutants are described below:

3.5.1 Respiratory tract exposure

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.

3.5.2 Alimentary tract exposure

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).

Self-Assessment Exercise

State three organisms that the alimentary tract could be exposed to

3.5.3 Skin and the eyes exposure

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.

3.5.4 Auditory exposure

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.

Self-Assessment Exercise

Attempt these questions. It should not take you more than 10 minutes.
List and explain three exposure patterns to air pollutants.

3.6   Summary

You have learnt what exposure patterns is all about and the various mode of its expression. These include the respiratory exposure, the alimentary tract exposure, the skin and the eye exposure and the auditory exposure patterns. In the next unit, we shall be considering the global concerns over pollution.

3.7   References/Further Reading/Web Resources

Adair, J. H. and 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: Ugooma Printing and Publishing Co. Nig.

Behar, J. V., Blancato, J. N., Pandian, M. D. and 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.

3.8   Possible Answers to Self-Assessment Exercise

Answer
Streptococci, Staphylococci, Salmonella

List and explain three exposure patterns to air pollutants

1. Alimentary Tract exposure
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).

2. Skin and the Eyes exposure
In this pattern, 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. Auditory exposure
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.

UNIT 4   OVERVIEW   OF   CURRENT   GLOBAL POLLUTION CONCERNS

Unit Structure

4.1   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.

4.2   Intended Learning Outcomes

By the end of this unit, you will be able to:

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

4.3   Main Content

4.4   Other 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 industrialization 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.

4.4.1 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.

Self-Assessment Exercise

State some sources of ocean pollution

4.4.2 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.

4.4.3 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.

4.4.4 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.

Self-Assessment Exercise

What is garbage dumping and give an example of its source?

4.4.5 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 realize 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.

4.4.6   Oceans pollution by car

Fig.4.3: 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.

4.4.7 Ocean pollution by agriculture

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 fertilizers.

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. 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.

Self-Assessment Exercise 1

Attempt this question. It should not take you more than 10 minutes.

4.4.8   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.

4.4.9 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.

4.4.10 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.

4.4.11 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.

4.4.12 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.

4.4.13 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.
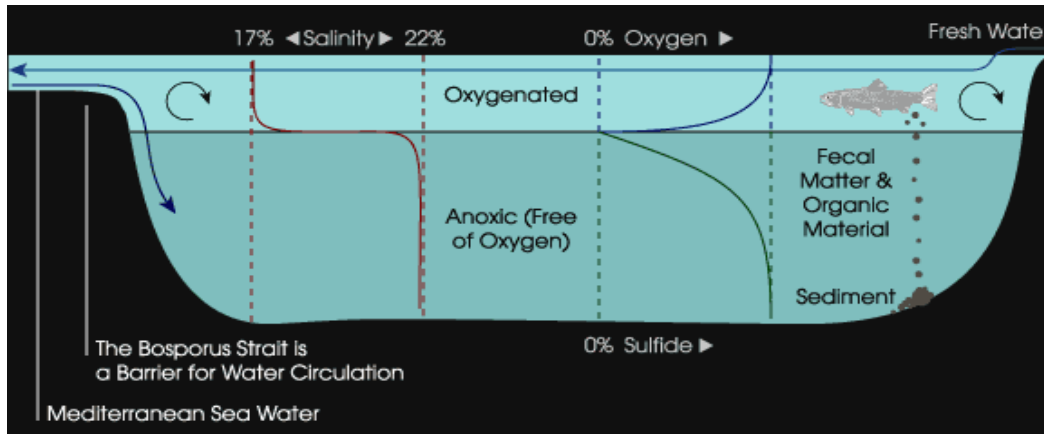
4.4.14 Anoxic water

Fig. 4.5: Anoxic Zones

The picture Figure 4.4 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 and nbsp cannot 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.
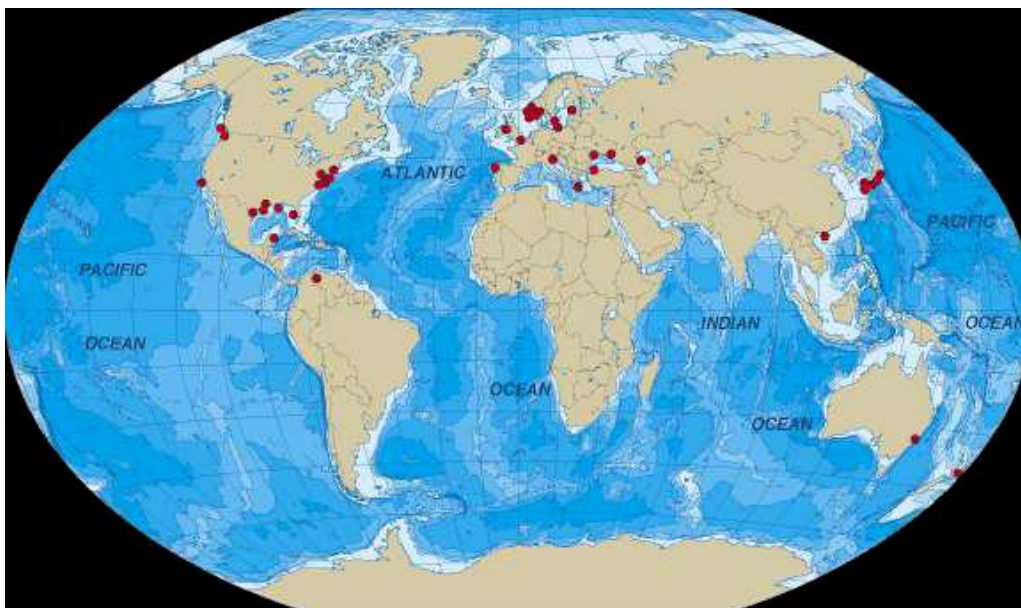

Fig. 4.5: Areas of Anoxic Waters
Note: The red dots show areas where anoxic waters are located

It is very important that we address the issues that affect the ocean. Ninety percent of sea creatures live in the sunlight and nbsp zone, 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.

4.5   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. 4.6: 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
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. 4.7: 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.

4.6   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 minimizing 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 minimize 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_oC)

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_oF) 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 realizing 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.

Self-Assessment Exercise 2

Attempt this question. It should not take you more than 5 minutes.
Describe global warming.

4.7   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.

4.8   References/Further Reading/Web Resources

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Castilleja School (USA). Oil pollution. www.JP.Kids-commons.net/vc96/vc-13ocean_pollution/ocean1.html

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.

4.9   Possible Answers to Self-Assessment

Self-Assessment Exercise 1
Describe any three pollutants that are of ocean pollution concerns

Answer
Oil spills, toxic wastes, and dumping of other harmful materials from agricultural source

Answer
Garbage dumping is the dumping of harmful materials into the ocean like human waste, ground-up garbage, water from bathing, and plastics. One main cause of garbage dumping occurs when sewage pipes share their space with storm water drains.

Answer

1. 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.

2. **Ocean pollution by cars**: Cars pollute the ocean a lot. Whenever a car gets driven, it gives out 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 and if not controlled fish and other creatures in the ocean will decrease.

3. **Garbage dumping** is the dumping of harmful materials into the ocean like human waste, ground-up garbage, water from bathing, and plastics. 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.

Self-Assessment Exercise 2

Describe global warming

Answer

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

End of Module Questions
1. The level of suspended solids as pollutants in water can be monitored by the use of equipment (**True/False**)

2. *Escherichia* coliform is an indicator of water contamination by microbes (**True/False**)

3. Which one of these is not needed for monitoring of soil pollution
(a). specimen jars (b). small trowel (c). butter knife (d). none of the above

4. The concentration and persistence of pollutants determines the severity of the pollutants (**True/False**)

5. The ingestion of pollutants through the mount is an example of alimentary tract exposure to pollutants (**True/False**)

MODULE 5

UNIT 1   CONTROL OF AIR POLLUTION

Unit Structure

1.1   Introduction

Air pollution refers to the release of pollutants into the air that are detrimental to human health and the planet as a whole. The burning of fossil fuels Sulfur dioxide emitted from the combustion of fossil fuels like coal, petroleum and other factory combustibles are one the major cause of air pollution. But, their overuse is killing our environment as dangerous gases are polluting the environment. However some measures can be undertaken to control pollution of the air.

1.2   Intended Learning Outcome

By the end of this unit, you will be able to:

- explain all methods used to control air pollution.

1.3   Main Content

1.4   Control of Air Pollution

Air pollution can be controlled by two fundamental approaches: preventive techniques and effluent control.

1.4.1 Preventive techniques

One of the effective means of controlling air pollution is to have proper equipment in place as a preventive measure. This includes:
- devices for removal of pollutants from the flue gases through scrubbers
- closed collection recovery systems through which it is possible to collect the pollutants before they escape should be available
- use of dry and wet collectors, filters, electrostatic precipitators, etc.

Providing a greater height to the stacks can help in facilitating the discharge of pollutants as far away from the ground as possible. Industries should be located in places so as to minimize the effects of pollution after considering the topography and the wind directions. Substitution of raw material that causes more pollution with those that cause less pollution can be done.

Self-Assessment Exercise

List two fundamental approaches by which air pollution may be controlled.

1.4.2 Other measures of controlling air pollution

1. **Avoid using vehicles**: People should avoid using vehicles for shorter distances. Rather they should prefer public modes of transport to travel from one place to another. This not only prevents pollution but also conserves energy.

2. **Energy conservation:** A large number of fossil fuels are burnt to generate electricity. Therefore, do not forget to switch off the electrical appliances when not in use. Thus, you can save the environment at the individual level. Use of energy-efficient devices such as CFLs also controls pollution to a greater level.

3. **Use of Energy efficient appliances:** Whether at the domestic level or at the industrial level, we must push for appliances that use energy efficiently, which result in complete combustion of fuel, as incomplete combustion causes air pollution.

4.   **Shifting industries:** Another possible solution to reduce the harmful effects of air pollution is to shift the manufacturing plants, factories and industries to remote areas with a low level of population.

5.   **Using Modern Techniques:** With technology making great advancements, there are now technologies available that can help reduce the release of pollutants in the air. Air filters, scrubbers, precipitators are just a few examples.

6.   **Shifting to Natural Gasses**: Instead of using and exhausting fossil fuels, shifting to greener options is a no-brainer. For example, using CNG (compressed natural gas) instead of petrol or diesel is a great option.

7.   Smoking in public places should be prohibited, because the cigarette smoke contains carcinogens such as benzopyrene.

8.   Planting of trees along the road sides and around industrial areas.

Self-Assessment Exercise (SAE)

Attempt this question. It should not take you more than 5 minutes
Enumerate five ways of controlling air pollution

1.5   Summary

Air pollution can be controlled by two fundamental approaches: preventive techniques and effluent control. Other measures that can be taken to control air pollution are energy conservation, use of energy efficient appliances, shifting to natural gases, prohibiting smoking in public places.

1.6   References/Further Reading/Web Resources

Environmental Pollution (Air, water, soil, thermal, and noise): causes, effects, and
Controls by Dr. Yashpal Singh Narwaria pdf.

Pollution, Causes, Effects and Control 4th Edition by Roy M. Harrison, Published by Royal Society of Chemistry.

1.7 Possible Answers to Self-Assessment Exercise

Answer
1. By preventive techniques and
2. Effluent control

Enumerate five ways of controlling air pollution
1. **Avoid using vehicles**: People should avoid using vehicles for shorter distances. Rather they should prefer public modes of transport to travel from one place to another. This not only prevents pollution but also conserves energy.

2. **Energy conservation:** A large number of fossil fuels are burnt to generate electricity. Therefore, do not forget to switch off the electrical appliances when not in use. Thus, you can save the environment at the individual level. Use of energy-efficient devices such as CFLs also controls pollution to a greater level.

3. **Use of energy efficient appliances:** Whether at the domestic level or at the industrial level, we must push for appliances that use energy efficiently, which result in complete combustion of fuel, as incomplete combustion causes air pollution.

4. **Shifting industries:** Another possible solution to reduce the harmful effects of air pollution is to shift the manufacturing plants, factories and industries to remote areas with a low level of population.
5. **Using modern techniques:** With technology making great advancements, there are now technologies available that can help reduce the release of pollutants in the air. Air filters, scrubbers, precipitators are just a few examples.

UNIT 2   CONTROL OF WATER POLLUTION

Unit Structure

2.1   Introduction
2.2   Intended Learning Outcome
2.3   Main Content
2.3.1 Sewage treatment
2.3.2 Industrial waste water treatment
      2.3.3 Agricultural waste water treatment
      2.3.4 Management of erosion and sediment control
      2.3.5 Control of urban runoff (storm water)
2.4   Physical Methods of Water Pollution Control
2.5   Chemical Methods of Water Pollution Control
2.6   Biological Methods of Water Pollution Control
2.7   Summary
2.8   References/Further Reading/Web Resources
2.9   Possible Answers to Self-Assessment Exercise

2.1   Introduction

Water pollution, to a larger extent, can be controlled by a variety of methods one of which is sewage treatment. Sewage treatment plants should be installed to treat sewage before releasing into water bodies. Practicing this can reduce the initial toxicity and the remaining substances can be degraded and rendered harmless by the water body itself.

2.2   Intended Learning Outcome

By the end of this unit, you will be able to:

•   describe the methods used to control water pollution.

2.3   Main Content

Control of water pollution requires also appropriate infrastructure and management plans. The infrastructure may include wastewater treatment plants, for example sewage treatment plants and industrial wastewater treatment plants. Agricultural wastewater treatment for farms, and erosion control at construction sites can also help prevent water pollution. Effective control of urban runoff includes reducing speed and quantity of flow.

Also chemical, biological and physical methods can be other methods to control water pollution. Chemical methods help in the control of water pollution. These chemical methods include precipitation, the ion exchange process, reverse osmosis, and coagulation. The reusing, reducing, and recycling of water wherever possible will advance a long way in overcoming the effects of water pollution. These chemical, biological and physical methods will be later addressed in this unit.

2.3.1 Sewage treatment

Municipal wastewater (or sewage) can be treated by centralized sewage treatment plants, decentralized wastewater systems, nature-based solutions or in onsite sewage facilities and septic tanks. For example, waste stabilization ponds are a low cost treatment option for sewage, particularly for regions with warm climates (Von Sparling, 2015). UV light (sunlight) can be used to degrade some pollutants in waste stabilization ponds (sewage lagoons) (Wang *et al*., 2021). The use of safely managed sanitation services would prevent water pollution caused by lack of access to sanitation (WHO, 2017).

Well-designed and operated systems (i.e., with secondary treatment stages or more advanced tertiary treatment) can remove 90 percent or more of the pollutant load in sewage (EPA, 2004). Some plants have additional systems to remove I and pathogens. While such advanced treatment techniques will undoubtedly reduce the discharges of micro-pollutants, they can also result in large financial costs, as well as environmentally undesirable increases in energy consumption and greenhouse gas emissions (Jones *et al*., 2007).

Sewer overflows during storm events can be addressed by timely maintenance and upgrades of the sewerage system.

Self-Assessment Exercise

List the chemical methods of controlling water pollution

2.3.2 Industrial wastewater treatment

Industrial wastewater treatment describes the processes used for treating wastewater that is produced by industries as an undesirable by-product. After treatment, the treated industrial wastewater (or effluent) may be reused or released to a sanitary sewer or to a surface water in the environment. Some industrial facilities generate wastewater that can be treated in sewage treatment plants. Most industrial processes, such as petroleum refineries, chemical and petrochemical plants have their own specialized facilities to treat their wastewaters so that the pollutant concentrations in the treated wastewater comply with the regulations

regarding disposal of wastewaters into sewers or into rivers, lakes or oceans. This applies to industries that generate wastewater with high concentrations of organic matter (e.g. oil and grease), toxic pollutants (e.g. heavy metals, volatile organic compounds) or nutrients such as ammonia (Tchobanoglous *et al*., 2003). Some industries install a pre-treatment system to remove some pollutants (e.g., toxic compounds), and then discharge the partially treated wastewater to the municipal sewer system (Von Sparling, 2015).

2.3.3 Agricultural wastewater treatment

Agricultural wastewater treatment is a farm management agenda for controlling pollution from confined animal operations and from surface runoff that may be contaminated by chemicals in fertilizer, pesticides, animal slurry, crop residues or irrigation water. Agricultural wastewater treatment is required for continuous confined animal operations like milk and egg production. It may be performed in plants using mechanized treatment units similar to those used for industrial wastewater. Where land is available for ponds, settling basins and facultative lagoons may have lower operational costs for seasonal use conditions from breeding or harvest cycles. Animal slurries are usually treated by containment in anaerobic lagoons before disposal by spray or trickle application to grassland. Constructed wetlands are sometimes used to facilitate treatment of animal wastes.

2.3.4 Management of erosion and sediment control

Sediment from construction sites can be managed by installation of erosion controls, such as mulching and hydro seeding, and sediment controls, such as sediment basins and silt fences. Discharge of toxic chemicals such as motor fuels and concrete washout can be prevented by use of spill prevention and control plans, and specially designed containers (e.g. for concrete washout) and structures such as overflow controls and diversion berms (EPA, 2012).

Erosion caused by deforestation and changes in hydrology (soil loss due to water runoff) also results in loss of sediment and, potentially, water pollution (Mapulanga and Nato, 2019).

2.3.5 Control of urban runoff (storm water)

Effective control of urban runoff involves reducing the velocity and flow of storm water, as well as reducing pollutant discharges. Local governments use a variety of storm water management techniques to reduce the effects of urban runoff. These techniques, called best management practices for water pollution in some countries, may focus

on water quantity control, while others focus on improving water quality, and some perform both functions.

Self-Assessment Exercise 1 (SAE 1)

> Attempt this question. It should not take you more than 10 minutes
>
> Describe sewage treatment and agricultural waste water treatment

2.4   Physical Methods of Water Pollution Control

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 utilize 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.

2.5   Chemical Methods of Water Pollution Control

Chemical treatment systems in water pollution control are those processes which utilize 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 utilize 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.

2.6 Biological Methods of Water Pollution Control

Biological water pollution control methods are those which utilize 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 utilized whether the microorganisms exist in a suspension or are attached to a surface. These processes are termed suspended growth and fixed film processes, respectively.

Self-Assessment Exercise 2 (SAE 2)

Attempt this question. It should not take you more than 10 minutes.

Explain the biological method of controlling water pollution.

2.7 Summary

In this unit you have learnt about the different methods of handling water pollution which includes sewage treatment, agricultural waste water treatment, control of urban runoff etc. Other methods include physical chemical and biological techniques of water treatment.

2.8 References/Further Reading/Web Resources

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1. Pollution prevention: Problems and Solution by Louis Theodore, R. Ryan DuPont and Joseph Reynolds. *Gordon and Breach Science Publishers.*

2. Air Pollution by Arthur C. Stern 2nd edition Vol 2: Analysis, Monitoring and Surveying of Pollutants Chapter 16. Academic Press New York London

3. Environmental Pollution (Air, water, soil, thermal, and noise): causes, effects, and
Controls by   Dr. Yashpal Singh Narwaria pdf

4. Pollution, Causes, Effects and Control 4th Edition by Roy M. Harrison, Published by Royal Society of Chemistry.

5. Environmental Pollution and Control 4th edition by J. Jeffrey Peirce, Ruth. F. Weiner and P. Aarne Vesilind.

2.9   **Possible Answers to Self-Assessment Exercise**

Answer
i. Precipitation   ii. Ion exchange process   iii. Reverse osmosis   iv. coagulation

SAE 1
Describe sewage treatment and agricultural waste water treatment.

Sewage treatment
Municipal wastewater (or sewage) can be treated by centralized sewage treatment plants, decentralized wastewater systems, nature-based solutions or in onsite sewage facilities and septic tanks. For example, waste stabilization ponds are a low cost treatment option for sewage, particularly for regions with warm climates (Von Sparling, 2015). UV light (sunlight) can be used to degrade some pollutants in waste stabilization ponds (sewage lagoons). The use of safely managed sanitation services would prevent water pollution caused by lack of access to sanitation.

Well-designed and operated systems (i.e., with secondary treatment stages or more advanced tertiary treatment) can remove 90 percent or more of the pollutant load in sewage. Some plants have additional systems to remove I and pathogens. While such advanced treatment techniques will undoubtedly reduce the discharges of micropollutants, they can also result in large financial costs, as well as environmentally undesirable increases in energy consumption and greenhouse gas emissions. Sewer overflows during storm events can be addressed by timely maintenance and upgrades of the sewerage system.

Agricultural wastewater treatment is a farm management agenda for controlling pollution from confined animal operations and from surface runoff that may be contaminated by chemicals in fertilizer, pesticides, animal slurry, crop residues or irrigation water. Agricultural wastewater treatment is required for continuous confined animal operations like milk and egg production. It may be performed in plants using mechanized treatment units similar to those used for industrial wastewater. Where land is available for ponds, settling basins and facultative lagoons may have lower operational costs for seasonal use conditions from breeding or harvest cycles. Animal slurries are usually treated by containment in anaerobic lagoons before disposal by spray or trickle application to grassland. Constructed wetlands are sometimes used to facilitate treatment of animal wastes.

SAE 2
Explain the biological method of controlling water pollution.

Biological Methods of Water Pollution Control
Biological water pollution control methods are those which utilize 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 utilized whether the microorganisms exist in a suspension or are attached to a surface. These processes are termed suspended growth and fixed film processes, respectively.

UNIT 3   CONTROL OF SOIL POLLUTION

Unit Structure

3.1   Introduction
3.2   Intended Learning Outcomes
3.3   Main Content
3.4   Summary
3.5   References/Further Reading/Web Resources
3.6   Possible Answers to Self-Assessment Exercise

3.1   Introduction

Soil pollution is defined as, "contamination of soil by human and natural activities which may cause harmful effect on living organisms. Several techniques have been developed to tackle soil contamination which can conserve the soil. These techniques will be discussed in this unit.

3.2   Intended Learning Outcomes

By the end of this, you will be able to:

•   explain the methods for the control of soil contamination
•   explain the technologies for soil remediation.

3.3   Main Content

Numerous attempts are being made to decontaminate polluted soils, including an array of both in situ (on-site, in the soil) and off-site (removal of contaminated soil for treatment) techniques. None of these is ideal for remediating contaminated soils, and often, more than one of the techniques may be necessary to optimize the cleanup effort.

1. **Soil erosion can be controlled by a variety of forestry and farm practices** e.g.
•   planting trees on barren slopes
•   contour cultivation and strip cropping may be practiced instead of shifting cultivation
•   terracing and building diversion channels may be undertaken.
•   reducing deforestation and substituting chemical manures by animal wastes also helps arrest soil erosion in the long term.

2. **Proper dumping of unwanted materials:** Excess wastes by man and animals pose a disposal problem. Open dumping is the most commonly practiced technique. Nowadays, controlled tipping is followed for solid waste disposal. The surface so obtained is used for housing or sports field.

3. **Production of natural fertilizers:** Bio-pesticides should be used in place of toxic chemical pesticides. Organic fertilizers should be used in place of synthesized chemical fertilizers. Example organic wastes in animal dung may be used to prepare compost manure instead of throwing them wastefully and polluting the soil.

4. **Proper hygienic condition**: People should be trained regarding sanitary habits. Example Lavatories should be equipped with quick and effective disposal methods.

5. **Public awareness:** Informal and formal public awareness programs should be imparted to educate people on health hazards by environmental education e.g. mass media, educational institutions and voluntary agencies can achieve this.

6. **Recycling and Reuse of wastes**: To minimize soil pollution, the wastes such as paper, plastics, metals, glasses, organics, petroleum products and industrial effluents etc. should be recycled and reused. Examples industrial wastes should be properly treated at source. Integrated waste treatment methods should be adopted.

7. **Ban on toxic chemicals:** Ban should be imposed on chemicals and pesticides like DDT, BHC, etc. which are fatal to plants and animals. Nuclear explosions and improper disposal of radioactive wastes should be banned.

Self-Assessment Exercise

Mention three ways soil erosion can be controlled.

Self-Assessment Exercise (SAE)

Attempt this question. It should not take you more than 10 minutes.
Enumerate the technologies to tackle soil remediation.

3.4   Summary

In this unit, you have learnt the methods and some technologies that could be employed to control soil pollution. Methods such as proper dumping of unwanted materials, production of natural fertilizers, and recycling of wastes are among the various methods of that can be used to control soil pollution.

📖 3.5   References/Further Reading/Web Resources

Pollution prevention: Problems and Solution by Louis Theodore, R. Ryan DuPont and Joseph Reynolds. *Gordon and Breach Science Publishers.*

Environmental Pollution (Air, water, soil, thermal, and noise): causes, effects, and
Controls by   Dr. Yashpal Singh Narwaria pdf

Pollution, Causes, Effects and Control 4th Edition by Roy M. Harrison, Published by Royal Society of Chemistry.

Environmental Pollution and Control 4th edition by J. Jeffrey Peirce, Ruth. F. Weiner and P. Aarne Vesilind.

3.6   Possible Answers to Self-Assessment Exercise

Answer
i. planting trees on barren slopes
ii. contour cultivation and strip cropping
iii. terracing and building diversion channels

In addition, several technologies have been developed to tackle soil remediation. Some important strategies followed for the decontamination of polluted soil are listed below.

1. Excavation and subsequent transportation of polluted soils to remote, uninhabited locations.

2. Extraction of pollutants via thermal remediation – the temperature is raised in order to force the contaminants into the vapor phase, after which they can be collected through vapors extraction.

3. Bioremediation: Bioremediation or phytoremediation involves the use of microorganisms and plants for the decontamination of soil.

4. Mycoremediation: involves the use of fungi for the accumulation of heavy metal contaminants.

Enumerate the technologies to tackle soil remediation

1. Excavation and subsequent transportation of polluted soils to remote, uninhabited locations.

2. Extraction of pollutants via thermal remediation – the temperature is raised in order to force the contaminants into the vapor phase, after which they can be collected through vapors extraction.

3. Bioremediation: Bioremediation or phytoremediation involves the use of microorganisms and plants for the decontamination of soil.

4. Mycoremediation: involves the use of fungi for the accumulation of heavy metal contaminants.

UNIT 4   CONTROL OF NOISE POLLUTION

Unit Structure

4.1   Introduction

Noise seriously affects heartbeat, breathing, and can cause constriction of blood vessels. It can cause headache, sleeplessness, irritability and may seriously affect the productive performance of human. Like other pollution, noise pollution needs to be controlled by measures which will maintain the acceptable levels of noise pollution for human beings so as to prevent its effects. These measures will be discussed in this unit

4.2   Intended Learning Outcomes

By the end of this unit, you will be able to:

* explain the measures of noise pollution control
* explain noise control in Nigeria.

4.3   Main Content

4.3.1 Measures of noise pollution control

There are four fundamental ways in which noise can be controlled

1.   Reducing noise at the source
2.   Blocking the path of noise
3.   Increasing the path length
4.   Protecting the recipient.

- **Reducing noise at the source**

In general, the best control method is to reduce noise levels at the source. Source reduction can be done by effectively muffling vehicles and machinery to reduce the noise. In industries noise reduction can be done by using rigid sealed enclosures around machinery lined with acoustic absorbing material. Isolating machines and their enclosures from the floor using special spring mounts or absorbent mounts and pads and using flexible couplings for interior pipelines also contribute to reducing noise pollution at the source.

However one of the best methods of noise source reduction is regular and thorough maintenance of operating machinery. Noise levels at construction sites can be controlled using proper construction planning and scheduling techniques. Locating noisy air compressors and other equipment away from the site boundary along with creation of temporary barriers to physically block the noise can help contribute to reducing noise pollution. Most of the vehicular noise comes from movement of the vehicle tires on the pavement and wind resistance. However poorly maintained vehicles can add to the noise levels. Traffic volume and speed also have significant effects on the overall sound. For example doubling the speed increases the sound levels by about 9 dBA and doubling the traffic volume (number of vehicles per hour) increases sound levels by about 3 dBA. A smooth flow of traffic also causes less noise than does a stop-and-go traffic pattern. Proper highway planning and design are essential for controlling traffic noise.

Establishing lower speed limits for highways that pass through residential areas, limiting traffic volume and providing alternative routes for truck traffic are effective noise control measures. The path of traffic noise can also be blocked by construction of vertical barriers alongside the highway. Planting of trees around houses can also act as effective noise barriers. In industries different types of absorptive material can be used to control interior noise. Highly absorptive interior finish material for walls, ceilings and floors can decrease indoor noise levels significantly.

Sound levels drop significantly with increasing distance from the noise source. Increasing the path length between the source and the recipient offers a passive means of control. Municipal land-use ordinances pertaining to the location of airports make use of the attenuating effect of distance on sound levels. Use of earplugs and earmuffs can protect individuals effectively from excessive noise levels. Specially designed earmuffs can reduce the sound level reaching the eardrum by as much as 40 dBA. However very often workers tend not to wear them on a regular basis despite company requirements for their use.

Self-Assessment Exercise

Mention four fundamental ways of controlling noise

4.4   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 8 hr 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:
1.   Public enlightenment through the media
2.   Health talks for noise generators
3.   Planning and organizing marketing areas for electronics and
4.   Education of itinerant hawkers of musical wares on noise pollution and sales management (Okereke, 2006).

For the general population, noise in Nigeria 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.

Self-Assessment Exercise (SAE)

Attempt this question. It should not take you more than 5 minutes. Highlight how noise pollution can be reduced in Nigeria.

4.5 Summary

You have learnt measures to be taken to reduce noise pollution and the control of noise pollution in Nigeria. Our city centers 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.

4.6 References/Further Reading/Web Resources

Pollution prevention: Problems and Solution by Louis Theodore, R. Ryan
     DuPont and Joseph Reynolds. *Gordon and Breach Science
     Publishers.*

Environmental Pollution (Air, water, soil, thermal, and noise): causes,
     effects, and
Controls by Dr. Yashpal Singh Narwaria pdf

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     Published by Royal Society of Chemistry.

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     Ruth. F. Weiner and P. Aarne Vesilind

4.7 Possible Answers to Self-Assessment Exercise

Answer
1. Reducing noise at the source
2. Blocking the path of noise
3. Increasing the path length
4. Protecting the recipient

1. Public enlightenment through the media
2. Health talks for noise generators
3. Planning and organizing marketing areas for electronics and
4. Education of itinerant hawkers of musical wares on noise pollution and sales management.

For the general population, noise in Nigeria 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.

UNIT 5   POLICY AND LEGISLATION MEASURES ON POLLUTION CONTROL

Unit Structure

5.1   Introduction
5.2   Intended Learning Outcomes
5.3   Main Content
5.4   Historical Perspectives
5.5   National Policy Measures on Pollution Control
5.6   National Legislation on Pollution Control
5.7   Summary
5.8   References/Further Reading/Web Resources
5.9   Answers to Self-Assessment Exercise

5.1   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.

5.2   Intended Learning Outcomes

By the end of this unit, you will 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.

5.3   Main Content

5.4   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 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.

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 characterized 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.

Self-Assessment Exercise

Mention the first agency established in Nigeria on pollution control policy

5.5   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.

The goals of policies and legislation on pollution control are summarized as follow:
1.   To control the environment from the harmful effects of pollutants
2.   To protect human health and property damage from the effects of pollution
3.   To prescribe standards and limitations for pollutants/effluents discharge
4.   To ensure the conservation of natural resources
5.   To advance the principles of sustainable development

5.6 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

Self-Assessment Exercise (SAE)

Attempt this question. It should not take you more than 5 minutes

Highlight the goals on policies and legislation on pollution control in Nigeria

5.7 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.

5.8 References/Further Reading/Web Resources

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

List of Text books
Pollution prevention: Problems and Solution by Louis Theodore, R. Ryan DuPont and Joseph Reynolds. *Gordon and Breach Science Publishers.*
Pollution, Causes, Effects and Control 4th Edition by Roy M. Harrison, Published by Royal Society of Chemistry.
Environmental Pollution and Control 4th edition by J. Jeffrey Peirce, Ruth. F. Weiner and P. Aarne Vesilind

5.9 Possible Answers to Self-Assessment Exercise (SAE)

Answer
The Federal Environmental Protection Agency (FEPA)

The goals of policies and legislation on pollution control are:
1.   To control the environment from the harmful effects of pollutants
2.   To protect human health and property damage from the effects of pollution
3.   To prescribe standards and limitations for pollutants/effluents discharge
4.   To ensure the conservation of natural resources
5.   To advance the principles of sustainable development.

End of Module Question
1.   The use of dry and wet collectors is one of the effective techniques of controlling air pollution (**True/False**)
2.   Which of these is not a means of controlling air pollution?
(a). avoid using of vehicles (b). energy conservation (c). use of modern techniques (d). none of the above
3.   Which one of these is not a method of controlling water pollution?
(a). chemical method (b). mechanical method (c). physical method (d). biological method

4.   Municipal waste water can be treated by sewage treatment plant (**True/False**)
5.   One of these is a common legislative instruments for pollution control in Nigeria.
(a). The LGAs bye law on sanitation (b). Factories Act of 1958 (c). Environmental sanitation laws (d). All of the above