ENVIRONMENTAL SCIENCE

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Lecture.1

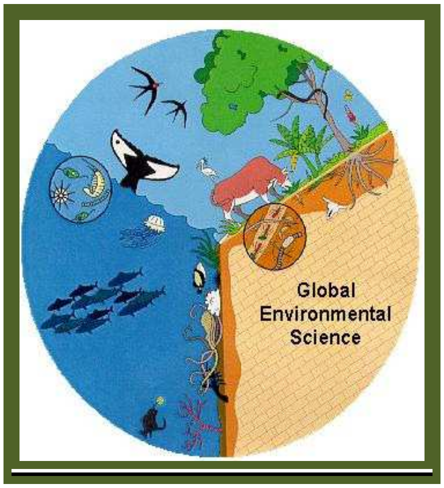
Introduction, definition, scope and importance of environmental studies.

Environment definition and importance

The word environment is derived from the French verb ***environner***, which means to "encircle" or "surround." Thus, our environment can be defined as the physical, chemical and biological world that surrounds us, as well as the complex of social and cultural conditions affecting an individual or community

Environmental Science

Environmental Science is an interdisciplinary field that involves both the physical sciences (physics, chemistry, biology, geology, geography, resource technology and engineering) and the social sciences (resource management and conservation, demography, economics, politics and ethics). It encompasses the surrounding conditions that affect man and other organisms. Natural and human resources are interdependent and the use or misuse of one affects the other.



Components

1. **Atmospheric sciences**
2. **Ecology**
3. **Environmental chemistry**

4. **Geosciences**

Importance of Environmental Studies: The environmental studies enlighten us, about the importance of protection and conservation of our indiscriminate release of pollution into the environment.

At present a great number of environment issues, have grown in size and complexity day by day, threatening the survival of mankind on earth. Environmental studies have become significant for the following reasons:

1. **Environment issues being of international importance:** It has been well recognized that environment issues like global warming and ozone depletion, acid rain, marine pollution and biodiversity are not merely national issues but global issues and hence must be tackled with international efforts and cooperation.
2. **Problems cropped in the wake of development:** Development, in its wake gave birth to Urbanization, Industrial Growth, Transportation Systems, Agriculture and Housing etc. However, it has become phased out in the developed world. The North, to cleanse their own environment has fact fully, managed to move 'dirty' factories of South. When the West developed, it did so perhaps in ignorance of the environmental impact of its activities. Evidently such a path is neither practicable nor desirable, even if developing world follows that.
3. **Explosively increase in pollution:** World census reflects that one in every seven persons in this planet lives in India. Evidently with 16 per cent of the world's population and only 2.4 per cent of its land area, there is a heavy pressure on the natural resources including land. Agricultural experts have recognized soil health problems like deficiency of micronutrients and organic matter, soil salinity and damage of soil structure.

Ecology

Ecology is the branch of biological science concerned with the relationships and interactions between living organisms and their physical surroundings or environment. Ecology comes from the Greek words **oikos** (house or place where one lives) and **logos**

(study of). Ecology means the Study of the "House" in which We Live. The term ecology was coined in 1866 by the German scientist Ernst Haeckel (1834–1919). Ecology can be defined more specifically as the "Study of the interactions between organisms and the non-living components of their environment. (Or) "Study of interrelationship between the organism and Environment"

Living organisms and the environment with which they exchange materials and energy together make up an **ecosystem,** which is the basic unit of ecology. An ecosystem includes **biotic components** – the living plants and animals and **abiotic components** – the air, water, minerals, and soil that constitute the environment. A third and essential component of most natural ecosystems is **energy**, usually in the form of sunlight.

Familiar examples of land-based or **terrestrial** ecosystems include forests, deserts, jungles, and meadows. Water-based or **aquatic** ecosystems include streams, rivers, lakes, marshes, and estuaries. There is no specific limitation on the size or boundaries of an ecosystem. A small pond can be studied as a separate ecosystem. A desert comprising hundreds of square kilometers or even the entire surface of earth can be viewed as an ecosystem.

Structural units of ecology: For many ecologists the basic structural units of ecological organization are species and populations. A biological species consists of all the organisms potentially able to interbreed under natural conditions and to produce fertile offspring. A **population** consists of all the members of a single species occupying a common geographical area at the same time. An ecological **community** is composed of a number of populations that lie and interact in a specific region.

Environment, Ecology and Ecosystem: Environment, Ecology and Ecosystem are three different terms. But they are interrelated. The natural surroundings of an organism, both living and physical are its environment. Light, Water, Air, Land etc., are our physical surroundings. Humans, Rats, Lizards, Dogs etc are our living surroundings. Scientists believe that natural environment is a better word to use given the common use of the word environment. It is a basic fact that the Earth includes a tremendous variety of living things which depend in some way on other living and nonliving things in its Environment. Definitely, as an organism, camel has a relationship with its environment. Humans have a working relationship with cows, chickens, bees etc. This study of how the existence and activity of organism influences its environment and the vice versa is ecology.

Ecosystem is a large geographical area where both biotic and abiotic components interact with each other. Eg. Desert, Ocean, Sea etc.

Questions

I. Fill ups

1. The word environment is derived from the French verb -----------------------

Ans: environner

2. The study of interrelationship between biotic & abiotic factor is called -------------------

Ans: Ecology

3. The term ecology was coined by ---------------------------

Ans: Ernest Haeckel, 1866

4. Ecosystem includes ----------------- and ------------------- components.

Ans: Biotic, Abiotic

5. Forest is the example for --------------------------- ecosystem.

Ans: **Terrestrial**

Match the following

6. Geo sciences - study of meteorology, GHG emissions.

7. Environmental chemistry - study of volcanic phenomena and evolution of earth’s crust.

8. Atmospheric sciences - study of chemical alternation in the environment.

Ans

6. Geo sciences - study of volcanic phenomena and evolution of earth's crust.

7. Environmental chemistry - study of chemical alternation in the environment.

8. Atmospheric sciences - study of meteorology, GHG emissions.

True / False

9. The word 'Ecology' comes from the Greek work 'oikos' and 'logos'
Ans: True

10. Environmental science is the field that involves only physical sciences

Ans: False (Physical & social sciences)

Lecture.2

Components of environment - structure of earth - different spheres of earth - atmosphere, hydrosphere, lithosphere, biosphere: Introduction and definition

Definitions of Environment: Some important definitions of environment are given by different scientist are as follows.

Components of environment

Boring: 'A person's environment consists of the sum total of the stimulation which he receives from his conception until his death.' It can be concluded from the above definition that Environment comprises various types of forces such as physical, intellectual, economic, political, cultural, social, moral and emotional. Environment is the sum total of all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturation of living organisms.

Douglas and Holland: 'The term environment is used to describe, in the aggregate, all the external forces, influences and conditions, which affect the life, nature, behaviour and the growth, development and maturity of living organisms.'

Generally, our surroundings are called as environment.

Elements of Environment

Environment is constituted by the interacting systems of physical, biological and cultural elements inter-related in various ways, individually as well as collectively. These elements may be explained as under:

(1) Physical elements

Physical elements are as space, landforms, water bodies, climate soils, rocks and minerals. They determine the variable character of the human habitat, its opportunities as well as limitations.

(2) Biological elements

Biological elements such as plants, animals, microorganisms and humans constitute the biosphere.

(3) Cultural elements

Cultural elements such as economic, social and political elements are essentially man-made features, which make cultural milieu.

Structure of Environment

Environment is both physical and biological. It includes both living and non-living components.

(i) Physical Environment

The Physical Environment is classified into three broad categories viz.

(i) Solid,

(ii) Liquid

(iii) Gas.

These represent the following spheres:

(i) The lithosphere (solid earth)

(ii) The hydrosphere (water component)

(iii) The atmosphere (gaseous component)

As such, the three basic of physical environment may be termed as under:

(i) Lithospheric Environment

(ii) Hydrospheric Environment

(iii) Atmospheric Environment

The scientists have classified them into smaller units based on different spatial scales, e.g.

(i) Mountain Environment

(ii) Glacier Environment

(iii) Plateau Environment

(iv) Coastal Environment

(ii) Biological Environment

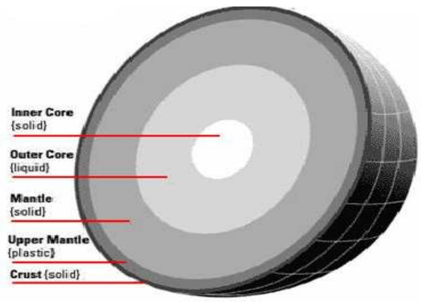
The biological of the environment consists of:

(i) Plants (flora)

(ii) Animals (fauna).

Thus, the biotic environment further is divided into floral environment and faunal environment. All the organisms work to form their social groups and organizations at several levels. Thus, the social environment is formed. In this social environment the organisms work to derive matter from the physical environment for their sustenance and development. This process gives birth to economic environment. Man claims to be most skilled and civilized of all the organisms. This is the reason why his social organization is most systematic.

Structure of Earth: The earth is a cold, spherical, solid planet of the solar system which spins on its axis and revolves around the sun at a certain constant distance. The solid component of earth is called lithosphere. The lithosphere is multi- layered and includes following three



main layers. 1. Crust 2. Mantle 3. Core. The core is the central fluid or vapourized sphere having diameter of about 2500 km from the center and is possibly composed of nickel-iron. The mantle extends about 2900 km above the core. The crust is the outermost solid zone of the earth and it is about 8-40 km above the mantle. The crust is very complex and its surface is covered with the soil supporting varied biotic communities.

The geologic component layers of Earth are at the following depths below the surface:

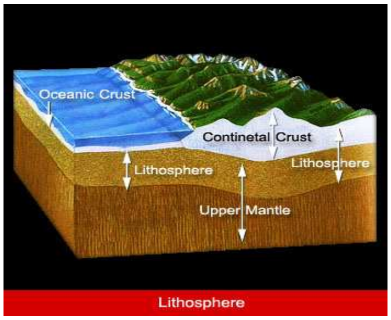
Depth		**Layer**
Kilometers	**Miles**	
0–60	0–37	Lithosphere
0–35	0–22	Crust
35–60	22–37	Uppermost part of mantle
35–2,890	22–1,790	Mantle
100–200	62–125	Asthenosphere
35–660	22–410	Upper mantle
660–2,890	410–1,790	Lower mantle
2,890–5,150	1,790–3,160	Outer core
5,150–6,360	3,160–3,954	Inner core

Spheres of Earth

Everything in Earth's system can be placed into one of four major subsystems: land, water, living things, or air. These four subsystems are called "spheres." Specifically, they are the "lithosphere" (land), "hydrosphere" (water), "biosphere" (living things), and "atmosphere" (air).

Lithosphere

Lithosphere is the outer mantle of the solid earth. It consists of minerals occurring in the earth's crusts and the soil e.g. minerals, organic matter, air and water. The lithosphere contains all of the cold, hard solid land of the planet's crust (surface), the semi-solid land underneath the crust, and the liquid land near the center of the planet. The surface of the lithosphere is very uneven. There are high mountain ranges like the Rockies and Andes, huge plains or flat areas like those in Texas, Iowa, and Brazil, and deep valleys along the ocean floor. The solid, semi-solid, and liquid land of the lithosphere form layers that are physically and chemically different. If someone were to cut through Earth to its center, these layers would be revealed like the layers of an onion. The outermost layer of the lithosphere consists of loose soil rich in nutrients, oxygen, and silicon. Beneath that layer lies a very thin, solid crust of oxygen and silicon. Next is a thick, semi-solid mantle of oxygen, silicon, iron, and magnesium. Below that is a liquid outer core of nickel and iron. At the center of Earth is a solid inner core of nickel and iron.



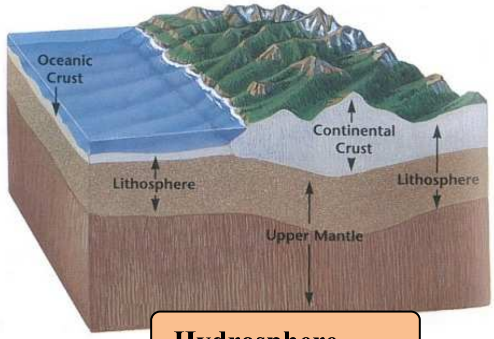
Hydrosphere

The Hydrosphere comprises all types of water resources oceans, seas, lakes, rivers, streams, reservoir, polar icecaps, glaciers, and ground water.

(i) 97% of the earth's water supply is in the oceans,

(ii)About 2% of the water resources is locked in the polar icecaps and glaciers.

(iii)Only about 1% is available as fresh surface water-rivers, lakes streams, and ground water fit



Hydrosphere

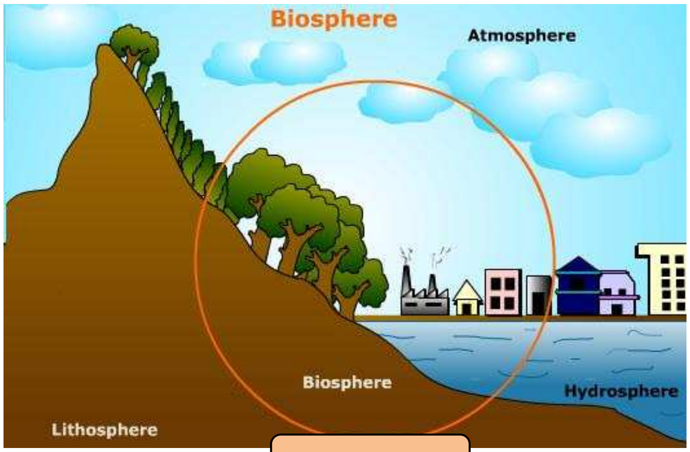
to be used for human consumption and other uses.

The hydrosphere contains all the solid, liquid, and gaseous water of the planet. It ranges from 10 to 20 kilometers in thickness. The hydrosphere extends from Earth's surface downward several kilometers into the lithosphere and upward about 12 kilometers into the atmosphere. A small portion of the water in the hydrosphere is fresh (non-salty). This water flows as precipitation from the atmosphere down to Earth's surface, as rivers and streams along Earth's surface, and as groundwater beneath Earth's surface. Most of Earth's fresh water, however, is frozen. Ninety-seven percent of

Earth's water is salty. The salty water collects in deep valleys along Earth's surface. These large collections of salty water are referred to as oceans. Water near the poles is very cold, while water near the equator is very warm. The differences in temperature cause water to change physical states. Extremely low temperatures like those found at the poles cause water to freeze into a solid such as a polar icecap, a glacier, or an iceberg. Extremely high temperatures like those found at the equator cause water to evaporate into a gas.

Biosphere

Biosphere indicates the realm of living organisms and their interactions with environment, *viz*., atmosphere, hydrosphere and lithosphere. This sphere includes all of the microorganisms, plants, and animals of Earth. Within the biosphere, living things form ecological communities based on the physical surroundings of an area. These communities are referred to as **biomes**. Deserts, grasslands, and tropical rainforests are three of the many types of biomes that exist within the biosphere. It is impossible to detect from space each individual organism within the biosphere. However, biomes can be seen from space.



Biosphere

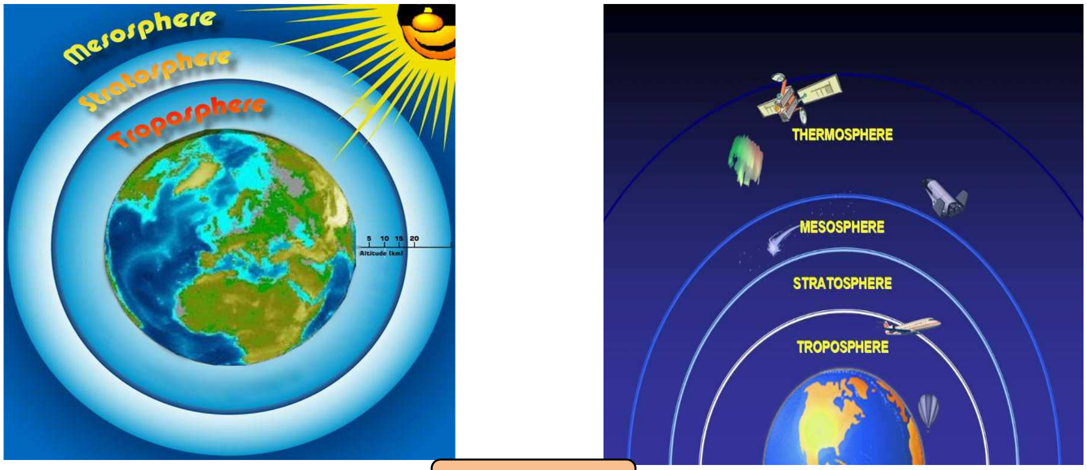
Atmosphere: The atmosphere implies the protective blanket of gases, surrounding the earth:

(a) It sustains life on the earth.

(b) It saves the Earth from the hostile environment of outer space.

(c) It absorbs most of the cosmic rays from outer space and a major portion of the electromagnetic radiation from the sun.

(d) It transmits only mere ultraviolet, visible, near infrared radiation (300 to 2500 nm) and radio waves. (0.14 to 40 m) while filtering out tissue-damaging ultra-violate waves below about 300 nm.



Atmosphere

The atmosphere contains all the air in Earth's system. It extends from less than 1 m below the planet's surface to more than 10,000 km above the planet's surface. The upper portion of the atmosphere protects the organisms of the biosphere from the sun's ultraviolet radiation. It also absorbs and emits heat. When air temperature in the lower portion of this sphere changes, weather occurs. As air in the lower atmosphere is heated or cooled, it moves around the planet. The result can be as simple as a breeze or as complex as a tornado.

Questions

I. Fill ups

1. The biosphere consists of --------------- and ----------- as their major living components

Ans: Flora, Fauna

2. Visible range of IR radiation -----------------

Ans: 300 – 2500 nm

3. The solid component of the earth is called -------------------

Ans: **lithosphere**

4. The percentage of fresh surface water source available for human consumptions is -----

Ans: 1 percent

5. In the structure of earth, the core layer is possibly composed of --------------------

Ans: **Nickel – Iron**

6. The major ecological communities/ecosystem are also termed as --------------

Ans: Biomes

Match the following

7. Hydrosphere - Consists of all the cold, hard solid hand of the planet

8. Atmosphere - Living things on the Earth

9. Lithosphere - Consists of all solid, liquid and gaseous state water

10. Biosphere - Consists of all the air components in earth’s system

Ans

7. Hydrosphere - Consists of all solid, liquid and gaseous state water

8. Atmosphere - Consists of all the air components in earth’s system

9. Lithosphere - Consists of all the cold, hard solid hand of the planet

10. Biosphere - Living things on the Earth

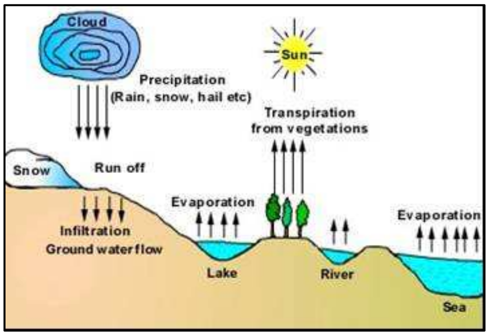
Lecture.3

Biogeochemical cycles – Importance

The flow of energy through the ecosystem drives the movement of nutrients within the ecosystem. Inorganic nutrients are chemical elements and compounds necessary to living organisms. Although an ecosystem needs a constant source of energy from outside, the nutrients upon which life depends can be recycled indefinitely. The pathways in which the chemical nutrients move through the biotic and abiotic components of the ecosystem are called **biogeochemical cycles** or **nutrient cycles.** Major biogeochemical cycles include the water cycle, carbon cycle, oxygen cycle, nitrogen cycle, phosphorous cycle, sulfur cycle and calcium cycle. Decomposers play a key role in many of these cycles, returning nutrients to the soil, water, or air, where they can again be used by the biotic constituents of the ecosystem.

An important aspect of biogeochemistry is the fact that elements can occur in various molecular forms that can be transformed among each other, often as a result of biological reactions. Such transformations are an especially important consideration for nutrients, i.e., those chemicals that are required for the healthy functioning of organisms. As a result of biogeochemical cycling, nutrients can be used repeatedly, nutrients contained in dead biomass can be recycled through inorganic forms, back into living organisms, and so on. Biogeochemistry is also relevant to the movements and transformations of potentially toxic chemicals in ecosystems, such as metals, pesticides, and certain gases. The important nutrient cycles considered here are the carbon cycle, the nitrogen cycle, and the phosphorus cycle. Carbon, nitrogen, and phosphorus are considered to be among the macronutrients essential to life apart from hydrogen, oxygen, potassium, calcium, magnesium, and sulfur. The many micronutrients, required only in very small quantities, include iron, manganese, copper, zinc, and sodium. Biogeochemical cycles are broadly classified into two i.e., 1. Sedimentary cycle (Phosphorous and Sulphur) 2. Gaseous cycle (Oxygen, Nitrogen, Carbon).

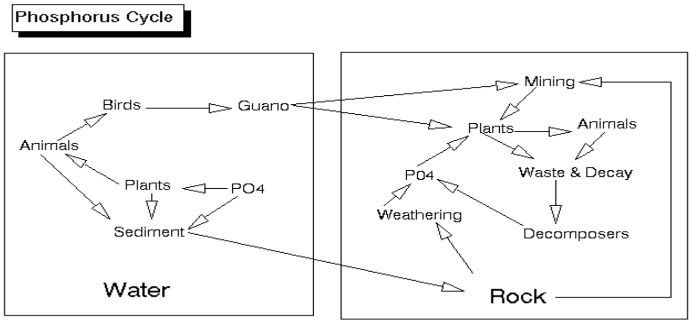
Hydrological (water) cycle



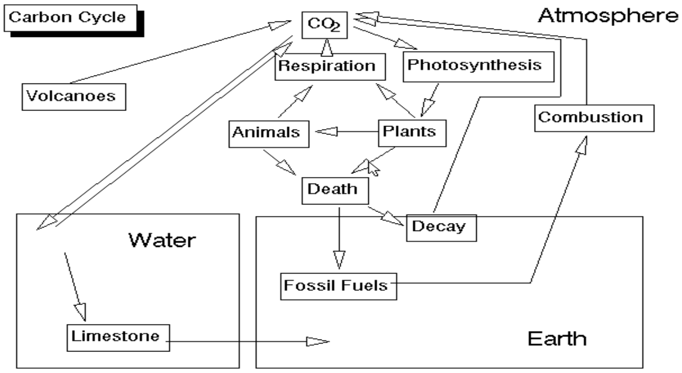
In the water cycle, energy is supplied by the sun, which drives evaporation whether it be from ocean surfaces or from treetops. The sun also provides the energy, which drives the weather systems, which move the water vapor (clouds) from one place to another (otherwise, it would only rain over the oceans). Precipitation occurs when water condenses from a gaseous state in the atmosphere and falls to earth. Evaporation is the reverse process in which liquid water becomes gaseous. Once water condenses, gravity takes over and the water is pulled to the ground. Gravity continues to operate, either pulling the water underground (groundwater) or across the surface (runoff). In either event, gravity continues to pull water lower and lower until it reaches the oceans (in most cases; the Great Salt Lake, Dead Sea, Caspian Sea, and other such depressions may also serve as the lowest basin into which water can be drawn). Frozen water may be trapped in cooler regions of the Earth (the poles, glaciers on mountaintops, etc.) as snow or ice, and may remain as such for very long periods of time. Lakes, ponds, and wetlands form where water is temporarily trapped. The oceans are salty because any weathering of minerals that occurs as the water runs to the ocean will add to the mineral content of the water, but water cannot leave the oceans except by evaporation, and evaporation leaves the minerals behind. Thus, rainfall and snowfall are comprised of relatively clean water, with the exception of pollutants (such as acids) picked up as the waster falls through the atmosphere. Organisms play an important role in the water cycle. As you know, most organisms contain a significant amount of water (up to 90% of their body weight). This water is not held for any length of time and moves out of the organism rather quickly in most cases. Animals and plants lose water through evaporation from the body surfaces and through evaporation from the gas exchange structures (such as lungs). In plants, water is drawn in at the roots and moves to the gas exchange organs, the leaves, where it evaporates quickly. This special case is called transpiration because it is responsible for so much of the water that enters the atmosphere. In both plants and animals, the breakdown of carbohydrates (sugars) to produce energy (respiration) produces both carbon dioxide and water as waste products. Photosynthesis reverses this reaction, and water and carbon dioxide are combined to form carbohydrates.

Phosphorus Cycle

Phosphorus is another nutrient that plays a central role in aquatic ecosystems and water quality. Unlike carbon and nitrogen, which come primarily from the atmosphere, phosphorus occurs in large amounts as a mineral in phosphate rocks and enters the cycle from erosion and mining activities. This is the nutrient considered to be the main cause of excessive growth of rooted and free-floating microscopic plants in lakes (algal blooms).

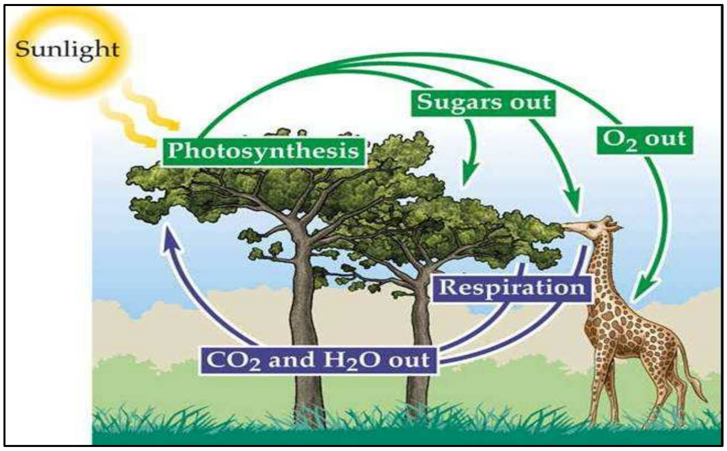


Carbon cycle



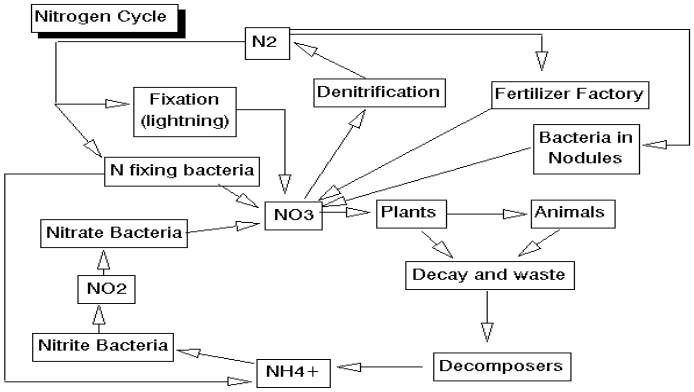
Carbon dioxide (CO_2) in the air and dissolved in water is the primary source of the element carbon. Through the process of photosynthesis, the carbon is removed from the CO_2 and incorporated with other chemical elements in complex organic molecules. The CO_2 eventually finds its way back into the atmosphere when the organics are broken down during respiration. The combustion of fossil fuels (oil and gasoline) for energy is a human activity that increases the concentration of CO_2 in the atmosphere. CO_2plays a role in absorbing radiated heat and in regulating global atmospheric temperatures. A rise in CO_2 levels in the atmosphere will tend to cause the average temperature to increase.

The Oxygen cycle



Oxygen is present in the carbon dioxide, in the carbohydrates, in water, and as a molecule of two oxygen atoms. Oxygen is released to the atmosphere by autotrophs during photosynthesis and taken up by both autotrophs and heterotrophs during respiration. In fact, all of the oxygen in the atmosphere is *biogenic*; that is, it was released from water through photosynthesis by autotrophs. It took about 2 billion years for autotrophs (mostly cyanobacteria) to raise the oxygen content of the atmosphere to the 21% that it is today; this opened the door for complex organisms such as multicellular animals, which need a lot of oxygen.

Nitrogen cycle



About 78 percent of the atmosphere is nitrogen gas (N_2), but in this molecular form it is not active in biological systems. The nitrogen must first be fixed in the form of nitrates (NO^{3-}), in which form it can be utilized by plants during photosynthesis. Eventually, it is combined with other substances and converted into proteins, consumed by heterotrophs and broken down again in the process of decay. Nitrification, the process in which nitrogen in the form of ammonia (NH_3) is converted to nitrate nitrogen, is of particular significance in water pollution control.

Questions

<u>Fill ups</u>

1. The pathways in which the chemical nutrients move through the components of ecosystem are called ---------------------

Ans: biogeochemical cycles

2. Biogeochemical cycles are also called as ---------------------------

Ans: Nutrient cycles

3. In biogeochemical cycles ---------------- plays a key role in returning nutrients to the soil, water or air

Ans: Decomposers

4. Biogeochemical cycles are broadly classified into ---------------- and -----------------

Ans: Sedimentary cycle, Gaseous cycle

5. Organisms contain amount of water up to --------- of their body weight.

Ans: 90%

Match

6. Oxygen - Eutrophication

7. Evaporation - produced by the combustion of fossil fuels

8. Carbon –di-oxide - Biogenic in nature

9. Phosphorus - Nitrifiers

10. Nitrification - process in which liquid water becomes gaseous

Ans

6. Oxygen - Biogenic in nature

7. Evaporation - process in which liquid water becomes gaseous

8. Carbon -di-oxide - produced by the combustion of fossil fuels

9. Phosphorus - Eutrophication

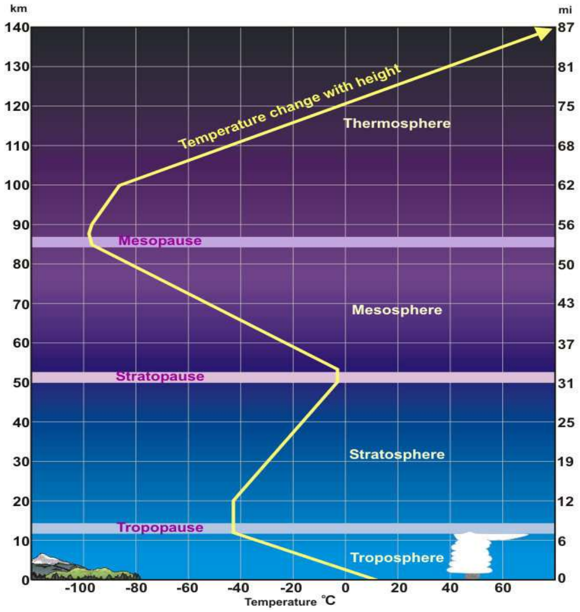
10. Nitrification - Nitrifiers

Lecture.4

Air environment - Structure, composition and importance of different layers of atmosphere

A clean air supply is essential to our own health and that of the environment. But since the industrial revolution, the quality of the air we breathe has deteriorated considerably - mainly as a result of human activities. Rising industrial and energy production, the burning of fossil fuels and the dramatic rise in traffic on our roads all contribute to air pollution in our towns and cities which, in turn, can lead to serious health problems. For example, air pollution is increasingly being cited as the main cause of lung conditions such as asthma - twice as many people suffer from asthma today compared to 20 years ago.

The multilayered gaseous envelope surrounding the planet earth is called atmosphere. It is an ocean of air which blends into outer space some 1000 km. The atmosphere is a reservoir of several elements essential to life and it serves many functions, including the filtering of radiant energy from the sun, insulation from heat loss at the earth's surface and stabilization of weather and climate owing to heat capacity of the air. There are five concentric layers within the atmosphere, which can be differentiated on the basis of temperature. These include the troposphere, the stratosphere, the mesosphere, the thermosphere and the exosphere. The Atmosphere is divided into layers according to major changes in temperature. Gravity pushes the layers of air down on the earth's surface. This push is called air pressure. 99% of the total mass of the atmosphere is below 32 kilometers.



(1) Troposphere

Troposphere - 0 to 12 km - Contains 75% of the gases in the atmosphere. This is where we live and where weather occurs. As height increases, temperature decreases in this region. The temperature drops about 6.5 degrees Celsius for every kilometer above the earth's surface. Tropopause - located at the top of the troposphere. The temperature remains fairly constant here. This layer separates the troposphere from the stratosphere.

Constituent	Percentage
Nitrogen	78.08
Oxygen	20.95
Argon	0.934
Carbon dioxide	0.0314*
Neon	0.0018
Helium	0.0005
Methane	0.0002*
Trypton	0.00011

Nitrous oxide	0.00005
Hydrogen	0.00005
Xenon	0.000008
Ozone	0.000001*

* Components are highly variable

The concentration of water vapour in this layer rate from 0 to more than 4%. Troposphere is more abundant in warm air. Troposphere is the layer of sulphates and is the region of strong air movements and cloud formation, i.e., it is the layer of most weather phenomena which affect different ecosystems of the biosphere.

(2) Stratosphere

Stratosphere - 12 to 50 km - in the lower part of the stratosphere. The temperature remains fairly constant (-60 degrees Celsius). This layer contains the ozone layer. Ozone acts as a shield for in the earth's surface. It absorbs ultraviolet radiation from the sun. This causes a temperature increase in the upper part of the layer.

It can be defined as the air mass extending from the tropopause (ie. upper most level of the troposphere), to the stratopause (ie ., upper most level of the stratosphere), about 50 km above the surface of the earth. The stratosphere exhibits several significant differences from the troposphere. Water vapour is virtually absent. The only clouds found in the stratosphere are very thin wispy clouds formed of tiny ice crystals. Ozone is present in significant quantities and it forms a well marked ozone layer called ozonosphere within the stratosphere.

Ozone is formed from oxygen by a photochemical reaction in which energy from the sun splits apart the oxygen molecule to form atomic oxygen. The atomic oxygen then combines with molecular oxygen to form ozone.

$$O_2 + \text{Solar energy} \longrightarrow 2O$$

$$O_2 + O \longrightarrow O_3$$

Ozone is in equilibrium with the rest of the air, which means that ozone is being produced from oxygen as fast as it is broken down to molecular oxygen. This is important because ozone absorbs UV radiation from the sun. In fact, the reason that the stratosphere bec omes warmer. With increasing distance from the earth is that the UV energy absorbed by the ozone is transformed into heat. Because of this heat, the ozonosphere also acts like a blanket that reduces the cooling rate of earth and thus adds to the effect of water vapour.

(3) Mesosphere

Mesosphere extends 50 to 80 km. This is the coldest region of the atmosphere. This layer protects the earth from meteoroids. They burn up in this area. Above the stratosphere is the mesosphere which is characterized by cold temperatures and very low atmospheric pressure. In fact, the temperature reversal, starts from the stratopause, i.e., temperature begins to drop, reaching a minimum about – 95^{o}C at a level some 80-90 km above the earth's surface. This level is termed the mesopause.

(4) Thermosphere

Above the mesosphere is the thermosphere which extends upto 500 km above the earth's surface and is characterized by steady temperature increase with height from mesopause. The thermosphere includes the region in which UV radiation and cosmic rays cause ionization of molecules like oxygen and nitric oxide. This region is called the ionosphere. In the thermosphere molecules of air so widely spaced that high frequency audible sounds are not carried by the atmosphere.

(5) Exosphere

Thermosphere - 80 km and up - The air is very thin. Thermosphere means "heat sphere". The temperature is very high in this layer because ultraviolet radiation is turned into heat. Temperatures often reach 2000 degrees Celsius or more. This layer contains:

Ionosphere - This is the lower part of the thermosphere. It extends from about 80 to 550 km. Gas particles absorb ultraviolet and X-ray radiation from the sun. The particles of gas become electrically charged (ions). Radio waves are bounced off the ions and reflect waves back to earth. This generally helps radio communication. However, solar flares can increase the number of ions and can interfere with the transmission of some radio waves.

The region of atmosphere above the thermosphere is called exosphere or outer space which lacks atoms except that of hydrogen and helium and extends up to 32,190 km from the planet. It has very high temperature due to solar radiations. Air is very thin here. This is the area where satellites orbit the earth.

Questions

1. Fill ups

1. The multilayered gaseous envelope surrounding the planet earth is called ----------------

Ans: atmosphere

2. Troposphere extends upto --------------- km

Ans: 0-12

3. The upper most level of the stratosphere is known as -----------------

Ans: stratopause

4. Ozone is formed from oxygen by ------------------ reaction

Ans: photochemical

5. The region of atmosphere above the thermosphere is called ---------------------

Ans: exosphere

True / False

6. Mesosphere means “heat sphere”.

Ans: False (Ans: Thermosphere)

7. Ozonosphere acts as blanket that reduces the cooling rate of earth

Ans: True

Match

8. Radio waves - absorbs UV radiation from the earth

9. Ozone - lower part of thermosphere

10. Ionosphere - reflects weaves back to earth and aids in
communication

11. ICM - Managing and protecting marine and coastal
environment

Ans

8. Radio waves - reflects weaves back to earth and aids in communication

9. Ozone - absorbs UV radiation from the earth

10. Ionosphere - lower part of thermosphere

11. ICM - Managing and protecting marine and coastal
environment

Lecture.5

Water environment - classification - freshwater, importance, availability, components, zones, biotic and abiotic interaction

Types and characteristics of water bodies

The aquatic biome can be broken down into two basic regions, **freshwater** (i.e., ponds and rivers) and **marine** (i.e., oceans and estuaries).

Fresh water is naturally occurring water on the Earth's surface in bogs, ponds, lakes, rivers and streams, and underground as groundwater in aquifers and underground streams. Freshwater is characterized by having low concentrations of dissolved salts (<1%) and other total dissolved solids. The term specifically excludes seawater and brackish water. Scientifically, freshwater habitats are divided into lentic systems, which are the still waters including ponds, lakes, swamps and mires; lotic systems, which are running water; and groundwater which flows in rocks and aquifers. There is, in addition, a zone which bridges between groundwater and lotic systems, which are the hyporheic zone, which underlies many larger rivers and can contain substantially more water than is seen in the open channel. It may also be in direct contact with the underlying groundwater.

The source of almost all freshwater is precipitation from the atmosphere, in the form of mist, rain and snow. A very small proportion is emitted from active volcanoes. Freshwater falling as mist, rain or snow contains materials dissolved from the atmosphere and material from the sea and land over which the rain bearing clouds have traveled. In industrialized areas rain is typically acidic because of dissolved oxides of sulfur and nitrogen formed from burning of fossil fuels in cars, factories, trains and aircraft and from the atmospheric emissions of industry. In extreme cases this acid rain results in pollution of lakes and rivers.

In coastal areas freshwater may contain significant concentrations of salts derived from the sea if windy conditions have lifted drops of seawater into the rain-bearing clouds. This can give rise to elevated concentrations of sodium, chloride, magnesium and sulfate as well as many other compounds in smaller concentrations. In desert areas, or areas with impoverished or dusty soils, rain bearing winds can pick up sand and dust and this can be deposited elsewhere in precipitation and causing the freshwater flow to be measurably contaminated both by insoluble solids but also by the soluble components of those soils. Significant quantities of iron may be transported in this way including the well documented transfer of iron rich rainfall falling in Brazil derived from sand-storms in the Sahara in northern Africa.

Water salinity based on dissolved salts in parts per thousand (ppt)			
Freshwater	**Brackish water**	**Saline water**	**Brine**
< 0.5	**0.5 – 30**	**30 – 50**	**> 50**

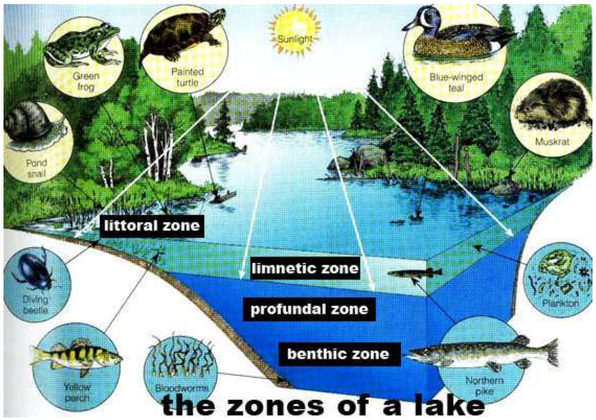
Freshwater Regions: Plants and animals in freshwater regions are adjusted to the low salt content and would not be able to survive in areas of high salt concentration (i.e., ocean). There are different types of freshwater regions: ponds and lakes, streams and rivers, and wetlands.

i. Ponds and Lakes

These regions range in size from just a few square meters to thousands of square kilometers. Scattered throughout the earth, several are remnants from the Pleistocene glaciations. Many ponds are seasonal, lasting just a couple of months while lakes may exist for hundreds of years or more. Ponds and lakes may have limited species diversity since they are often isolated from one another and from other water sources like rivers and oceans. Lakes and ponds are divided into three different “zones” which are usually determined by depth and distance from the shoreline.

The topmost zone near the shore of a lake or pond is the **littoral zone**. This zone is the warmest since it is shallow and can absorb more of the Sun’s heat. It sustains a fairly diverse community, which can include several species of algae (like diatoms), rooted and floating aquatic plants, grazing snails, clams, insects, crustaceans, fishes, and amphibians. In the case of the insects, such as dragonflies and midges, only the egg and larvae stages are found in this zone. The vegetation and animals living in the littoral zone are food for other creatures such as turtles, snakes, and ducks.

The near-surface open water surrounded by the littoral zone is the **limnetic zone**. The limnetic zone is well lighted (like the littoral zone) and is dominated by plankton, both phytoplankton and zooplankton. Planktons are small organisms that play a crucial role in the food chain. Without aquatic plankton, there would be few living organisms in the world, and certainly no humans. A variety of freshwater fish also occupy this zone.



Plankton have short life spans - when they die, they fall into the deep-water part of the pond, the **profundal zone.** This zone is much colder and denser than the other two. Little light penetrates all the way through the limnetic zone into the profundal zone. The fauna are heterotrophs, meaning that they eat dead organisms and use oxygen for cellular respiration.

Classification of lakes

- On the basis of formation of lakes they are broadly grouped into two

  i. Natural ii. Artificial

Natural lake

Artificial lake

- On the basis of productivity, lakes are grouped into two

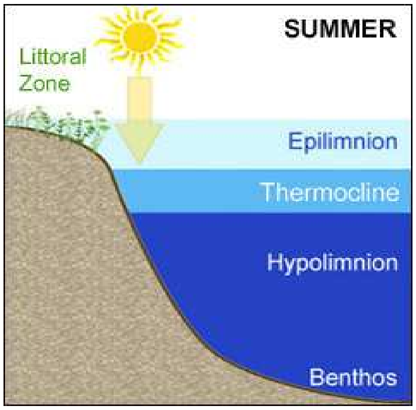
Oligotrophic	: Very little plant and animals, poor in nutrients.
Eutrophic	: More plants and animals, rich in nutrients.

Oligotrophic lake

Eutrophic Lake

Thermal stratification of lakes

- Epilimnion : Upper stratum of water exposed to sunlight
- Hypolimnion : Basal stratum when water remains always cool and does not circulate
- Thermocline : Transitional zone between eplimnion and hypolimnion where temperature changes occur



On the basis of light penetration lakes have the following zones

1. Euphotic zones : Sunlight present in this region extends up to 53 m.
2. Disphotic zones : Sunlight is present but the quantity of sunlight in low. Extends up to 200 m.
3. Aphotic zones : Light is absent in this region. Extend from 200 m to bottom of the lakes.

ii. Streams and Rivers

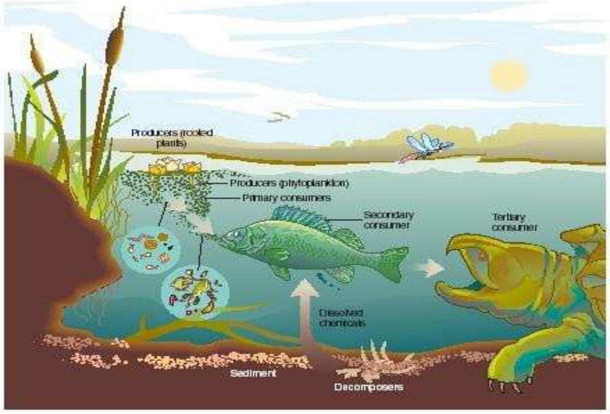
These are bodies of flowing water moving in one direction. Streams and rivers can be found everywhere - they get their starts at headwaters, which may be springs, snowmelt or even lakes, and then travel all the way to their mouths, usually another water channel or the ocean. The characteristics of a river or stream change during the journey from the source to the mouth. The temperature is cooler at the source than it is at the mouth. The water is also clearer, has higher oxygen levels, and freshwater fish such as trout and heterotrophs can be found there. Towards the middle part of the stream/river, the width increases, as does species diversity - numerous aquatic green plants and algae can be found. Toward the mouth of the river/stream, the water becomes murky from all the sediments that it has picked up upstream, decreasing the amount of light that can penetrate through the water. Since there is less light, there is less diversity of flora, and because of the lower oxygen levels, fish that require less oxygen, such as catfish and carp, can be found.

iii. Wetlands

These are areas of standing water that support aquatic plants. Marshes, swamps, and bogs are all considered wetlands. Plant species adapted to the very moist and humid conditions are called hydrophytes. These include pond lilies, cattails, sedges, tamarack, and black spruce. Marsh flora also includes such species as cypress and gum. Wetlands have the highest species diversity of all ecosystems. Many species of amphibians, reptiles, birds (such as ducks and waders), and furbearers can be found in the wetlands. Wetlands are not considered freshwater ecosystems as there are some, such as salt marshes, that have high salt concentration these support different species of animals, such as shrimp, shellfish, and various grasses.

Ecological classification of lentic ecosystem

- **Producers:** Macro vegetation (large plants), Micro vegetation (plankton)
- **Consumers:** Macro consumers (insects, fishes), Micro consumers (crustacean)
- **Decomposers:** Bacteria, fungi.



Organisms in fresh water may also be classified based on their habitat and also the zones at which they are found.

- **Benthos**: This includes organisms found in the bottom of fresh waters. Eg. Fresh water mussel, fresh water snail.
- **Periphyton (Aufurichs)**: This includes organisms which are found attached to the stems and leaves of plants. Eg. Insect larvae.

- **Plankton**: It includes both phytoplankton (algae) and zooplankton (crustacean)
- **Nekton**: These include organisms which swim or actively move about in fresh waters. Eg. Aquatic insects, fishes and amphibians.
- **Neuston**: These are organisms which swim or rest on the surface. Eg. Surface feeders.

Water distribution

Water is a critical issue for the survival of all living organisms. Many can use salty water but many organisms including the great majority of higher plants and most mammals must have access to freshwater to grow bigger. Some terrestrial mammals, especially desert rodents appear to survive without drinking but they do generate water through the metabolism of cereal seeds and they also have mechanisms to conserve water to the maximum degree.

Only three percent of the water on Earth is freshwater, and about two-thirds of this is frozen in glaciers and most of the rest is underground and only 0.3 percent is surface water. Freshwater lakes, most notably Lake Baikal in Russia and the Great Lakes in North America, contain seven-eighths of this fresh surface water. Swamps have most of the balance with only a small amount in rivers, most notably the Amazon River. The atmosphere contains 0.04% water. In areas with no freshwater on the ground surface, freshwater derived from precipitation may, because of its lower density, overlie saline ground water in lenses or layers.

- **Aquatic organisms**
- **Agriculture**
- **Limiting resource**
- **Freshwater withdrawal**
- **Causes of limited fresh water**
- **Another source of fresh water**

Questions

1. The aquatic biome is divided into ---------------------- and --------------------

Ans: Freshwater, Marine

2. The mean surface open water surrounded by the litteral zone is the -------------

Ans: Limnetic zone

3. The transitional zone between epilimnion and hypolimnion is said to be -----------------

Ans: thermocline

4. ----------------- is a process in which salt is separated from the water.

Ans: Distillation

Match

5. Eutrophic - Deep water part of pond
6. Profundal zone - Light is absent in this region
7. Wetland - Surface feeders
8. Aphotic zone - Marshes, swamps and bogs
9. Eutrophication - Poor in nutrients with less plants and animals
10. Neuston - Rich in nutrients with more plants and animals

Ans

5. Oligotrophic - Poor in nutrients with less plants and animals
6. Profundal zone - Deep water part of pond
7. Wetland - Marshes, swamps and bogs
8. Aphotic zone - Light is absent in this region
9. Eutrophic - Rich in nutrients with more plants and animals
10. Neuston - Surface feeders

Lecture.6

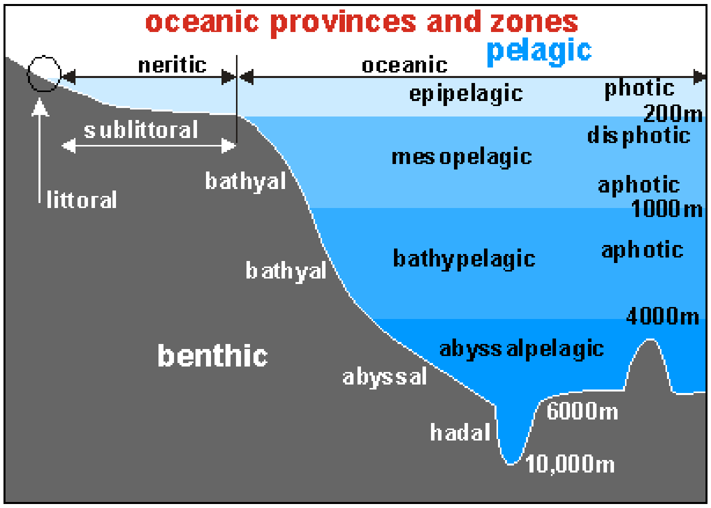
Marine water - Importance, Availability, Components, Zones, Biotic and Abiotic interaction

Marine Regions

Marine regions cover about three-fourths of the Earth's surface and include oceans, coral reefs, and estuaries. Marine algae supply much of the world's oxygen supply and take in a huge amount of atmospheric carbon dioxide. The evaporation of the seawater provides rainwater for the land.

i. Oceans

The largest of all the ecosystems, oceans are very large bodies of water that dominate the Earth's surface. Like ponds and lakes, the ocean regions are separated into separate zones: intertidal, pelagic, abyssal, and benthic. All four zones have a great diversity of species. Some say that the ocean contains the richest diversity of species even though it contains fewer species than there are on land.



The **intertidal zone** is where the ocean meets the land - sometimes it is submerged and at other times exposed, as waves and tides come in and out. Because of this, the communities are constantly changing. On rocky coasts, the zone is stratified

vertically. Where only the highest tides reach, there are only a few species of algae and mollusks. In those areas usually submerged during high tide, there is a more diverse array of algae and small animals, such as herbivorous snails, crabs, sea stars, and small fishes. At the bottom of the intertidal zone, which is only exposed during the lowest tides, many invertebrates, fishes, and seaweed can be found. The intertidal zone on sandier shores is not as stratified as in the rocky areas. Waves keep mud and sand constantly moving, thus very few algae and plants can establish themselves-the fauna include worms, clams, predatory crustaceans, crabs, and shorebirds.

The **pelagic zone (0 to 200 m)** includes those waters further from the land, basically the open ocean. The pelagic zone is generally cold though it is hard to give a general temperature range since, just like ponds and lakes; there is thermal stratification with a constant mixing of warm and cold ocean currents. The flora in the pelagic zone includes surface seaweeds. The fauna include many species of fish and some mammals, such as whales and dolphins. Many feed on the abundant plankton.

The **benthic zone (200 to 1500 m)** is the area below the pelagic zone, but does not include the very deepest parts of the ocean. The bottom of the zone consists of sand, slit, and/or dead organisms. Here temperature decreases as depth increases toward the abyssal z one, since light cannot penetrate through the deeper water. Flora are represented primarily by seaweed while the fauna, since it is very nutrient-rich, include all sorts of bacteria, fungi, sponges, sea anemones, worms, sea stars, and fishes.

The deep ocean is the **abyssal zone (> 1550 mt)**. The water in this region is very cold (around 3° C), highly pressured, high in oxygen content, but low in nutritional content. The abyssal zone supports many species of invertebrates and fishes. Mid-ocean ridges (spreading zones between tectonic plates), often with hydrothermal vents, are found in the abyssal zones along the ocean floors. Chemosynthetic bacteria thrive near these vents because of the large amounts of hydrogen sulfide and other minerals they emit. These bacteria are thus the start of the food web as they are eaten by invertebrates and fishes.

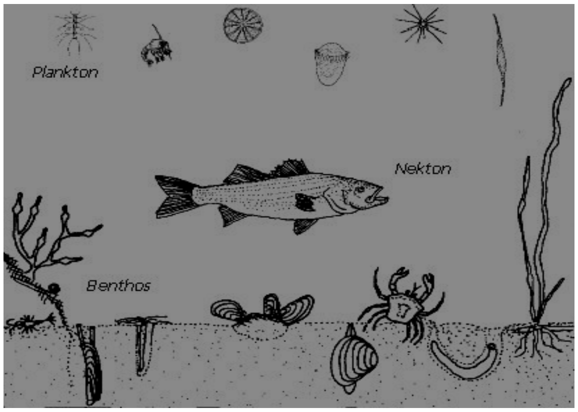
Ecological classification of marine biota: The organisms living in different zones of the sea are classified ecologically. They are:

(1) Plankton: Organisms which float or drift in the surface layers of the sea and are passively moved about by winds and currents are known as plankton. It includes protests, plants and animals and most of these are microscopic to minute in size. The plankton constitutes a major source of food for the fishes.

(2) Nekton: These are animals which move about freely by their own efforts, in open sea. Eg. Fishes, turtles, sea snakes, seals, whales, dolphins etc.

(3) Neuston: These are organisms which swim of rest on the surface of the sea. Eg. Flying fishes, dolphin fishes etc.

(4) Benthos: These forms inhabit the bottom of the seas and are called benthic forms.



Classification of marine biota

ii. Coral Reefs

Coral reefs are widely distributed in warm shallow waters. They can be found as barriers along continents (e.g., the Great Barrier Reef of Australia), fringing islands, and atolls. Naturally, the dominant organisms in coral reefs are corals. Corals are interesting since they consist of both algae (zooanthellae) and tissues of animal polyp. Since reef waters tend to be nutritionally poor, corals obtain nutrients through the algae via photosynthesis and also by extending tentacles to obtain plankton from the water. Besides corals, the fauna include several species of microorganisms, invertebrates, fishes, sea urchins, octopuses, and sea stars.

Coral Reefs

Coral reefs are made up of calcareous skeletal remains and secretion of corals and certain algae. They are confined largely to the warm waters of the pacific and Indian oceans. The reef building corals grow best in waters having an average annual temperature of about 24 °C at a depth of about 40-50 meters with salinity of 35 g per litre. They cannot grow in fresh or turbid waters or in highly saline lagoons.

Corals build protective shells of calcium carbonate around their bodies, which after their death, sink and accumulate on the sea bottom. Coral families usually produce forms that resemble branching trees or shrubs. In due course, the inner spaces between the branching coralline structures are filled up by the deposition of calcium carbonate either by lime secreting organism or by debris brought by sea waves.

iii. Estuaries

Estuaries are areas where freshwater streams or rivers merge with the ocean. This mixing of waters with such different salt concentrations creates a very interesting and unique ecosystem. Microflora like algae, and macroflora, such as seaweeds, marsh grasses, and mangrove trees (only in the tropics), can be found here. Estuaries support a diverse fauna, including a variety of worms, oysters, crabs, and waterfowl.

Estuaries

Physical alteration and the destruction of habitats are now considered one of the most significant threats to coastal areas. Half of the world's wetlands, and even more of its mangrove forests, have been lost over the past century to physical alterations, the major causes being accelerating social and economic development and poor-planning (UNEP, 2002). There are currently about one billion people living in coastal urban areas. It is estimated that almost 50% of the world's coasts are threatened by development-related activities. The intense pressure on coastal ecosystems calls for preventive and protective action at all levels - local, national, regional and global.

Integrated Coastal Management: Integrated Coastal Management (ICM) is increasingly being recognized as an effective method for managing and protecting marine and coastal environments and associated freshwater catchments. It merits wider application, both for resolving existing problems and for dealing effectively with new ones.

ICM incorporates and promotes the following actions:

- Coordinated, cross-sectoral and holistic approaches to the management of environmental resources and amenities, taking full account of environmental, public health, economic, social and political considerations
- Environmental impact assessments, risk management, and cost-benefit analyses in all decision making processes, and incorporating the value of ecosystem services wherever possible
- The active involvement and participation of all major stakeholders (local authorities, private sector and interested public) in the design and implementation of ICM
- Regular reviews of management systems and their implementation, and adjusting of priorities, targets and methods where necessary
- Strengthened institutional capacities through training and retraining programmes.

If existing global and regional environmental agreements had been implemented as intended, coastal areas would not be in their current precarious state. In many countries, legislative frameworks to achieve national goals and implement multilateral agreements are weak and inadequately enforced.

To address this situation, ICM recommends the following actions:

- Governments should adapt national legal instruments to conform to the provisions of internationally endorsed agreements
- National and international attention should focus on compliance with existing international agreements rather than the development of new ones, unless they have compelling justification
- Governments must adopt a consistent and coordinated approach in dealing with different international organizations and agreements
- International bodies responsible for the implementation of global environmental agreements should improve the coordination of their secretariats and governing bodies

- Further attention should be devoted at the regional level to harmonizing national approaches and measures, and to cost-effective collaboration; the full potential of voluntary commitments and targets should be explored, including with the private sector; and further legally binding instruments should be developed.

Unsurprisingly, the coastal areas with the greatest population densities are also those with the most **Shoreline degradation.**

The areas surrounding the Black Sea, the Mediterranean and southern Asia have the highest proportion of altered land, while the coastal zones of the Arctic, northeast Pacific, south Pacific, West and Central Africa, East Africa, the Red Sea/Gulf of Aden, and Kuwait have the highest proportions of least modified land. In order to better manage and protect the oceans and coasts using effective methods such as Integrated Coastal Management, we also need to continuously improve our understanding of the current state of biophysical, social, and economic relationships and formulate sustainable, ecosystem-based policies and measures that are supported by assessments at national, regional and global scales. Also needed is an overview of the global marine environment that encompasses socio-economic considerations and shows the linkages between the state of the marine environment and human well-being.

In response to these needs, the United Nations General Assembly (UNGA) has requested, through Resolution 60/30, that UNEP and UNESCO-IOC co-lead a process which aims to provide a better understanding of the marine assessment landscape to determine the ways in which on-going global, regional and national level assessment work and processes can contribute to the regular assessment and reporting of the state of the marine environment.

Options, a framework and the feasibility of establishing such a process (referred to as a ‘Regular Process’) will be proposed to the United Nations General Assembly, in October 2009. Amongst other aims, it will identify linkages between human impacts on the marine environment, environmental change and human well-being and will explore ways to ensure linkages between regions so that issues of common concern can be tackled in a coordinated way, taking into account best practices and regional strengths and capacities.

Since the 1990s, the scientific community has been warning about the rapidly changing climate, endeavouring to convince people to take urgent measures to mitigate the changes. These multiple warnings have been ignored until very recently, but the issue is now a priority with many international organizations. However, all reliable climate scenarios run by the IPCC and published in the fourth assessment reports show the following results:

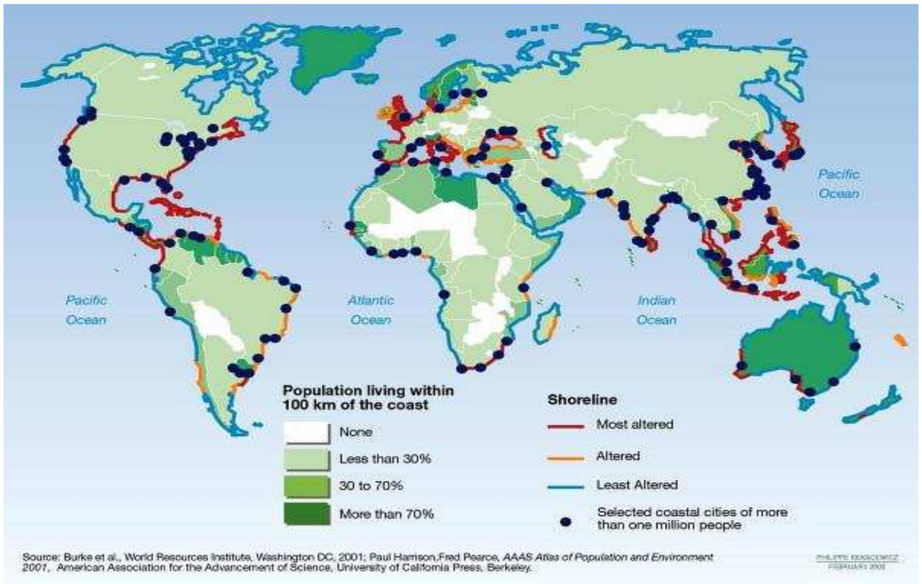
Cause of degradation	Estuaries	Inter-tidal Wetlands	Open Ocean
Drainage of coastal ecosystems for agriculture, deforestation, and mosquito control measures	🔵	🟢	🔵
Dredging and channelisation for navigation and flood protection	🔵	🔵	🔴
Solid waste disposal, road construction, and commercial, industrial or residential development	🔵	🔵	🟢
Conversion for aquaculture	🔵	🔵	🔵
Construction of dykes, dams and seawalls for flood and storm control, water supply and irrigation	🔵	🔵	🔵
Discharge of pesticides, herbicides, domestic and industrial waste, agricultural runoff and sediment loads	🔵	🔵	🔵
Mining of wetlands for peat, coal, gravel, phosphates, etc.	🟢	🔴	🟢
Logging and shifting cultivation	🟢	🔵	🔴
Fire	🟢	🟢	🔴
Sedimentation of dams, deep channels and other structures	🔵	🔵	🔵
Hydrological alteration by canals, roads and other structures	🔵	🔵	🔵
Subsidence due to extraction of groundwater, oil, gas and other minerals	🔵	🔴	🟢

🔵 Common and major cause of degradation
🟢 Present but not a major cause
🔴 Absent or uncommon

Source: United Nations Environment Programme (UNEP).

DELPHINE DIGOUT
APRIL 2002

The accelerating changes in our global climate will undoubtedly cause major changes in the patterns of water cycle and geographical distribution, in the near future. Some regions will receive less precipitation, some more, and this will significantly affect agricultural activity. While some regions will see a reduction in arable land, others will have more suitable land for agriculture.



Source: Burke et al., World Resources Institute, Washington DC, 2001; Paul Harrison, Fred Pearce, *AAAS Atlas of Population and Environment 2001*, American Association for the Advancement of Science, University of California Press, Berkeley.

It’s likely that certain types of agriculture will migrate and traditional areas for crops will change. In other words, climate change will alter the geography of traditional crop areas, which may impact on the world’s capacity to provide enough food for all.

- agriculture and rural development will be violently hit by climate change
- poverty and under-nourishment will grow with the uncertainty of food supply
- the climatologic regime will imply more risk of vulnerability for both humans and biodiversity
- A reduction of glaciers will imply a growing security risk for hundreds of millions living near coasts.

In other words, ongoing climate change will mean that the water supply for human communities will become more and more uncertain. The IPCC has stated that between 2000 and 2005 in the northern hemisphere, climate change accelerated faster than predicted, with the consequence that the water cycle could change in an unpredictable way, leading to the possibility of increases in extreme weather. The fear is that with all these changes, even if the quantity of water in the world does not change, the level of accessibility of the theoretically available water may significantly change.

Questions

1. Marine regions cover about ------------- of earth's surface

Ans: 3/4th

2. The ocean zone that extends downwards over 1550 mile is called ----------

Ans: abyssal

3. -------------- are the forms that inhabits at the bottom of the seas.

Ans: Benthos

4. Expand UNEP.

Ans: United Nations Environment Programme.

Match

5. Coral reefs - logging, mining & shifting cultivation
6. IPCC - confined largely to warm waters of Indian ocean
7. Degradation - Assesses the climate change scenarios

Ans

5. Coral reefs - confined largely to warm waters of Indian ocean
6. IPCC - Assesses the climate change scenarios
7. Degradation - logging, mining & shifting cultivation

True / False

8. Corals build protective shells of calcium oxalate around their bodies

Ans: False

9. Estuaries are areas where freshwater streams merge with the ocean

Ans: True

10. Benthic zone is basically the open ocean

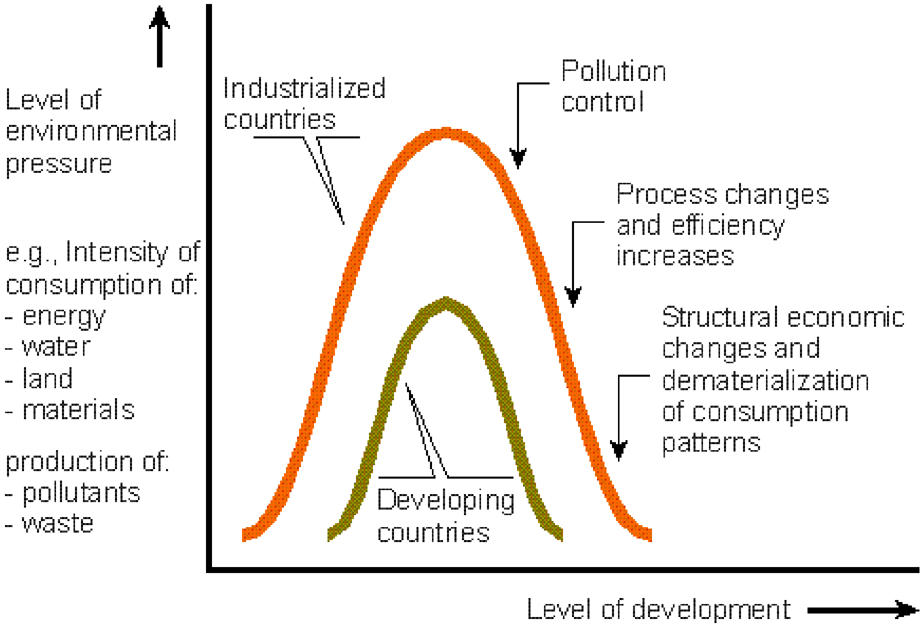
Ans: False

Lecture.7

Global and Indian environment – past and present status

The Global Environment Outlook *(GEO-1) report* shows that significant progress has been made in the last decade in confronting environmental challenges in both developing and industrial regions. World-wide, the greatest progress has been in the realm of institutional developments, international co-operation, public participation, and the emergence of private-sector action. Legal frameworks, economic instruments, environmentally sound technologies, and cleaner production processes have been developed and applied. Environmental impact assessments have become standard tools for the initiation, implementation, and evaluation of major development and investment projects in many countries around the world.

As a result, several countries report marked progress in curbing environmental pollution and slowing the rate of resource degradation as well as reducing the intensity of resource use. The rate of environmental degradation in several developing countries has been slower than that experienced by industrial countries when they were at a similar stage of economic development.



Environmental transitions

Internationally, Agenda 21 - the plan of action adopted by Governments in 1992 in Rio de Janeiro- provides the global consensus on the road map towards sustainable development. The Commission on Sustainable Development offers an intergovernmental forum to co-ordinate and monitor progress on the plan's implementation. A financial mechanism, the Global Environment Facility, addresses the incremental costs that developing countries face in responding to selected global environmental problems. UNEP continues to be the environmental voice of the United Nations, responsible for environmental policy development, scientific analysis, monitoring, and assessment. Increasingly, United Nations organizations, the World Bank, and Regional Banks are "greening" their programmes. Recently signed international agreements are entering into force, older treaties are being improved, and new approaches to international policy are being developed, tested, and implemented.

Since Rio, a growing body of actors-Governments, non-governmental organizations (NGOs), the private sector, civil society, and the scientific and research community-have responded to environmental challenges in a variety of ways and have taken great strides towards incorporating environmental considerations in their day-to-day activities. Groups such as the World Business Council for Sustainable Development, the Earth Council, and the International Council for Local Environment Initiatives provide effective non-governmental forums for world-wide co-operation and information sharing. Increasingly, Government departments are called on to take environmental considerations into account, and consequently environment assumes a more important role in international relations and transactions. The participation of a broad range of ministries (other than those on the environment) in the negotiation and implementation of the Biodiversity, Climate, and Desertification Conventions and the increasing array of voluntary agreements, codes of conduct, and guidelines generated by the industry, banking, and insurance sectors all exemplify the encouraging trend.

Nevertheless, despite this progress on several fronts, from a global perspective the environment has continued to degrade during the past decade, and significant environmental problems remain deeply embedded in the socio-economic fabric of nations in all regions. Progress towards a global sustainable future is just too slow. A sense of urgency is lacking. Internationally and nationally, the funds and political will are insufficient to halt further global environmental degradation and to address the most pressing environmental issues-even though technology and knowledge are available to do so. The recognition of environmental issues as necessarily long-term and cumulative, with serious global and security implications, remains limited. The reconciliation of environment and trade regimes in a fair and equitable manner still remains a major challenge. The continued preoccupation with immediate local and national issues and a general lack of sustained interest in global and long-term environmental issues remain major impediments to environmental progress internationally. Global governance structures and global environmental solidarity remain too weak to make progress a world-wide reality. As a result, the gap between what has been done thus far and what is realistically needed is widening.

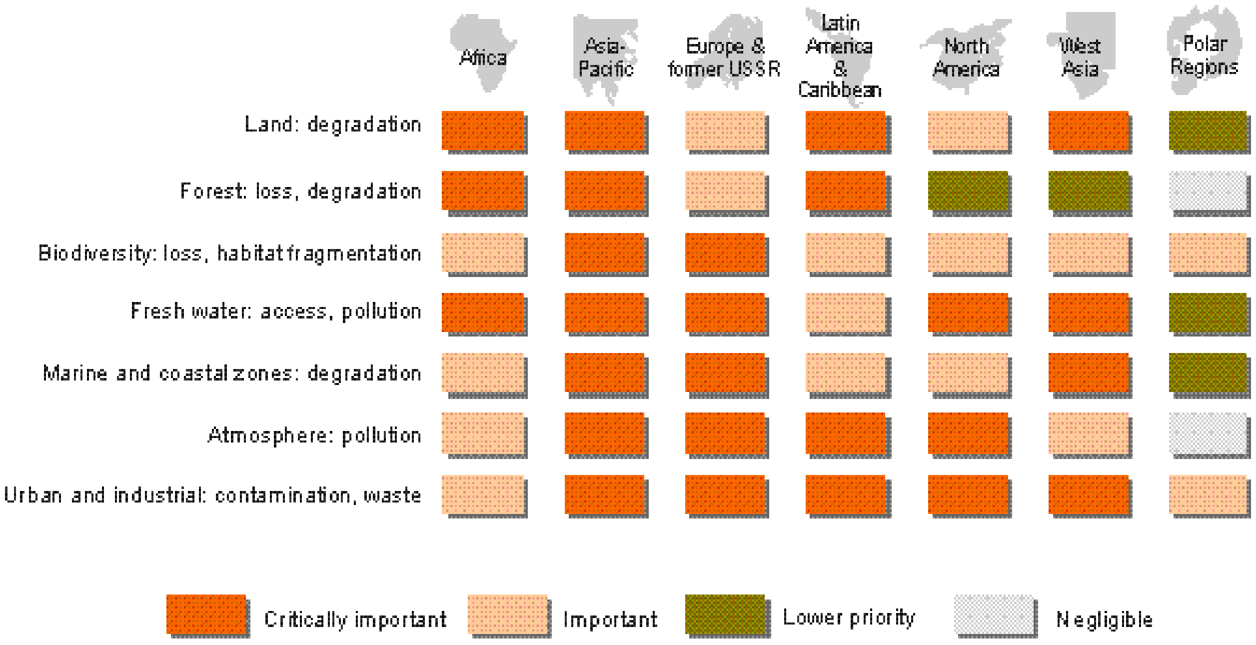
Comprehensive response mechanisms have not yet been fully internalized at the national level. The development at local, national, and regional levels of effective environmental legislation and of fiscal and economic instruments has not kept pace with the increase in environmental institutions. In the private sector, environmental advances by several major transnational corporations are not reflected widely in the practices of small- and medium-sized companies that form the backbone of economies in many countries.

In the future, the continued degradation of natural resources, shortcomings in environmental responses, and renewable resource constraints may increasingly lead to food insecurity and conflict situations. Changes in global biogeochemical cycles and the complex interactions between environmental problems such as climate change, ozone depletion, and acidification may have impacts that will confront local, regional, and global communities with situations they are unprepared for. Previously unknown risks to human health are becoming evident from the cumulative and persistent effects of a whole range of chemicals, particularly the persistent organic pollutants. The effects of climate variability and change are already increasing the incidence of familiar public health problems and leading to new ones, including a more extensive reach of vector borne diseases and a higher incidence of heat-related illness and mortality. If significant major policy reforms are not implemented quickly, the future might hold more such surprises.

GEO-1 substantiates the need for the world to embark on major structural changes and to pursue environmental and associated socio-economic policies vigorously. Key areas for action must embrace the use of alternative and renewable energy resources, cleaner and leaner production systems world-wide, and concerted global action for the protection and conservation of the world's finite and irreplaceable fresh-water resources.

Overview of Regional Status and Trends

Regional Concerns: Relative Importance Given to Environmental Issues by Regions

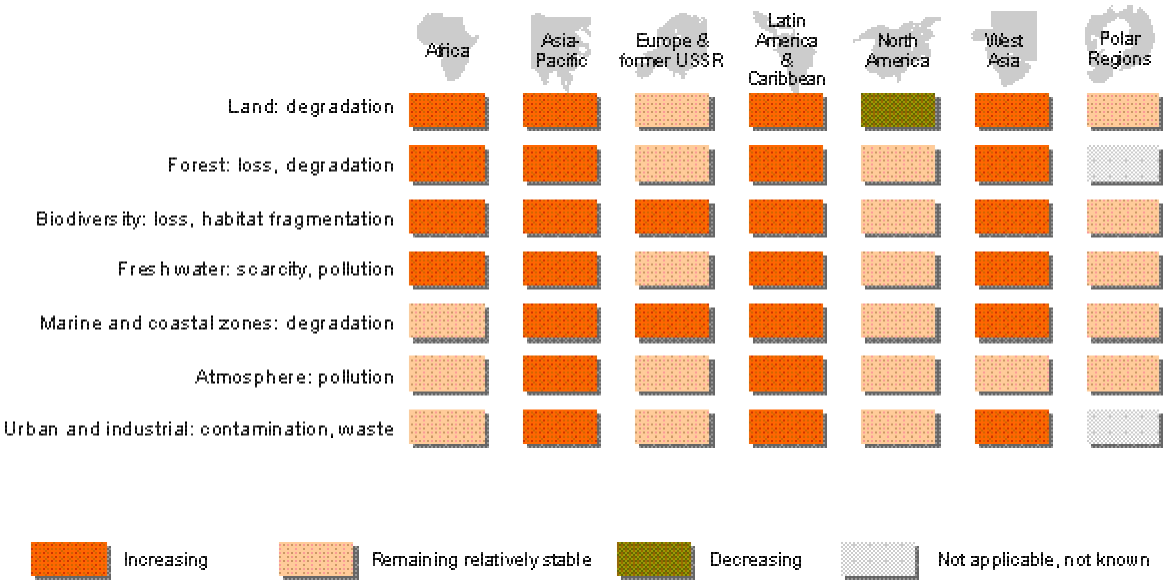


	Africa	Asia-Pacific	Europe & former USSR	Latin America & Caribbean	North America	West Asia	Polar Regions
Land: degradation	🟧	🟧	🟨	🟧	🟨	🟧	🟩
Forest: loss, degradation	🟧	🟧	🟨	🟧	🟩	🟩	⬜
Biodiversity: loss, habitat fragmentation	🟨	🟧	🟧	🟨	🟨	🟨	🟨
Fresh water: access, pollution	🟧	🟧	🟧	🟨	🟧	🟧	🟩
Marine and coastal zones: degradation	🟨	🟧	🟧	🟨	🟨	🟧	🟩
Atmosphere: pollution	🟨	🟧	🟧	🟧	🟧	🟨	⬜
Urban and industrial: contamination, waste	🟨	🟧	🟧	🟧	🟧	🟧	🟨

🟧 Critically important 🟨 Important 🟩 Lower priority ⬜ Negligible

The above figure reflects trends for the same issues, without depicting the rate of changes in these trends. In many instances, although trends are increasing, the rate of increase over the years has slowed down or was less than the rate of increase in economic growth previously experienced by countries with comparable economic growth. This suggests that several countries are making the transition to a more sustainable environment at a lower level of economic development than industrial countries typically did over the last 50 years.

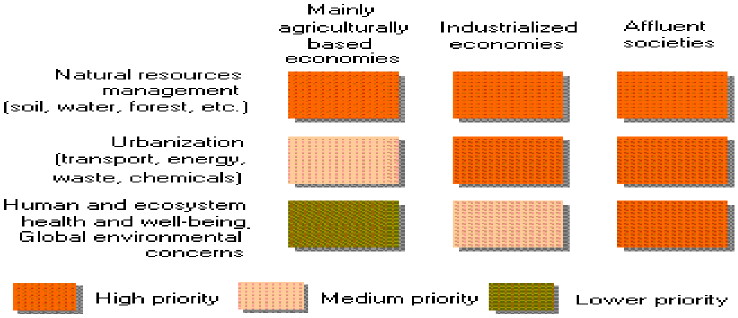
Regional Environmental Trends



	Africa	Asia-Pacific	Europe & former USSR	Latin America & Caribbean	North America	West Asia	Polar Regions
Land: degradation	🟥	🟥	🟧	🟥	🟩	🟥	🟧
Forest: loss, degradation	🟥	🟥	🟧	🟥	🟧	🟥	⬜
Biodiversity: loss, habitat fragmentation	🟥	🟥	🟥	🟥	🟧	🟥	🟧
Freshwater: scarcity, pollution	🟥	🟥	🟧	🟥	🟧	🟥	🟧
Marine and coastal zones: degradation	🟧	🟥	🟥	🟥	🟧	🟥	🟧
Atmosphere: pollution	🟧	🟥	🟧	🟥	🟧	🟧	🟧
Urban and industrial: contamination, waste	🟧	🟥	🟧	🟥	🟧	🟥	⬜

🟥 Increasing 🟧 Remaining relatively stable 🟩 Decreasing ⬜ Not applicable, not known

As nations develop, different sets of environmental concerns assume priority. Initially, prominence is given to issues associated with poverty alleviation and food security and development- namely, natural resource management to control land degradation, provide an adequate water supply, and protect forests from overexploitation and coastal zones from irreversible degradation. Attention to issues associated with increasing industrialization then follows. Such problems include uncontrolled urbanization and infrastructure development, energy and transport expansion, the increased use of chemicals, and waste production. More affluent societies focus on individual and global health and well-being, the intensity of resource use, heavy reliance on chemicals, and the impact of climate change and ozone destruction, as well as remaining vigilant on the long-term protection needs of natural resources. The following Figure illustrates the observed progression on environmental priority issues.



	Mainly agriculturally based economies	Industrialized economies	Affluent societies
Natural resources management (soil, water, forest, etc.)	🟧	🟧	🟧
Urbanization (transport, energy, waste, chemicals)	⬜	🟧	🟧
Human and ecosystem health and well-being, Global environmental concerns	🟫	⬜	🟧

🟧 High priority ⬜ Medium priority 🟫 Lower priority

Looking to the Future

The first GEO Report concludes with a brief exploration, based on model analyses, of what we might expect in the future for a selected number of environmental issues. The results highlight the integrated nature of the environment and underscore the need for more systematic analysis of linkages between environment, social, economic, institutional, and cultural sectors and among different environmental issues, such as biodiversity, climate, land, and water.

Preliminary results from the model analyses confirm trends revealed by the regional chapters. They indicate that, despite both declining global birth rates since 1965 and recent policy initiatives towards more efficient and cleaner resource use in some regions, the large increases in world population, expanding economies in industrializing countries, and wasteful consumption patterns particularly in developed countries of the world will continue to increase global resource and energy consumption, generate burgeoning wastes, and spawn environmental contamination and degradation. Pressures on remaining biodiversity and natural ecosystems will increase accordingly.

If no fundamental changes occur in the amount and type of energy used, global carbon dioxide emissions will increase, and the declining trends in acidifying sulphur and nitrogen concentrations may be reversed. In light of the apparent effects of human activity on climate, contingency plans to adapt to projected climate change will be required in the near future. These include the development of drought-resistant crops, increases in water use efficiency, the avoidance of ecosystem fragmentation, and an improvement of the adaptive capabilities in all regions.

With only moderate application of improved agricultural management and technology in developing regions, the demands of growing populations and the increasing burden of poverty may well lead to substantial expansion of agricultural activities into marginal lands at the expense of remaining wilderness and associated biodiversity. Although the models project adequate availability of water and food on a global basis, regional deficiencies could be aggravated in the near future. The combination of increased pressure on land by expanding urbanization and losses of productive land through degradation and unsustainable management practices may lead to shortages in arable land and water, impeding development in several regions. Global food trade can supplement these regional shortfalls, but will create dependencies and require importing countries to engage in other production activities to finance essential food imports.

In such a scenario, sharp regional differences will remain and poverty will be aggravated in several regions. If global economic gains are not accompanied more explicitly by investment in education, social development, and environmental protection, a move towards a more equitable, healthy, and sustainable future for all sectors of society will not be realized, and a new spate of urban and pollution-related health impacts may surface.

Questions

1. Agenda – 21- the plan of action was adopted by governments at ---------------in brazil.

Ans: Rio de Janeiro

2. Acid rain is an example of ---------------- pollution

Ans: Air

3. ----------------- is the largest remaining natural ecosystems on Earth

Ans: Polar Regions

4. ----------------- is widespread alarm in Asia and Pacific regarding the over exploitation of Marine fisheries.

Ans: Oil spills

Match

5. Natural forest fires - standard tools for evaluation and
development projects

6. Environmental impact assessment - substantiates the mud of world on
environmental
policies

7. GEO-1 - Most serious environmental problem

8. Habitat fragmentation - degradation of forests

9. Air pollution - increases in water use efficiency

10. Drought resistant crops - Threat to biodiversity

Ans

5. Natural forest fires - degradation of forests

6. Environmental impact assessment - standard tools for evaluation & development
projects

7. GEO-1 - substantiates the mud of world on
environmental
policies

8. Habitat fragmentation - Threat to biodiversity

9. Air pollution - Most serious environmental problem

10. Drought resistant crops - increases in water use efficiency

Lecture.8

Environmental pollution - definition, types of pollution, pollutant, types of pollutants

Pollution

Any undesirable change in the physical, chemical and biological properties of air, water and soil that adversely affects the life is called pollution. The pollution may be due to human activities or natural ecosystems. Natural pollution contaminates the air by storms, forest fire, volcanoes and natural processes (methane from marshy lands). Man-made pollutants threaten the integrity of the nature.

Types of pollution

The various types of pollution are classified based on the environment, based on sources of pollutant or nature of pollutants. Based on environment they are classified as Soil pollution, water pollution, and air pollution. Based on sources of pollutants, they are classified as automobile pollution, agricultural pollution and industrial pollution (tanneries, distilleries, nuclear power plants, chemical industries, etc.). Based on nature of pollutants, pollution is classified as pesticide pollution, plastic pollution, heavy metal pollution, radiation pollution, oil pollution, sewage pollution, noise pollution, etc.

Pollutants

Any substance present in concentrations high enough to cause adverse effect in the environment/living organisms. Substances that cause pollution is also called pollutants.

Environment Protection Act, 1986 (EPA, 1986) defines pollutant, as any solid, liquid or gaseous substance present in such a concentration as may be, or tend to be, injurious to environment.

Pollutants : Source and Effects

Source	Pollutants	Effect
Yard care/ Landscape Pollutants	• Fertilizers, weed killer, insecticide, fungicides, and grass, tree and shrub clippings wash to stormdrains or soak into groundwater when it rains	• Phosphorus and nitrogen from fertilizers cause algal blooms, which depletes water of oxygen, killing fish and aquatic life • Pesticides and herbicides can be harmful to humans and aquatic organisms (some are carcinogenic or attack the nervous system) • Loose grass clippings and leaves clog drainage systems and/or cause algal blooms in water
Automobile pollutants	• Oil, antifreeze, brake fluid, grease and metals on streets and driveways run off pavement to stormdrains or soak into groundwater • Nitrogen and other contaminants emitted from automobiles settle in water • Oil, grease, transmission fluids, etc. spilled from automobiles, trucks, buses, planes, etc. wash to stormdrain or creek	• Oil, petroleum products and other toxins from automobiles kill fish, plants, aquatic life and even people (contaminate drinking water). Used oil from a single oil change can ruin a million gallons of water-a year's supply for 50 people. • Some of these toxins and metals are absorbed in various aquatic life and can cause medical problems to humans when contaminated fish and shellfish are consumed. • Pollutants such as heavy metals and automobile fluids are toxic to aquatic life (interferes with photosynthesis, respiration, growth and reproduction).
Organic waste-once part of a living animal (feces or food)	• Failing sewer systems spilling out raw sewage after a heavy rain • Leaking or failing septic systems • Pet wastes not collected and disposed of appropriately • Pathogens from rotting food or dead animals • Discharge from food-processing plants, meat-packing houses, dairies and other industrial sources • Organic waste from fibers originating from textile and plant processing plants • Wastewater treatment plants	• Fecal coliform bacteria in pet droppings and septic tank overflows can cause infections and diseases by getting into drinking water and recreation areas • Pathogens from food and dead animals may also cause infections and diseases if they enter water sources • Phosphorus and nitrogen from organic material cause algal blooms, which depletes water of oxygen, killing fish and aquatic life
Household	• Improperly disposed paint, solvents	• Paint, cleaning supplies and other toxic

chemicals	and other chemicals runoff or soak into the ground • Household and commercial cleaning agents wash into water and stormdrains • Washing car	materials contaminate drinking water and kill fish, animals and plants • Detergents cause explosive plant and algae growth, which depletes water of oxygen, killing fish and animals as well as creating a terrible smell
Trash	• Litter washed into stormdrains, creeks, and groundwater	• Looks and smells unpleasant; can harm wildlife
Sediment	• Soil and sediment absorb toxins and transport them to creek beds and groundwater • Construction of new buildings, homes and streets causes excessive erosion • Paved roads cannot absorb chemicals, soil and suspended particles in runoff	• Sediment settles to the bottom of a creek or lake and prevents sunlight from reaching plants, clogs fish gills, chokes other organisms and can smother fish spawning and nursery areas
Pool chemicals	• Swimming pool water illegally discharged to a creek	• Chlorine kills aquatic life
Toxic runoff/ petrochemicals	• Grease and other toxins from restaurants, vehicles, machinery, cleaning products, garbage and toxic waste not disposed of properly • Fuel and oil spilled on the pavement washes to storm drains and/or bodies of water • Chemical spills or medical waste improperly managed	• Oil, petroleum products and other toxins from automobiles kill fish, plants, aquatic life and even people. One quart of oil will contaminate thousands of gallons of water because it doesn't dissolve • These toxins as well as trace metals and degreasing agents used on automobiles contaminate drinking water and can cause major illness • Some of these toxins and metals absorbed in various aquatic life cause medical problems in people when contaminated fish and shellfish are eaten.

Questions

Fill ups

1. Any undesirable change in the physical, chemical and biological properties of air, water and soil that adversely affects the life is called ---------------

Ans: Pollution

2. One example of industrial pollution -------------------

Ans: Tanneries/distilleries/ nuclear power plants /chemical industries

3. Environment protection act was passed in the year ---------

Ans: **1986**

4. Paint is the source of ----------------------- pollutant

Ans: household chemical

5. ------------------- bacteria is an indicator of drinking water pollution

Ans: coliform / E-coli

Match

6. Organic waste - source of heavy metal contamination in groundwater

7. Landscape pollutant - Deplete oxygen in water, kills fish and animals

8. Automobile industry - Biomedical (or) hospital wastes like carcasses, outdated medicines

9. Hazardous wastes - Once part of a living animal

10. Detergents - Fertilizers

Ans

6. Organic waste - Once part of a living animal

7. Landscape pollutant - Fertilizers

8. Automobile industry - source of heavy metal contamination in groundwater

9. Hazardous wastes - Biomedical (or) hospital wastes like carcasses, outdated medicines

10. Detergents - Deplete oxygen in water, kills fish and animals

Lecture.9

Air pollution, major air pollutants, source, effect and control measures

Air is necessary for the survival of all higher forms of life on earth. On an average, a person needs at least 30 lb of air every day to live, but only about 3 lb of water and 1.5 lb of food. A person can live about 5 weeks without food and about 5 days without water, but only 5 minutes without air. Naturally, everyone likes to breathe fresh, clean air. But the atmosphere, that invisible yet essential ocean of different gases called air, is as susceptible to pollution from human activities as are water and land environments.

Any undesirable change in the physical, chemical and biological properties of air that adversely affects the life is called air pollution. Air pollution may be simply defined as the presence of certain substances in the air in high enough concentrations and for long enough duration to cause undesirable effects. “Certain substances” may be any gas, liquid or solid, although certain specific substances are considered significant pollutants because of very large emission rates or harmful and unwanted effects. “Long enough durations” can be anywhere from a few hours to several days or weeks; on a global scale, durations of months and years are of concern.

Air pollution

Major air pollutants: Sources and Effects

Pollutant	**Sources**	**Effects**
Ozone. A gas that can be found in two places. Near the ground (the troposphere), it is a major part of smog. The harmful ozone in the lower atmosphere should not be confused with the protective layer of ozone in the upper atmosphere (stratosphere), which screens out harmful ultraviolet rays.	Ozone is not created directly, but is formed when nitrogen oxides and volatile organic compounds mix in sunlight. That is why ozone is mostly found in the summer. Nitrogen oxides come from burning gasoline, coal, or other fossil fuels. There are many types of volatile organic compounds, and they come from sources ranging from factories to trees.	Ozone near the ground can cause a number of health problems. Ozone can lead to more frequent asthma attacks in people who have asthma and can cause sore throats, coughs, and breathing difficulty. It may even lead to premature death. Ozone can also hurt plants and crops.
Carbon monoxide. A gas that comes from the burning of fossil fuels, mostly in cars. It cannot be seen or smelled.	Carbon monoxide is released when engines burn fossil fuels. Emissions are higher when engines are not tuned properly, and when fuel is not completely burned. Cars emit a lot of the carbon monoxide found outdoors. Furnaces and	Carbon monoxide makes it hard for body parts to get the oxygen they need to run correctly. Exposure to carbon monoxide makes people feel dizzy and tired and gives them headaches. In high concentrations it is fatal. Elderly people with heart disease are

	heaters in the home can emit high concentrations of carbon monoxide, too, if they are not properly maintained.	hospitalized more often when they are exposed to higher amounts of carbon monoxide.
Nitrogen dioxide. A reddish-brown gas that comes from the burning of fossil fuels. It has a strong smell at high levels.	Nitrogen dioxide mostly comes from power plants and cars. Nitrogen dioxide is formed in two ways—when nitrogen in the fuel is burned, or when nitrogen in the air reacts with oxygen at very high temperatures. Nitrogen dioxide can also react in the atmosphere to form ozone, acid rain, and particles.	High levels of nitrogen dioxide exposure can give people coughs and can make them feel short of breath. People who are exposed to nitrogen dioxide for a long time have a higher chance of getting respiratory infections. Nitrogen dioxide reacts in the atmosphere to form acid rain, which can harm plants and animals.
Particulate matter. Solid or liquid matter that is suspended in the air. To remain in the air, particles usually must be less than 0.1-mm wide and can be as small as 0.00005 mm.	Particulate matter can be divided into two types—coarse particles and fine particles. Coarse particles are formed from sources like road dust, sea spray, and construction. Fine particles are formed when fuel is burned in automobiles and power	Particulate matter that is small enough can enter the lungs and cause health problems. Some of these problems include more frequent asthma attacks, respiratory problems, and premature death.

	plants.	
Sulfur dioxide. A corrosive gas that cannot be seen or smelled at low levels but can have a “rotten egg” smell at high levels.	Sulfur dioxide mostly comes from the burning of coal or oil in power plants. It also comes from factories that make chemicals, paper, or fuel. Like nitrogen dioxide, sulfur dioxide reacts in the atmosphere to form acid rain and particles.	Sulfur dioxide exposure can affect people who have asthma or emphysema by making it more difficult for them to breathe. It can also irritate people's eyes, noses, and throats. Sulfur dioxide can harm trees and crops, damage buildings, and make it harder for people to see long distances.
Lead. A blue-gray metal that is very toxic and is found in a number of forms and locations.	Outside, lead comes from cars in areas where unleaded gasoline is not used. Lead can also come from power plants and other industrial sources. Inside, lead paint is an important source of lead, especially in houses where paint is peeling. Lead in old pipes can also be a source of lead in drinking water.	High amounts of lead can be dangerous for small children and can lead to lower IQs and kidney problems. For adults, exposure to lead can increase the chance of having heart attacks or strokes.
Toxic air pollutants. A large number of chemicals that are known or suspected to cause	Each toxic air pollutant comes from a slightly different source, but many	Toxic air pollutants can cause cancer. Some toxic air pollutants can also

cancer. Some important pollutants in this category include arsenic, asbestos, benzene, and dioxin.	are created in chemical plants or are emitted when fossil fuels are burned. Some toxic air pollutants, like asbestos and formaldehyde, can be found in building materials and can lead to indoor air problems. Many toxic air pollutants can also enter the food and water supplies.	cause birth defects. Other effects depend on the pollutant, but can include skin and eye irritation and breathing problems.
Stratospheric ozone depleters. Chemicals that can destroy the ozone in the stratosphere. These chemicals include chlorofluorocarbons (CFCs), halons, and other compounds that include chlorine or bromine.	CFCs are used in air conditioners and refrigerators, since they work well as coolants. They can also be found in aerosol cans and fire extinguishers. Other stratospheric ozone depleters are used as solvents in industry.	If the ozone in the stratosphere is destroyed, people are exposed to more radiation from the sun (ultraviolet radiation). This can lead to skin cancer and eye problems. Higher ultraviolet radiation can also harm plants and animals.

Greenhouse gases. Gases that stay in the air for a long time and warm up the planet by trapping sunlight. This is called the “greenhouse effect” because the gases act like the glass in a greenhouse. Some of the important greenhouse gases are carbon dioxide, methane, and nitrous oxide.	Carbon dioxide is the most important greenhouse gas. It comes from the burning of fossil fuels in cars, power plants, houses, and industry. Methane is released during the processing of fossil fuels, and also comes from natural sources like cows and rice paddies. Nitrous oxide comes from industrial sources and decaying plants.	The greenhouse effect can lead to changes in the climate of the planet. Some of these changes might include more temperature extremes, higher sea levels, changes in forest composition, and damage to land near the coast. Human health might be affected by diseases that are related to temperature or by damage to land and water.

Automobile emissions

The automobile, powered by piston-type internal combustion engine, is so widely used that it has become the dominant source of air pollutants in large urban cites.

Automotive engines generally operate on "fuel rich" mixtures, which mean that there is not quite enough oxygen to completely burn the fuel. As a result there is an excess of unburnt hydrocarbons, particularly along the cylinder walls, and substantial amounts of carbon monoxide. This efficient production of carbon monoxide has made automobiles the most important source of this poisonous gas in the urban atmosphere.

Automobile emissions

Many of the carcinogens found in the exhaust from diesel engines are polycyclic aromatic hydrocarbons (PAH) and are archetypical carcinogens. Best known of these is benzo-a-pyrene. Benzene represents a large part of the total volatile organic emissions from automobiles. Yet the compound is also recognized by many as imposing a substantial carcinogenic risk to modern society. Toluene, although by no means as carcinogenic as benzene, is also emitted in large quantities. Toluene proves a very effective compound at initiating photochemical smog and also reacts to form the eye irritant peroxybenzoyl nitrate. The highly dangerous compound dioxin can be produced in auto exhausts where chlorine is present (anti-knock agents often contain chlorine).

Many exotic elements that are added to improve the performance of automotive fuels produce their own emissions. The best known is the anti-knock agent tetraethyl lead, which was added in such large quantities that it became the dominant source of lead particles in the air. A wide range of long-term health effects, such as lowering IQ, have been associated with exposure to lead. Although lead in urban populations is still rather high, the use of unleaded gasoline has decreased the problem somewhat. Although huge quantities of fossil fuels are burnt in power generation and a range of industrial processes, automobiles make a significant and growing contribution to carbon dioxide emissions which enhance the greenhouse effect. The nitrogen oxides emitted by automobiles are ultimately converted to nitric acid and these are making an increasing contribution to rainfall acidity. Diesel-powered vehicles use fuel of higher sulfur content and can contribute to the sulfur compounds in urban air.

Thus while air pollution problems might well be cured by a wide range of sociological changes, a technological fix has been favoured, such as the use of catalytic converters. Although much attention is being given to lowering emissions of volatile organic compounds, it is likely that non-polluting vehicles will have to be manufactured and better a mass transmit system created.

Effects of ambient air pollution

Air pollution is known to have many adverse effects, including those on human health, buildings and other exposed materials, vegetation, agricultural crops, animals, aquatic and terrestrial ecosystems, and the climate of earth as a whole.

Health effects

Perhaps the most important effect of air pollution is the harm it causes to human health. Generally, air pollution is most harmful to the very old and the very young. Many elderly people may already suffer from some form of heart or lung disease, and their weakened condition can make them very susceptible to additional harm from air pollution. The sensitive lungs of new born infants are also susceptible to harm from dirty air. But it is not just the elderly or the very young who suffer; healthy people of all ages can be adversely affected by high levels of air pollutants. Major health effects are categorized as being acute, chronic, or temporary.

There is much evidence linking lung cancer to air pollution, although the actual cause-and – effect relationship is still unknown. Typical effects of sulfur dioxide, oxides of nitrogen, and ozone include eye and throat irritation, coughing and chest pain. Nitrogen dioxide is known to cause pulmonary edema, an accumulation of excessive fluids in the lungs. Ozone, a highly irritating gas, produces pulmonary congestion; symptoms of ozone exposure may include dry throat, headache, disorientation, and altered breathing patterns.

Air Pollution control strategies

There are several approaches or strategies for air pollution control. The most effective control would be to prevent the pollution from occurring in the first place.

Complete source shutdown would accomplish this, but shutdown is only practical under emergency conditions, and even then it causes economic loss. Nevertheless, state public health officials can force industries to stop operations and can curtail highway traffic if an air pollution episode is imminent or occurring.

Another option for air pollution control is source location in order to minimize the adverse impacts in a particular locality. An important approach for air pollution control is to encourage industries to make fuel substitutions or process changes. For example, making more use of solar, hydroelectric, and geothermal energy would eliminate much of the pollution caused by fossil fuel combustion at power generating plants. Nuclear power would do the same, but other problems related to high level radioactive waste disposal and safety remain to be solved.

Fuel substitutions are also effective in reducing pollution from mobile sources. For example, the use of reformulated gasoline or alternative fuels such as liquefied petroleum gas, compressed natural gas, or methanol for highway vehicles would help to clear the air. The use of correct operation and maintenance practices is important for minimizing air pollution and should not be overlooked as an effective control strategy.

Air pollution control strategies can be divided into two categories, the control of particulate emissions and the control of gaseous emissions. There are many kinds of equipment which can be used to reduce particulate emissions. Physical separation of the particulates from the air using settling chambers, cyclone collectors, impringers, wet scrubbers, electrostatic precipitators, and filtration devices, are some processes that are typically employed. Gaseous emissions are controlled by similar devices and typically can be used in conjunction with particulate control options, such as scrubbers, adsorption systems, condensers, flares, and incinerators.

Scrubbers utilize the phenomena of adsorption to remove gaseous pollutants from the air stream. There is a wide variety of scrubbers available for use, including spray towers, packed towers, and venturi scrubbers. A wide variety of solutions can be used in this process as absorbing agents. Lime, magnesium oxide, and sodium hydroxide are typically used.

Adsorption can also be used to control gaseous emissions. Activated carbon is commonly used as an adsorbent in configurations such as fixed bed and fluidized bed absorbers. Another means of controlling both particulate and gaseous air pollutant emission can be accomplished by modifying the process which generates these pollutants. For example, modifications to process equipment or raw materials can provide effective source reduction. Also, employing fuel cleaning methods such as desulfurization and increasing fuel-burning efficiency can lessen air emissions.

Global Air Pollution

Air pollution problems are not necessarily confined to a local or regional scale. Atmospheric circulation can transport certain pollutants far away from their point of origin, expanding air pollution to continental or global scales; it can truly be said that air quality problems know no international boundaries. Some air pollutants are known to be associated with changes in earth's climate, requiring consideration of governmental actions to limit their impacts. Two important air pollution problems that are generally considered worldwide in scope are global warming and depletion of stratospheric ozone.

Questions

1. On an average a person needs at least ------- of air everyday to live.

Ans: 30 lb

2. --------------- is a reddish –brown gas that comes from burning of fossil fuels.

Ans: Nitrogen- di-oxide

3. Particulate matter can be divided into ----------- and ----------- particles

Ans: coarse, fine

4. One example of carcinogenic gas is -----------------

Ans: Arsenic/Asbestos/ benzene / dioxin

5. --------------------is commonly used as an adsorbent in fixed bed and fluidized bed absorbers

Ans: Activated carbon

Match

6. Global warming - Chloro fluorocarbons (CFC's)
7. Scrubbers - Rotten egg smellers.
8. Paddy field - Air pollution problems
9. Stratospheric ozone depletion - Source of methane gas
10. H_2S - Removes gaseous pollutant from air stream

Ans

6. Global warning - Air pollution problems
7. Scrubbers - Removes gaseous pollutant from air stream
8. Paddy field - Source of methane gas
9. Stratospheric ozone depletion - Chloro fluorocarbons (CFC's)
10. H_2S - Rotten egg smellers.

Lecture.10

Criteria air pollutants, Air Quality Index (AQI), National ambient air quality standards. Important air pollution events

Criteria Air Pollutants 'Criteria air pollutants' is a term used internationally to describe air pollutants that have been regulated and are used as indicators of air quality.

The five primary criteria pollutants include the gases- sulfur dioxide (SO_2), nitrogen oxides (NO_x) and carbon monoxide (CO), solid or liquid particulates (smaller than 10 µm), and particulate lead.

1. Sulfur dioxide

Certain fossil fuels, particularly coal, may contain the element sulfur. When these fuels are burned for power or heat, the sulfur is also burned or oxidized. Sulfur dioxide is a colorless gas with a sharp, choking odour. It is a primary pollutant because it is emitted directly in the form of SO_2. The sulfuric acid (H_2SO_4) mist is a secondary pollutant because it is not emitted directly, but is formed subsequently in the atmosphere. It is a constituent of acid rain, an important regional air pollution problem.

2. Nitrogen oxides

There are many forms of nitrogen oxides (characterized collectively as NO_x), but the one that is of greatest importance is nitrogen dioxide (NO_2). Most emissions are initially in the form of nitric oxide (NO), which by itself is not harmful at concentrations usually found in the atmosphere. But NO is readily oxidized to NO_2, which in the presence of sunlight can further react with hydrocarbons to form photochemical smog. Smog is, of course, harmful. NO_2 also reacts with the hydroxyl radical (OH^-) to form nitric acid (HNO_3), which contributes to the problem of acid rain. Although NO is colorless, NO_2 is pungent, irritating gas that tends to give smog a reddish brown color.

3. Carbon Monoxide

During complete combustion of fossil fuels, carbon atoms in the fuel combine with oxygen molecules to form carbon dioxide (CO_2). But the process of combustion is rarely complete. Incomplete combustion of the fuel may occur when the oxygen supply is insufficient, when the combustion temperatures are too low, or when residence time in the combustion chamber is too short. Carbon monoxide (CO), a product of incomplete combustion, is the most abundant of the criteria air pollutants.

Carbon monoxide is completely invisible; it is colorless, odorless, and tasteless. Almost 70 per cent of the total carbon monoxide emissions come from highway vehicles, and atmospheric concentrations are very much a function of urban traffic patterns. CO levels, which typically range from 5 to 50 ppm in city air, may often reach 100 ppm on congested highways (cigarette smoke contains more than 400 ppm of carbon monoxide).

4. Solid or liquid particulates

Extremely small fragments of solids or liquid droplets suspended in air are called particulates. Most particulates range in size from 0.1 to 100 µm (one micrometer, or 1 µm, is one millionth of a meter; it may also be called a micron). The particulate materials of most concern with regard to adverse effects on human health are generally less than 10 µm in size and are referred to as PM_{10}.

Suspended solids roughly 1 to 100 µm in size are called dust particles, while smaller suspended solids (less than 1 µm) may be called either smoke or fumes. Dust is formed from materials handling activities or mechanical operations, including grinding, wood working, and sandblasting. Smoke is a common product of incomplete combustion; smoke particles consist mostly of carbonaceous material. Fumes, usually consisting of very small metallic oxide particles, are typically formed during certain high temperature chemical reactions and vapor condensation.

5. Lead particulates

This toxic metal, in the form of a fume (less than 0.5 µm in size), is one of the criteria pollutants. In the past, major sources of lead (Pb) fumes were motor vehicles that burned gasoline containing a lead based antiknock additive. Young children are particularly at risk from lead poisoning because even slightly elevated levels of lead in the blood cause learning disabilities, seizures, permanent brain damage, and even death.

National Ambient Air Quality Standards (NAAQS) (Source: USEPA)

Pollutant	**Primary Stds.**	**Averaging Times**	**Secondary Stds.**
Carbon Monoxide	9 ppm	8-hour	None
	35 ppm (40 mg/m^3)	1-hour	None
Lead	1.5 µg/m^3	Quarterly Average	Same as Primary
Nitrogen Dioxide	0.053 ppm (100 µg/m^3)	Annual (Arithmetic Mean)	Same as Primary
Particulate Matter (PM$_{10}$)	50 µg/m^3	Annual (Arith. Mean)	Same as Primary
	150 ug/m^3	24-hour	
Particulate Matter (PM$_{2.5}$)	15 µg/m^3	Annual (Arith. Mean)	Same as Primary
	65 ug/m^3	24-hour	
Ozone	0.08 ppm	8-hour	Same as Primary
	0.12 ppm	1-hour	Same as Primary
Sulfur Oxides	0.03 ppm	Annual (Arith. Mean)	-------
	0.14 ppm	24-hour	-------

	-------	3-hour	0.5 ppm (1300 ug/m^3)

The **Air Quality Index** (**AQI**) (also known as the **Air Pollution Index** (**API**) or **Pollutant Standard Index** (**PSI**)) is a number used by government agencies to characterize the quality of the air at a given location. As the AQI increases, an increasingly large percentage of the population is likely to experience increasingly severe adverse health effects. To compute the AQI requires an air pollutant concentration from a monitor or model. The function used to convert from air pollutant concentration to AQI varies by pollutant, and is different in different countries. Air quality index values are divided into ranges, and each range is assigned a descriptor and a color code. Standardized public health advisories are associated with each AQI range. An agency might also encourage members of the public to take public transportation or work from home when AQI levels are high.

Important Air Pollution Episodes

1. London Smog 1952 (4000 deaths)
2. Black Fog 1962 (400 deaths)
3. Killer Smog of Donora 1984 (steel industry, wire plank and H_2SO_4 plants)
4. The Meuse valley Disaster Belgium 1930 (Sulphate, inorganic acids, Metallic oxidants)
5. The Inter State suit Duck town, Tennesse 1900.
6. Pittsburgh (Alleghency country) Pennsylvania.
7. Before 1948, Pittsburgh was nick named as ‘Smoke city’.
8. Bay of smoker, Los Angeles, California 1958.

9. Bhopal Gas Tragedy 1984, December 2, Methyl Iso Cyanate termed as one of the world’s ever severe industrial accident.

10. Sri Ram food and Fertilizer Ltd., Delhi 1987, Oleum gas leakage.

11. National fertilizer plant, Paripat (Haryana) Ammonia gas, 1992.

12. The Chernobyl Disaster, USSR 1986, Ukraine 50,000 people had to be evacuated, large tracts of agricultural land in various combine remain inhospitable for many years 1000 of tones of vegetables and milks were destroyed radioactivated cattle’s were slaughtered.

Questions

1. ---------------------- are used as indicators of air quality

Ans: Criteria Air pollutants

2. The size of the solid or liquid particulates ranges smaller than ----------µm

Ans: 10

3. -------------------- is an example for secondary pollutant

Ans: Sulfuric acid mist/Ozone/PAN

4. ---------- is a common product of incomplete combustion of carbonaceous material

Ans: smoke

<u>Match</u>

5. Constituent of acid rain - Carbon monoxide

6. Completely invisible gas - National ambient air quality standards

7. USEPA - Sulphur dioxide

<u>Ans</u>

5. Constituent of acid rain - Sulphur dioxide

6. Completely invisible gas - Carbon monoxide

7. USEPA - National ambient air quality standards

True / False

8. Nitrogen oxides is the most abundant of the criteria air pollutants

Ans: False (carbon monoxide)

9. Major sources of lead are automobiles

Ans: True

10. The toxic gas emitted at Bhopal (gas tragedy) was Methyl thiocyanate

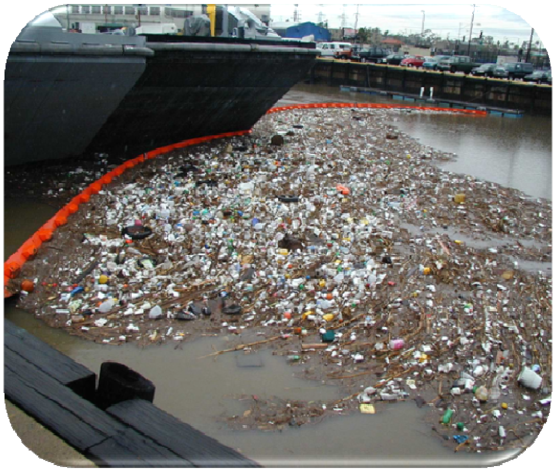
Ans: False (Methyl iso cyanate)

Lecture.11

Water pollution, source, effect and control measures, water quality standards, eutrophication

Water like air, is an indispensable and one of the most precious of natural resources on this planet. Most of our water bodies such as ponds, lakes, streams and river have become polluted as a consequence of increasing industrialization, urbanization and other development activities. Water has such a strong tendency to dissolve other substances and sometimes referred to as the universal solvent. This is largely because of its polar molecular structure. Pure water (pure H_2O) is not found under natural conditions in streams, lakes, ground water, or the oceans. It always has something dissolved or suspended in it. Because of this, there is not any definite line of demarcation between clean water and contaminated water.

In general terms, water is considered to be polluted when it contains enough foreign material to render it unfit for specific beneficial use, such as for drinking, recreation, or fish propagation. Actually human activity is the cause of the poor water quality and cause water pollution. The water pollution is defined as addition of any substances that alter the physical and chemical characteristics of water in any way which interferes with its use for legitimate purposes.



Water pollution

Classification of water pollutants

To understand the effects of water pollution and the technology applied in its control, it is useful to classify pollutants into various groups or categories. First, a pollutant can be classified according to the nature of its origin as either a **point source** or a **dispersed source pollutant (non point source)**.

A point source pollutant is one that reaches the water from a pipe, channel or any other confined and localized source. The most common example of a point source of pollutants is a pipe that discharges sewage into a stream or river. Most of these discharges are treatment plant effluents.

A dispersed or non point source is a broad, unconfined area from which pollutants enter a body of water. Surface runoff from agricultural areas carries silt, fertilizers, pesticides, and animal wastes into streams, but not at only one particular point. These materials can enter the water all along a stream as it flows through the area. Acidic runoff from mining areas is a dispersed pollutant. Storm water drainage systems in towns and cities are also considered to be dispersed sources of many pollutants, because, even though the pollutants are often conveyed into streams or lakes in drainage pipes or storm sewers, there are usually many of these discharges scattered over a large area.

Point source pollutants are easier to deal with while pollutants from dispersed sources are much more difficult to control. Many people think that sewage is the primary culprit in water pollution problems, but dispersed sources cause a significant fraction of the water pollution. The most effective way to control the dispersed sources is to set appropriate restrictions on land use. For example, the following list identifies nine specific types of water pollutants.

1. Pathogenic organisms, 2. Oxygen – demanding substances, 3. Plant nutrients, 4. Toxic organics, 5. Inorganic chemicals, 6. Sediment, 7. Radioactive substances, 8. Heat, 9. Oil

Domestic sewage is a primary source of the first three types of pollutants. **Pathogens,** or disease – causing microorganisms, are excreted in the feces of infected persons and may be carried into waters receiving sewage discharges. Sewage from communities with large populations is very likely to contain pathogens of some type.

Sewage also carries **oxygen-demanding substances**, the organic wastes that exert a biochemical oxygen demand as they are decomposed by microbes. BOD changes the ecological balance in a body of water by depleting the dissolved oxygen (DO) content. Conventional sewage treatment processes significantly reduce the amount of pathogens and BOD in sewage, but do not eliminate them completely. Certain viruses, in particular, may be somewhat resistant to the sewage disinfections process. To decrease the amounts of nitrogen and phosphorous in sewage, usually some form of advanced sewage treatment must be applied.

Toxic organic chemicals, primarily pesticides, may be carried into water in the surface runoff from agricultural areas. Perhaps the most dangerous type is the family of chemicals called chlorinated hydrocarbons. They are very effective poisons against insects that damage agricultural crops. Unfortunately, they can also kill fish, birds, and mammals, including humans. And they are not very biodegradable, taking more than 30 years in some cases to dissipate from the environment.

Toxic organic chemicals can also get into water directly from industrial activity, either from improper handling of the chemicals in the industrial plant or, as has been more common, from improper and illegal disposal of chemical wastes. Proper management of toxic and other hazardous wastes is a key environmental issue, particularly with respect to the protection of groundwater quality. Poisonous inorganic chemicals, specifically those of the heavy metal group, such as lead, mercury, and chromium, also usually originate from industrial activity and are considered hazardous wastes.

Oil is washed into surface waters in runoff from roads and parking lots, and ground water can be polluted from leaking underground tanks. Accidental oil spills from large transport tankers at sea occasionally occur, causing significant environmental damage. Blowout accidents at offshore oil wells can release many thousands of tons of oil in a short period of time. Oil spills at sea may eventually move toward shore, affecting aquatic life and damaging recreation areas.

Sources and impacts of water pollution

There are many causes for water pollution but two general categories exist: direct and indirect contaminant sources.

Direct sources include effluent outfalls from factories, refineries, waste treatment plants etc. that emits fluids of varying quality directly into urban water supplies.

Indirect sources include contaminants that enter the water supply from soils/groundwater systems and from the atmosphere via rain water. Soils and groundwaters contain the residue of human agricultural practices (fertilizers, pesticides, etc.) and improperly disposed of industrial wastes. Atmospheric contaminants are also derived from human practices (such as gaseous emissions from automobiles, factories)

Contaminants can be broadly classified into organic, inorganic, radioactive and acid/base. Examples from each class and their potential sources are too numerous to discuss here. Some of the sources of water pollution are as follows;

1. Sewage and other oxygen demanding wastes which contain decomposable organic matter and pathogens.
2. Industrial wastes (metal salts to complex synthetic organic chemicals).
3. Agricultural waste and agricultural inputs (fertilizer, pesticides, biocides).
4. Physical pollutants (heat and radioactive substances).

1. Sewage and other oxygen demanding wastes

Sewage is defined as the waterborne waste derived from home (domestic wastes) and animal or food processing plants which includes human excreta, soaps, detergents, paper and cloth. Water pollution is caused by uncontrolled dumping of wastes of villages, towns and cities into ponds, lakes, streams or rivers. The discharge of sewage into water bodies results into the following.

Sewage water pollution

a. Depletion of oxygen contents

Dissolved oxygen is the total amount of oxygen dissolved in water. Oxygen depletion is caused by aerobic bacteria in the decomposition of organic matter. The quantity of oxygen utilized by bacteria in degradation of organic substances is called **biological oxygen demand**. Also it can be defined as the amount of oxygen required by the bacteria to stabilize the organic matter. On an average basis, the demand for oxygen i.e. BOD value, is proportional to the amount of organic waste present in water. The BOD value can be a measure of waste strength and also an indicates of degree of pollution. Along with BOD, the quantity of oxygen dissolved in a body of water (DO) is indicated by the kind of biotic life, which lives there. When dissolved oxygen is reduced below 4 to 5 ppm of water, fish are scarce. BOD test should be restricted to only suitable wastes in management of treatment plants. However for other kinds of wastes chemical oxygen demand (COD) values would be more appropriate.

COD: “It is the amount of oxygen required by organic matter in a sample of water for its oxidation by a strong chemical oxidant and is expressed as ppm of oxygen taken from a solution of potassium dichromate in two hours”.

b. Stimulation of algal growth

A major ingredient of most detergents is phosphate. When discharged into water, the phosphate supports luxuriant growth or blooms of algae. Extensive growth of algae often withdraws great quantities of oxygen from water to the detriment of other organisms and produces bad odour when decay. In a poorly oxygenated condition, with increased CO_2, fishes and other animals die and clean river is turned into a stinking drain. (Eutrophication)

c. Spreading infectious diseases

Microorganisms, usually viruses, bacteria some protozoans and helminthes occur in water bodies as a result of sewage disposal therein spread several infectious diseases. The degree of water pollution is assessed by the presence of Escherichia coli. Their quantity in water is indicative of the degree of pollution due to animal and human excrements. On the basis of number of E. coli in water body the degree of water pollution may be distinguished as

Drinking water	3/ lit
Satisfactory quality	10/lit
Polluted water	>100/lit

Eighty per cent of the diseases in India and other developing countries are linked with contaminated water.

2. Industrial wastewater

Most of the rivers and fresh water streams which pass near the major cities are polluted by industrial wastes of effluents. Effluents from these contain a wide variety of both inorganic and organic pollutants such as oils, greases, plastics, methylic wastes, suspended solids, phenols, toxins and other chemical substances, many of which are not readily susceptible to degradation and cause very serious pollution problems. Arsenic, cadmium, copper, chromium, mercury, zinc and nickel are some of the most common heavy metals discharged from industries.

Mercury: The safe level of mercury in surface water for domestic use as prescribed by Central Pollution Control Board, New Delhi is <0.002 ppm, the limit prescribed by the WHO is <0.001 ppm. Mercury poisen – minantta disease or cat tail dance syndrome

Fluoride: Sources of fluorine compounds are nature, man's activities and other air borne sources. According to WHO, fluoride concentration below 0.5 ppm causes dental caries and mottling of teath. But when fluoride level exceeds 0.5 ppm over a period of 5-10 years may result in fluorosis or paralysis-fluoride is not absorbed in the blood stream. It has an affinity for calcium and gets accumulated in bones resulting pain in bones and joints and outward bending of legs from the knees (knock knee syndrome)

Lead: Lead poisoning is common in adults. Lead and processing industries constitute the major sources of serious lead pollution. Lead pollution causes gastrointestinal troubles, neuromuscular effects and affects central nervous system (CNS - Central Nervous Syndrome) also.

Cadmium: Causes Itai – Itai (or) ouch-ouch disease to human beings

The discharge of industrial waste results into the following

i. Organic substances deplete the oxygen content.

ii. Inorganic substances render the water unfit for drinking and other purposes.

iii. Acids and alkalies adversely affect the growth of fish and other aquatic life.

iv. Toxic substances like cyanide, phenol and other heavy metals cause damage to flora and fauna.

v. Oil and other greasy floating substances interfere with breathing system of aquatic life.

3. Agricultural waste

Modern agricultural practices require the use of large amount of fertilizers, pesticides and other soil additives. Some of these along with waste are washed off lands through irrigation, rainfall, drainage and leaching into the rivers and streams where they can seriously disturb the aquatic ecosystem. Depletion of dissolved oxygen caused by phosphate induced algal growth leads to death of fish and other aquatic biota. In presence of phosphates, nitrates too bring about an exaggerate growth of vegetation.

a. Nitrate pollution

Excessive and indiscriminate use of chemical fertilizers and synthetic feed for livestock often lead to accumulation of nitrates in water. When such waters are drunk by cattle or humans these nitrates taken into body are converted to toxic nitrites by intestinal bacteria. This in turn combines with the hemoglobin to form methaemoglobin, which interferes with the oxygen-carrying capacity of the blood, producing a serious disease known as methaemoglobinaemia. The various ailments that result from this disease include damage to respiratory and vascular system, blue colouration of the skin (Blue baby syndrome) and even cancer. A person in good health contains 0.8% of methaemoglobin. Symptoms of methaemoglobinaemia can be perceived as soon as the mathaemoglobin reaches a level of 10 per cent in the blood.

The WHO laid down the permissible concentration of NO_3 in water at 45 mg L^{-1}. Nitrates could become toxic when it occurred in association with sulphates.

b. Eutrophication

The non-flowing water bodies such as ponds or lakes during their early stages of formation are relatively barren and deficient in nutrients to support the aquatic life and are referred to as oligotrophic (nutrient poor). With the passage of time, organic substances from the surrounding areas accumulate and the water body becomes highly productive or Eutrophic. A comparative account of Oligotrophic and Eutrophic lakes is given below:

Eutrophication thus denotes the enrichment of a water body by input of organic material of surface run off containing nitrates and phosphates. This may happen naturally but very slowly, often over a period of hundreds of years. Human activity generally responsible for rapid eutrophication as domestic waste, agricultural and land drainage and organic industrial waste or their decomposition products reach the water bodies and induce the productivity and composition of aquatic life. Eutrophication leads to increase in the growth of aquatic plants and often to algal blooms. The extensive algal growth have resulted in killing of fishes by interfering with recreation, excluding light intensity necessary for photosynthesis by other aquatic plants and thereby preventing the release of oxygen into the water or depleting the oxygen through decay or respiration with bloom. Some algal bloom release toxic substances that kill fishes, domestic animals and birds and water begins to stink.

Lake Erie (USA) is an excellent example of eutrophication from man's activities. In 1965, 87t of phosphates were dumped into the lake leading to the development of 350 t of algal slime. The various measures suggested to step eutrophication are as follows:

1. Treatment of waste water in order to minimize nutrient inputs.
2. Reduction in the amount of nutrient solubilized in water through stimulation of bacterial multiplication.
3. Harvesting and removal of algal blooms to check recycling of nutrients into the water.
4. Removal of dissolved nutrients from water physically or chemically. Phosphorus can be removed by various methods of precipitation. Nitrogen can be removed by (a) ion exchange, (b) electrodialysis, (c) reverse osmosis and (d) denitrification

4. Physical pollutants

Chemical industries, fossil fuel and nuclear power plants use lot of water for cooling purposes and return this water to stream at a high temperature. The hot water interferes with the natural conditions in the lake and river affecting aquatic life. This is a thermal pollution as heat acts as a pollutant. The thermal pollution is thus the raising of temperature of part of the environment (water in this case) by the discharge of substances whose temperature is higher than the ambient. Some plants and animals are killed outright by the water, if it is very hot some of the adverse environmental effects of the thermal pollution are:

i. Fish eggs hatch so early.
ii. Trout eggs commonly fail to hatch.
iii. BOD increases as warm water holds less oxygen.
iv. Change in diurnal and seasonal behaviour of organisms.
v. Decrease in species diversity.
vi. Affects migration of some aquatic life.

Prevention and control of water pollution

Natural purification of chemically contaminated groundwater can take decades and perhaps centuries, and cleanup efforts are sometimes much too expensive to be practical. The best way, then, to control groundwater pollution is to prevent it from occurring in the first place. Laws related to solid and hazardous waste disposal now significantly reduce new contamination. Not only are physical barriers between the waste and the groundwater required, but monitoring wells must be installed in some cases to provide early warning of possible leakage.

Land-use management applied on the local level by towns and cities can be effective in preventing aquifer contamination. For example, zoning ordinances that prevent residential or industrial development in areas that are known groundwater recharge zones can reduce pollution problems. Strict enforcement of regulations pertaining to the siting, design, and construction of septic systems can reduce or eliminate the incidence of sewage contamination of private wells. Prudent application of pesticides and fertilizers in agricultural areas can also be effective in this regard. Control of water bodies and of organism serving the purpose of water protection should be reinforced and carried out by all available means including legal enforcement under the provisions laid down in water (prevention and control of pollution) Act 1974 and Environmental (protection) Act, 1986. The various ways / techniques suggested for prevention and control of water pollution are as follows.

1. Stabilization of Ecosystem

This is the most reliable way to control water pollution. This would involve reduction in waste input, trapping of nutrients, fish management and aeration. Some of species of algae such as chlorella spirulina are excellent biological oxidants that can be used to reduce pollution load in a water body. Water hyacinth, *Eichhornia crassipes* , a luxuriantly growing weed may also be employed to remove phosphorus, nitrogen from a water body. It can also reduce BOD, COD and organic carbon.

2. Reutilization and recycling of waste

Various kinds of wastes such as paper pulp, municipal and industrial effluents, sewage and thermal pollutants can be recycled to advantage. For example, urban waste could be recycled to generate cheaper fuel gas and electricity.

3. Removal of pollutants

The various physico-chemical devised for removal of chemical, biological or radiobiological pollutants involve adsorption, electrodialysis, ion exchange and reverse osmosis. Of the various techniques, reverse osmosis deserves special mention. This technique is based on the removal of salts and other substances from water by forcing the later through a semi permeable membrane under a pressure that exceeds the osmotic pressure so that flow is in the reverse direction to the normal osmotic flow. Techniques devised by CSIR for the control of water pollution have been successfully employed for the removal and reuse of pollutants from industrial effluents.

a. Removal of ammonia from industrial waste water: Ammonia is removed in the form of ammonium sulphate which can be reused for the manufacture of fertilizer.

b. Removal of mercury: Mercury thrown out from chlor-alkali plants is removed and recovered by mercury –selective ion exchange resin.

c. Removal of phenolics: Phenolics in waste water from pulp, paper mill, petroleum refineries, tanneries etc are removed by the use of polymeric adsorbents.

d. Decolorization of water: An electrolyte decomposition technique has been developed to decolorize the sample of saree dying and printing industries.

e. Removal of sodium salts: Reverse osmosis technique has been developed to recover sodium sulphate from rayon mill effluent.

Water quality standards

Water quality standards are benchmarks established to assess whether the quality of rivers and lakes is adequate for fish and other aquatic life, recreation, drinking, agriculture, industry and other uses.

International standard for drinking water quality (WHO)

Sl.No	Parameter	Units	Maximum permissible limit
1	pH	-	6.5-9.2
2	Ar	mg L^{-1}	0.05
3	NH_3	mg L^{-1}	0.5
4	BOD	mg L^{-1}	6.0
5	Ca	mg L^{-1}	100
6	Cd	mg L^{-1}	0.01
7	Cr	mg L^{-1}	0.05
8	Cu	mg L^{-1}	1.5
9	Cl	mg L^{-1}	500
10	Cyanide	mg L^{-1}	0.05
11	COD	mg L^{-1}	10
12	Fe	mg L^{-1}	1.0
13	Pb	mg L^{-1}	0.1

14	Mg	mg L^{-1}	150
15	Mn		0.5
16	Hg	mg L^{-1}	0.001
17	Nitrate and Nitrite	mg L^{-1}	45
18	Phenol	mg L^{-1}	0.002
19	PAH	mg L^{-1}	0.2
20	Pesticides	mg L^{-1}	-
21	*E. coli*	-	10/100ml
22	Total hardness	mg L^{-1}	500
23	TDS	mg L^{-1}	500

Irrigation Water Quality Standards (for discharge)

S.No.	Parameter	Inland surface water
1.	Colour and odour	colorless and odorless
2.	Suspended Solids, mg/l, Max	100
3.	Particle size of suspended solids	Shall pass 850 micron IS Sieve
4.	Dissolved solids (inorganic), mg/l	2100
5.	pH value	5.5 to 9.0
6.	Temperature °C, Max	Shall not exceed 40 in any section of the stream within 15 meters down stream from the effluent outlet
7.	Oil and grease, mg/l, max	10

8.	Total residual chlorine, mg/l, Max.	1.0
9.	Ammonical nitrogen (as N), mg/l, Max.	50
10.	Total Kjeldahl nitrogen (as N), mg/l, Max.	100
11.	Free Ammonia (as NH_3), mg/l, Max.	5.0
12.	Biochemical Oxygen Demand (5 days at 20°C) Max.	30
13.	Chemical Oxygen Demand, mg/l, Max.	250
14.	Arsenic (as As), mg/l, Max.	0.2
15.	Mercury (as Hg), mg/l, Max.	0.01
16.	Lead (as Pb), mg/l, Max.	0.1
17.	Cadmium (as Cd), mg/l, Max.	2.0
18.	Hexavalent chromium (as Cr+6) mg/l, Max.	0.1
19.	Total chromium as (Cr), mg/l, Max.	2.0
20.	Copper (as Cu), mg/l, Max.	3.0
21.	Zinc (as Zn), mg/l, Max.	5.0
22.	Selenium (as Se), mg/l, Max.	0.05
23.	Nickel (as Ni), mg/l, Max.	3.0
24.	Boron (as B), mg/l, Max.	2.0
25.	Percent Sodium, Max.	---

26.	Residual sodium carbonate, mg/l, Max.	---
27.	Cyanide (as CN), mg/l, Max.	0.2
28.	Chloride (as Cl), mg/l, Max.	1000
29.	Fluoride (as F), mg/l, Max.	2.0
30.	Dissolved Phosphates (as P), mg/l, Max.	5.0
31.	Sulphate (as SO_4), mg/l, Max.	1000
32.	Sulphide (as S), mg/l, Max.	2.0
33.	Pesticides	Absent
34.	Phenolic compounds (as C_6H_5OH), mg/l, Max.	1.0
35.	Radioactive materials	
	(a)Alpha emitters MC/ml, Max. (b) Beta emitters uc/ml, Max.	10^{-7} 10^{-6}

Questions

1. Domestic sewage carries ------------------- substances

Ans: oxygen – demanding

2. An example of point source water pollution is ----------------------

Ans: Factories, Refineries or any factory waste water let out

3. The quantity of oxygen utilized by bacteria in degradation of organic substances is called ------

Ans: Biological Oxygen Demand

4. The faecal pollution of water is assessed by the presence of --------------------- organism.

Ans: *Escherichia coli*

Match

5. Lead poisoning - Cat-tail dance syndrome

6. Mercury poisoning - Itai – Itai disease

7. Cadmium - Gastrointestinal

Ans

5. Lead poisoning - Gastrointestinal

6. Mercury poisoning - Cat-tail dance syndrome

7. Cadmium - Itai – Itai disease

True / False

8. WHO laid down the permissible concentration of NO_3 in water as 45 mg/l

Ans: True

9. *Spirulina* is an excellent example for biological reductants

Ans: False

10. Ion – exchange technique is used to recover sodium sulphate from rayon mill effluent

Ans: False (Reverse osmosis)

Lecture.12

Soil pollution, source, effect and control measures

Soil is the loose and unconsolidated outer layer of earth's crust that is powdery in nature and made up of small particles of different sizes. Soil ecosystem includes inorganic and organic constituents, and the microbial groups. Soil microorganisms are the active agents in the decomposition of plant and animal solid wastes and said to be nature's garbage disposal system. The soil microbes keep our planet earth free of unwanted waste materials and recycle the elements (C, N, and P) through mineralization. Soil microbes decompose a variety of compounds, cellulose, lignin, hemi cellulose, proteins, lipids, hydrocarbons etc. The soil microbial community has little or no action on many man-made synthetic polymers. The persistent molecules that fail to be metabolized or mineralized have been termed as **recalcitrants.**

An undesirable change in the physical, chemical or biological characterization of soil may harmfully affect the life or create a potential health hazard of any living organisms.

Soil pollution could result from a whole range of situations, and can have lasting effects on all types of ecosystems and human health. Soil may become contaminated through dry deposition or by toxins becoming integrated into in the ground water.

Soil Pollutants

- Acid rain : Oxides of sulphur and nitrogen
- Heavy metals: Lead, Cadmium, Chromium, Copper, Nickel, Arsenic, Titanium, Mercury, Selenium etc.
- Industrial wastes
- Sewage
- Agricultural wastes: Fertilizers, Pesticides, Herbicides, Other Chemicals
- Volcanoes
- Oil, grease and other petroleum products
- Asbestos

- Other solid wastes

Paper and paper products, Polythene bags and covers, Oil cans , Cloth wastes, Tires, Carcasses, Radioactive wastes, Municipal solid wastes, Hospital wastes, Animal wastes, Plastics, glass and other bio non degradable wastes, Crop residues

Plastics

Plastics form a major part of global domestic and industrial waste. Not being biodegradable, waste plastic accumulates, adding to pollution. In USA plastic are 7% in weight of all solid waste but 30% of the volume. Standard plastic takes several hundreds of years to disintegrate, over 400 years for the plastic bottles used for mineral water.

Plastics pollution

Using photodegradable plastic or biodegradable plastic can solve plastic pollution problem. Photodegradable plastic contains an element sensitive to UV rays. Under the effect of solar rays the element is activated and breaks the polymeric chain of the photodegradable plastic. It results in small fragments that are easily digested by microbes.

Biodegradable plastic

Biodegradable plastic is made by adding at least 6% starch and an oxidizing agent (vegetable oil) to the polymers during manufacture. In the biologically active soil environment, the biodegradable plastic is decomposed easily. The metallic salts naturally present in soil interact with the oxidizing agent to form ferro oxides, which attack the polymer bonds and set the biodegradation of plastic in motion. Parallely, soil microbes break up the starch grains (amyloids), which results in an increased attack surface and accelerates the auto oxidation process. The presence of starch reduces the water resistance of plastic. Addition of a fine protective layer to the starch based plastic; make it possible to obtain high degree of water-resistance. In future, plastics with 50% starch will appear in the market. Biodegradable plastics may offer many solutions to the pollution problems.

Heavy metals

Heavy metal pollution

Lead: Contamination of soils by lead is a major concern in many countries at the moment including the U.K. It is believed that the primary cause of the increased levels found in many soils is car exhaust emissions. Although unleaded petrol has been available for some time now the lead particles still remain from the time when lead was added to fuel as a thinner. In America, lead poisoning has been termed 'the silent epidemic'. 900,000 children under the age of 6 have a blood lead concentration of at least 10 nano grams / litre, this is the critical threshold, above this level lead is believed to have psychological effects on factors such as intelligence. The high concentrations of lead were also seen in hair and blood samples of local residents, although not to such an extent. This suggests that there is some kind of barrier which reduces the bioavailability of lead, within the body. In Derbyshire this is the process whereby the lead is slowly eroded into the secondary element of pyromorphite, which has a very low bioavailability is not easily put into solution.

Chromium: As a trace element, chromium is essential for many organisms (just like iron), however an excess in chromium and many chromium compounds are poisonous. Chromium compounds are found in pigments and wastewater from tanneries. These materials can be cancerous, lead to eczema or impair the mucous membranes in the period 1985-1995.

Copper: Copper is a toxic heavy metal. It ends up in the marine environment particularly through rivers and polluted dredged materials. Since the ban on using paint containing tin, copper is often used as an anti-foul material on ship hulls. In the vicinity of military training grounds, the bottom is locally polluted with copper from munition remnants. The Netherlands contributes around 25% to the total load of copper in the North Sea. With algae, a concentration of 0.5 microgametes of copper per litre seawater will decrease photosynthesis (and thereby growth decline). With higher concentrations (around 10 microgametes per litre), crustaceans will also be affected.

Nickel: Nickel is found in nature. It is a heavy metal applied in producing steel and as a surface layer for metal products. In addition, nickel is used in a large number of alloys, batteries, the electrochemical industry and as catalyst, for example in congealing vegetable fats. It is in all probability an essential trace element. Some nickel compounds are cancerous. A concentration of 0.003 to 0.1 mg/l will lead to a decrease in bacteria growth

Arsenic: Arsenic has been known to be poisonous for centuries. It is a heavy metal. The inorganic arsenic compounds are reputed to be extremely toxic, and are used in cases such as rat poison. Arsenic compounds are used in the production of copper, lead, zinc, steel and iron, as well as in agriculture. Arsenic affects fish and amphibians by increasing the chance in changes in hereditary material, and could cause an unnaturally high death rate among birds.

Cadmium: Cadmium is a heavy metal. It is found throughout nature, especially as an impurity in zinc minerals. It is a white metal, fairly soft, easily flexible and non-corrosive. Due to dumping by human activities (especially the industry, and indirectly from dredging activities), the concentration of cadmium measured in the coastal waters is approximately 5 times higher than the natural concentration. Cadmium is poisonous for almost all organisms. That's why limiting the dumping of cadmium in the past decade has had a high priority, and with great success: the discharges have decreased by 81%.

Mercury: Mercury is a heavy metal, originating from industry, most often from burning fossil fuels and from dumps. In addition, mercury is found in pesticides and fertilizers, is used in the production of chlorine and the removal of sulphur from natural gas. Actually, mercury is found naturally in low amounts in natural gas. Mercury poisoning damages the nerves, which can lead to deafness, blindness and paralysis. Less acute poisoning could lead to loss of concentration and memory and memorial disorders

Titanium: In the 1980s, Greenpeace successfully conducted a campaign against the dumping of titanium dioxide wastes; for example, they prevented dumping ships from entering the harbours. In addition, Greenpeace gathered evidence concerning the effects dumping had on sea life. Scientists also discovered the consequences for those fish which had come into contact with the waste. With such evidence and facts on hand, pressure could be applied on the policy makers and the titanium dioxide dumpers themselves. Titanium dumping has deceased since 1989.

Agriculture: Agriculture is an industry which works directly with the soil as a result it is bound to have some effects on the makeup of the soil. The uses of pesticides and fertilizers have come under scrutiny for many reasons. One of the most harmful ecotoxicological effects is that of the eutrophication of water bodies. This occurs due to over use and poor management of Phosphorous and Nitrogen fertilizers. It leads to over productivity in the water body and eventually to deoxygenating of the water, meaning that more fragile populations and communities cannot survive. This has many implications, not only for the environment and wildlife involved but it may also affect human activity such as drinking water, or leisure activities like swimming and fishing.

Bioaccumulation and biomagnifications of these poisons as they move along the food chain is also a major problem which has influence on the whole ecosystem. One of the most famous incidents was that of the near extinction of the Peregrine Falcon in areas of North America during the late 1960's which lead to the den of the pesticide DDT. Persistent Organic Pollutants (POPs) are chemical substances that persist in the environment, bioaccumulate through the food web, and pose a risk of causing adverse effects to human health and the environment. With the evidence of long-range transport of these substances to regions where they have never been used or produced and the consequent threats they pose to the environment of the whole globe, the international community has now, at several occasions called for urgent global actions to reduce and eliminate releases of these chemicals.

Industrial Effluents: Contamination of drinking water supplies from industrial waste is a result of various types of industrial processes and disposal practices. Industries that use large amounts of water for processing have the potential to pollute waterways through the discharge of their waste into streams and rivers, or by run-off and seepage of stored wastes into nearby water sources. Other disposal practices which cause water contamination include deep well injection and improper disposal of wastes in surface impoundments. Industrial waste consists of both organic and inorganic substances. Organic wastes include pesticide residues, solvents and cleaning fluids, dissolved residue from fruit and vegetables, and lignin from pulp and paper to name a few. Effluents can also contain inorganic wastes such as brine salts and metals.

Industrial pollution

Effects of soil pollutants

- Affects soil health and productivity

- Affects plant and animals
- Affects soil microbes
- Ground water contamination through seepage
- Affects human health
- Causes biomagnification etc.

Soil Remediation process

Phytoremediation

The process of recovery of hazardous substances from soil or ground water contaminated with municipal or industrial wastes etc. by using plants is called phytoremediation. Among vascular plants, some aquatic weeds such as species of Salvia, Lemna, Azolla, sedges and tree species are known to tolerate and uptake heavy metals. Bamboo can accumulate Zn, Cd, Ni and Pb (lead). Flower crops could be an effective method of remediating soil polluted due to disposal of tannery effluent.

Biological transformation of heavy metals

Biological transformation of heavy metals is an important detoxification mechanism that can occur in many habitats and can be carried out by a variety of microorganisms especially bacteria and fungi. As a result of biological action, metals undergo changes in valency and or conversion into organometallic compounds.

1. Bioconversions involving changes in valency and resulting in production of volatile or less toxic compounds have been shown in several cases. e.g. oxidation of As (III) to As (V) and mercury ion to metallic mercury.

2. Transformation of metals into organometallic compounds by methylation, e.g. lead, mercury. Although the product of methylation may be more toxic than free metal, they are often volatile and released into atmosphere. Organometallic compounds can also undergo degradation, which may result in the metal being liberated in a volatile form. e.g. mercury.

Recovery of heavy metals

Green plants such as specific strains of Indian mustard (*Brassica juncea*) can accumulate heavy metals when grown in chromium-contaminated soils. Modified strains of this plant have been shown to accumulate up to 40% of their biomass as heavy metals, such as lead and chromium. While microorganisms breakdown the organic bonds, the plants themselves take up the metals through their root system and sequester the contaminants in their cells. Useful plants can be found growing on ore outcroppings or contaminated areas. For instance, a variety of tree, *Seberia acuminata* (Sapotaceae), a native of New Caledonia accumulates an astonishing 20 to 25% of its body dry weight of nickel. The plant bleeds bluish green latex (sap).

The lead accumulating plants, such as common ragweed (*Ambrosia artemisiifolia*) and hemp dogbane (*Apocynum cannabinum*) exhibited shoot concentrations of 400 and 250 mg Pb kg^{-1} respectively. Efforts are being made to develop more efficient soil remediation methodologies by breeding or bioengineering plants which have the ability to absorb, translocate, and tolerate Pb while producing sufficient biomass.

Bio stimulation: Stimulation of the native microbes for site remediation

Bioventing: It is the In-situ method of bio remediation in which air is supplied to an unstaturated soil zone through installation of wells connected to associated pumps and blowers which draw a vacuum on the soil.

Air spraying: It involves the injection of air into the saturated zone of a contaminated soil.

Questions

<u>Fill up</u>

1. ----------- is the loose and unconsolidated outer layer of the earth’s crust which is amorphous in nature.

Ans: Soil

2. The persistent molecules that fail to be metabolized or mineralized is known as --------------

Ans: recalcitrant

3. In America, --------- poisoning is termed ‘the silent epidemic’

Ans: Lead

4. ------------- is a heavy metal used as rat poison.

Ans: Arsenic

5. ------------------ are chemical substances that bioaccumulates through the food web, causes adverse effect on human health and environment.

Ans: Persistent organic pollutants (POPs)

Match

6. *Brassica juncea* - Lead accumulating plant

7. *Seberia acuminate* - Eutrophication

8. *Apacynum cannabinum* - Recovery of hexavalent chromium from contaminated soils

9. Bioventing - Accumulates toxic Nickel

10. Use of pesticides and fertilizers - In situ method of bio remediation

Ans

6. *Brassica juncea* - Recovery of hexavalent chromium from contaminated soil

7. *Seberia acuminate* - Accumulates toxic Nickel

8. *Apacynum cannabinum* - Lead accumulating plant

9. Bioventing - In situ method of bio remediation

10. Use of pesticides and fertilizers - Eutrophication

Lecture.13

Noise pollution, source, effect and control measures

The word noise is derived from the Latin word nausea. Unwanted sound that causes discomfort to the listener is called noise. Wrong sound in wrong place at wrong time is also called as noise.

The root cause

- Modern mechanization and technological innovation have greatly increased the source of noise forced to consider it a major component of environmental pollution.
- Formerly it was limited with the industrial environment only where heavy machines used to work round the clock. But with growing population heavy traffic and urban crowd and electrical entertainment it has become new irritant and some of environmental assistance.

Sources

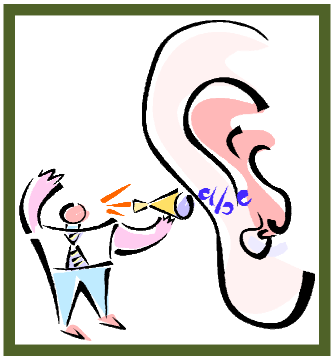
Natural - Thunder

Man made - Industrial and Non-industrial

Industrial source: Industries of various kinds such as textile, iron, steel, utensils, automobiles, fertilizers, paper, ceramics and thermal power stations are the major contribution of noise. Machines in connection with threshing, grinding, drilling, bunching, weaving, boiler making, forging, pressing and blasting operations.

Industrial source of pollution

Non-industrial source: (a) Domestic noise (b) Loud speaker (c) Construction work (d)Traffic (e) Crowded markets (f) Theatres (g) Religious function (h)Cultural festivals (i) Trains (j) Air craft's (k) Projection of satellites (l) Atomic explosions.



Non-industrial source of pollution

Measurement of Noise: Sound consists of repeated alternate compressions and expansions of air. The pitch of sound is determined by frequency and intensity of sound. The intensity of noise is measured by 'decibels' dB. (deci = 10 and the name of scientist Alfred Graham Bell).

$$dB = 10 \times \log_{10} \frac{I}{I_0}$$

I = Sound Intensity

I_0 = Softest audible sound intensity

Human ear is known to be sensitive to an extremely wide intensity from 0 to 190 dB. Here, '0' dB is threshold of hearing while 180 dB is threshold of pain. Some people will feel discomfort with 85 db and most people may not feel discomfort even with sound of 115 dB. Pain is usually felt at 140 dB. The sound intensity is measured by instrument Larnharometer. The effect of sound as man depends upon its frequency.

Frequency = Number of vibrations per second.

It is denoted by Hertz. One Hz = 1 vibration / second.

People can hear sound from 16 to 20000 hz, but this range is reduced with age. Why the sound which at one time gives soothing touch to the ear becomes noise at another occasion.

Ambient and quality standards for noise

Place	**Limits dB**	
	Day time	**Night time**
Industrial area	75	70
Commercial area	65	55
Residential area	55	45
Silent zone	50	40

Effect of Noise pollution

Effect on human beings

- Affects physiological and mental health
- Reduces job efficiency
- Reduces enjoyment of life at home.
- Prolonged exposure to noise beyond 90 dB may cause hearing loss.
- In some cases, it causes auditory fatigue, nervousness, irritability, increased blood pressure, cardio-vascular, respiratory, glandular, deafness and neurological disorders. Physiological disorder : Neurosis, anxiety, insomnia, hypertension

Effects on wildlife: Decline is migratory birds to a habitat if it becomes noisy animals become dull and inactive.

Effects on non living things: High intensity of noise, such as vibrations emanating from heavy machineries cause shattering of window glasses, loosen the plaster of house walls, cracks in walls.

- Some time even cause the shattering of the foundation of the building.
- Noise may also cause depreciation of the residential property located nearby air path, highways, industrial areas and other noise prone areas.

Control of noise pollution

(1) Control of noise at source

- Designing and fabricating silencing devices and then use in air craft, motor cycles, industrial machines and home appliances.
- Segregating the noisy equipments.

- Introducing less noisy machines in plan of noisy areas.
- Conducting noisy operations in open spaces far away from residential zones.
- Setting up industries 5 km away from residential zones.

(2) Control of transmission: This is achieved by covering the room walls with sound absorbing materials constrained layer damping technique.

(3) Protection of exposed person: Using weaving devices such as ear plugs and ear muffs.

(4) Creation of vegetation and buffer zones: Growing of noise absorbing plants like Ashoka, Banyan, Neem, Legume, Tamarind, Coconut etc. in the road side and in front of buildings.

(5) Environmental education and awareness: People may be made aware of health hazards of noise pollution through news papers, Television, Articles, Radio, News reels in cinema halls etc.

(6) Legislation: Strict laws and enforcement; Appointing Noise Inspectors.

Noise Source	**Intensity** (dB)
Breathing	10
Soft whisper	20
Library	30
Low volume radio (Walkman)	35
Normal conversation	35 to 60
Telephone	60
Alarm clock	70
Traffic	70 to 90
Lions roar (at 12 feet)	105

Thunder, Jet, Train whistle (at 50 feet)	110
Air craft Jet take off (at 100 feet)	120
Siren	150
Space rocket	170

Questions

1. The word noise is derived from the latin word ------------------

Ans: nausea

2. The intensity of noise is measured by -------------------

Ans: Decibels

3. The maximum permissible limit for noise is ---------------

Ans: 90-120 dB

4. Name any industry that contributes more of noise.

Ans: Thermal power stations/Automobiles/paper/Iron & Steel

5. The sound intensity is measured by instrument

Ans: Larnharometer

<u>Match</u>

6. One hertz - felt at 140 dB.

7. Pain and discomfort - Appointing Noise Inspectors

8. Theatres - 1 vibration / Second

9. Setting up of industries at 5 km, away from residential zone - Non-Industrial source of noise

10. Legislation - Control of noise at source

Ans

6. One hertz - 1 vibration / Second

7. Pain and discomfort - felt at 140 dB.

8. Theatres - Non-Industrial source of noise

9. Setting up of industries at 5 km, away from residential zone - Control of noise at source

10. Legislation - Appointing Noise Inspectors

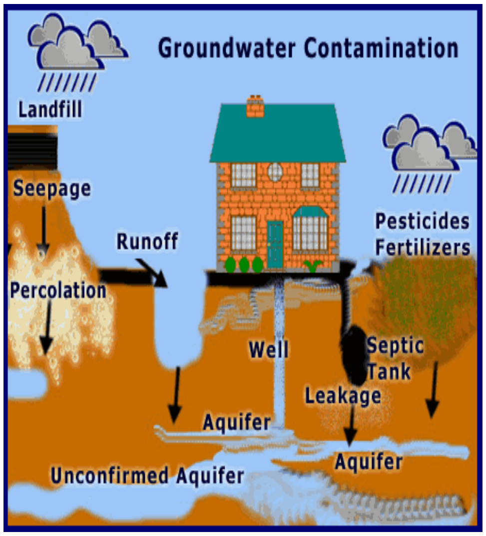
Lecture.14

Impact of different pollution on human, organism and environment

It is a well-known fact that clean water is absolutely essential for healthy living. Adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth, yet it has been observed that millions of people worldwide are deprived of this. Freshwater resources all over the world are threatened not only by over exploitation and poor management but also by ecological degradation. The main source of freshwater pollution can be attributed to discharge of untreated waste, dumping of industrial effluent, and run-off from agricultural fields. Industrial growth, urbanization and the increasing use of synthetic organic substances have serious and adverse impacts on freshwater bodies. It is a generally accepted fact that the developed countries suffer from problems of chemical discharge into the water sources mainly groundwater, while developing countries face problems of agricultural run-off in water sources. Polluted water like chemicals in drinking water causes problem to health and leads to water-borne diseases which can be prevented by taking measures even at the household level.

Groundwater and its contamination

Many areas of groundwater and surface water are now contaminated with heavy metals, POPs (persistent organic pollutants), and nutrients that have an adverse affect on health. Water-borne diseases and water-caused health problems are mostly due to inadequate and incompetent management of water resources. Safe water for all can only be assured when access, sustainability, and equity can be guaranteed. Access can be defined as the number of people who are guaranteed safe drinking water and sufficient quantities of it. There has to be an effort to sustain it, and there has to be a fair and equal distribution of water to all segments of the society. Urban areas generally have a higher coverage of safe water than the rural areas. Even within an area there is variation: areas that can pay for the services have access to safe water whereas areas that cannot pay for the services have to make do with water from hand pumps and other sources. In the urban areas water gets contaminated in many different ways, some of the most common reasons being leaky water pipe joints in areas where the water pipe and sewage line pass close



together. Sometimes the water gets polluted at source due to various reasons and mainly due to inflow of sewage into the source.

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

Pesticide

Run-off from farms, backyards, and golf courses contain pesticides such as DDT that in turn contaminate the water. Its effects on the ecosystems and health are endocrine and reproductive damage in wildlife. Groundwater is susceptible to contamination, as pesticides are mobile in the soil. It is a matter of concern as these chemicals are persistent in the soil and water. The organophosphates and the carbonates present in pesticides affect and damage the nervous system and can cause cancer. Some of the pesticides contain carcinogens that exceed recommended levels. They contain chlorides that cause reproductive and endocrinal damage.

Nutrients

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

Synthetic organics

Many of the 100000 synthetic compounds currently in use today are found in many of the aquatic environment and accumulate in the food chain. POPs or Persistent organic pollutants, represent the most harmful element for the ecosystem and for human health, for example, industrial chemicals and agricultural pesticides. These chemicals can accumulate in fish and cause serious damage to human health. Where pesticides are used on a large-scale, groundwater gets contaminated and this leads to the chemical contamination of drinking water.

Acid rain

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

Fluoride

Fluoride in the water is essential for protection against dental caries and weakening of the bones, but higher levels can have an adverse effect on health. In India, high fluoride content is found naturally in the waters in Rajasthan. Excess fluorides can cause yellowing of the teeth and damage to the spinal cord and other crippling diseases.

Arsenic

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

Lead

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

Other heavy metals

These contaminants come from mining waste and tailings, landfills, or hazardous waste dumps. Heavy metals cause damage to the nervous system and the kidney, and ther metabolic disruptions.

Petrochemicals

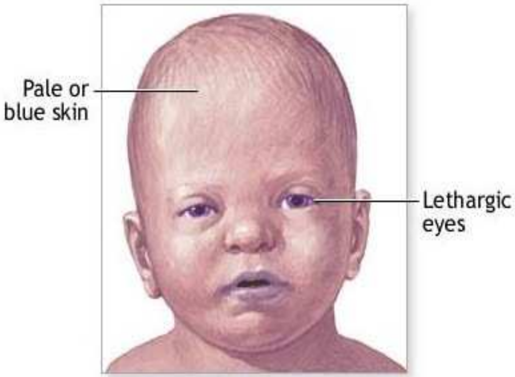
Petrochemicals contaminate the groundwater from underground petroleum storage tanks. Benzene and other petrochemicals can cause cancer even at low exposure levels.

Chlorinated solvents

Metal and plastic effluents, fabric cleaning, electronic and aircraft manufacturing are often discharged and contaminate groundwater. Also causes reproduction disorders and some cancers.

Nitrates

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



Blue baby syndrome

Salts

It makes the fresh water unusable for drinking and irrigation purposes.

Disease

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

Cause	Water-borne diseases
Bacterial infections	Typhoid , Cholera , Paratyphoid fever , Bacillary dysentery
Viral infections	Infectious Hepatitis (jaundice) Poliomyelitis
Protozoal infections	Amoebic dysentery

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

Most intestinal (enteric) diseases are infectious and are transmitted through faecal waste. Pathogens – which include virus, bacteria, protozoa, and parasitic worms – are disease-producing agents found in the faeces of infected persons. These diseases are more prevalent in areas with poor sanitary conditions. These pathogens travel through water sources and interfuses 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.

Preventive measures

Water-borne epidemics and health hazards in the aquatic environment are mainly due to improper management of water resources. Proper management of water resources has become the need of the hour as this would ultimately lead to a cleaner and healthier environment. In order to prevent the spread of water-borne infectious diseases, people should take adequate precautions. The city water supply should be properly checked and necessary steps taken to disinfect it. Water pipes should be regularly checked for leaks and cracks. At home, the water should be boiled, filtered, or other methods and necessary steps taken to ensure that it is free from infection.

Minamata: environmental contamination with methyl mercury

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

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

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

Questions

1. Fresh water resources are threatened not only by over exploitation and poor management also by

Ans: Ecological Degradation

2. The main source of freshwater pollution is

Ans: discharge of untreated waste / dumping of industrial effluent / run off from agricultural fields.

3. Any one source of groundwater contamination

Ans: Pesticides (or) sewage (or) Nutrients runoff from agricultural field.

4. Name any one water – borne viral infection

Ans: (Jaundice / Poliomyelitis)

5. Excess of ------------------ in waternheavy metal causes yellowing of teeth

Ans: Fluoride

Match

6. Nitrates - Cholera

7. Protoxoal infection - Methyl mercury intoxication

8. Bacterial infection - Benzene

9. Petrochemicals - Blue baby sundrome

10. Minamata disease - Amoebic dysentery

Ans

6. Nitrates - Blue baby syndrome

7. Protozoal infection - Amoebic dysentery

8. Bacterial infection - Cholera

9. Petrochemicals - Benzene

10. Minamata disease - Methyl mercury intoxication

Lecture.15

Food contaminants, preservatives, artificial colours, source, effects and regulations

Food contamination refers to the presence of harmful chemicals and microorganisms in food which can cause consumer illness. A separate issue is genetically modified food, or the presence in foods of ingredients from genetically modified organisms, also referred to as a form of food contamination.

Impact

The impact of chemical contaminants on consumer health and well-being is often apparent only after many years of prolonged exposure at low levels (e.g. cancer). Chemical contaminants present in foods are often unaffected by thermal processing (unlike most microbiological agents). Chemical contaminants can be classified according to the source of contamination and the mechanism by which they enter the food product.

Agrochemicals

Agrochemicals are used in agricultural practices and animal husbandry with the intention to increase productivity. Such agents include pesticides (e.g. insecticides, herbicides, rodenticides), plant growth regulators, veterinary drugs (e.g. nitrofuran, fluoroquinolones, malachite green, chloramphenicol), and bovine somatotropin (rBST).

Environmental contaminants

Environmental contaminants are chemicals that are present in the environment in which the food is grown, harvested, transported, stored, packaged, processed, and consumed. The physical contact of the food with its environment results in its contamination. Possible sources of contamination are:

Air: radionuclides (^{137}Caesium, ^{90}Strontium), polycyclic aromatic hydrocarbons (PAH).

Water: arsenic, mercury.

Soil: cadmium, nitrates, perchlorates.

Polychlorinated biphenyls (PCB) , dioxins, and polybrominated diphenyl ethers (PBDE) are ubiquitous chemicals, which are present in air, water, soil, and the entire biosphere.

Packaging materials: antimony, tin, lead, perfluorooctanoic acid (PFOA), semicarbazide, benzophenone, isopropylthioxanthone (ITX), bisphenol A.

Processing/cooking equipment: copper, or other metal chips, lubricants, cleaning and sanitizing agents.

Naturally occurring toxins: mycotoxins, phytohaemagglutinin, pyrrolizidine alkaloids, grayanotoxin, mushroom toxins, scombrotoxin (histamine), ciguatera, shellfish toxins, tetrodotoxin, among many others.

Banned pesticides, carcinogens

There are many cases of banned pesticides or carcinogens found in foods.

- Greenpeace exposed in 2006 in China that 25% of surveyed supermarkets agricultural products contained banned pesticides. Over 70% of tomatoes that tested were found to have the banned pesticide Lindane, and almost 40% of the samples had a mix of three or more types of pesticides.Fruits were also tested in this investigation. Tangerines, strawberries and Kyofung grapes samples were found contaminated by banned pesticides, including the highly toxic Methamidophos. These fruits can also be found in Hong Kong market. Greenpeace says there exists no comprehensive monitoring on fruit produce in the Hong Kong as of 2006.

- In India, soft drinks were found contaminated with high levels of pesticides and insecticides, including lindane, DDT, malathion and chlorpyrifos.

Hair in food

Many people consider hair in food to be particularly unpleasant, however there are certain risks to be considered such as choking and repulsion induced vomiting. There are also considerations of contaminants on the hair itself such as waxes or other hair products that may cause problems. It is claimed sometimes that it does not usually pose any serious health risk, but in other cases it is claimed that it does pose a health risk.

For example, people working in the food industry are required to cover their hair. Also, when people are served food which contains hair in restaurants or cafes, people may complain to the manager. Despite this, it is not valid ground to sue the restaurant in the United States but in the United Kingdom it breaks the regulations of the UK Food Safety Act 1990 and is known to cause food poisoning and people can sue for this. In one case a supermarket considered banning a man with a beard working there. In such cases there exists protection for food workers who have facial hair, which is called 'snood'.

The cause of people's disgust with hair in food could be that hair is not easily digestible and is the wrong shape for being processed in the body. Hair in food was often a common cause of complaint from people eating food, before the introduction of complete capture hairnets.

Processing contaminants

Processing contaminants are generated during the processing of foods (e.g. heating, fermentation). They are absent in the raw materials, and are formed by chemical reactions between natural and/or added food constituents during processing. The presence of these contaminants in processed foods can not be entirely avoided. However, technological processes can be adjusted and/or optimized in order to reduce the levels of formation of processing contaminants. Examples are: nitrosamines, polycyclic aromatic hydrocarbons (PAH), heterocyclic amines, histamine, acrylamide, furan, benzene, trans fat, monochloropropanediol (MCPD), semicarbazide, 4-hydroxynonenal (4-HNE), and ethyl carbamate. There is also the possibility of metal chips from the processing equipment that requires metal detection. In many conveyor lines, the line will be stopped, or when weighing the product with a Check weigher, the item can be rejected for over- or underweight as well as detection of very small pieces of metals.

Emerging food contaminants

While many food contaminants have been known for decades, the formation and presence of certain chemicals in foods has been discovered relatively recently. These are the so-called **emerging food contaminants**, e.g. acrylamide, furan, benzene, perchlorate, perfluorooctanoic acid (PFOA), monochloropropanediol (MCPD), 4-hydroxynonenal and (4-HNE).

Safety and regulation

Acceptable Daily Intake (ADI) levels and tolerable concentrations of contaminants in individual foods are determined on the basis of the "No Observed Adverse Effect Level" (NOAEL) in animal experiments, by using a safety factor (usually 100). The maximum concentrations of contaminants allowed by legislation are often well below toxicological tolerance levels, because such levels can often be reasonably achieved by using good agricultural and manufacturing practices.

The establishment of ADIs for certain emerging food contaminants is currently an active area of research and regulatory debate.

A **preservative** is a natural or synthetic chemical that is added to products such as foods, pharmaceuticals, paints, biological samples, wood, etc. to prevent decomposition by microbial growth or by undesirable chemical changes.

Preservatives in foods

Preservative food additives can be used alone or in conjunction with other methods of food preservation. Preservatives may be antimicrobial preservatives, which inhibit the growth of bacteria and fungi and mold growth, or antioxidants such as oxygen absorbers, which inhibit the oxidation of food constituents. Common antimicrobial preservatives include calcium propionate, sodium nitrate, sodium nitrite, sulfites (sulfur dioxide, sodium bisulfite, potassium hydrogen sulfite, etc.) and disodium EDTA. Antioxidants include BHA and BHT. Other preservatives include formaldehyde (usually in solution), glutaraldehyde (kills insects), ethanol and methylchloroisothiazolinone. The benefits and safety of many artificial food additives (including preservatives) are the subject of debate among academics and regulators specializing in food science and toxicology, and of course biology.

Natural food preservation

Natural substances such as salt, sugar, vinegar, and diatomaceous earth are also used as traditional preservatives. Certain processes such as freezing, pickling, smoking and salting can also be used to preserve food. Another group of preservatives targets enzymes in fruits and vegetables that continue to metabolize after they are cut. For instance, citric and ascorbic acids from lemon or other citrus juice can inhibit the action of the enzyme phenolase which turns surfaces of cut apples and potatoes brown. FDA standards do not currently require fruit and vegetable product labels to reflect the type of preservative used in the products.

Food colouring

Food coloring (colouring) is any substance that is added to food or drink to change its colour. Food colouring is used both in commercial food production and in domestic cooking. Due to its safety and general availability, food colouring is also used in a variety of non-food applications, for example in home craft projects and educational settings.

Purpose of food coloring

People associate certain colors with certain flavors, and the color of food can influence the perceived flavor in anything from candy to wine. For this reason, food manufacturers add dyes to their products. Sometimes the aim is to simulate a color that is perceived by the consumer as natural, such as adding red coloring to glace cherries (which would otherwise be beige), but sometimes it is for effect, like the green ketchup that Heinz launched in 2000.

While most consumers are aware that food with bright or unnatural colors (such as the green ketchup mentioned above) likely contain food coloring, far fewer people know that seemingly "natural" foods such as oranges and salmon are sometimes also dyed to mask natural variations in color. Color variation in foods throughout the seasons and the effects of processing and storage often make color addition commercially advantageous to maintain the color expected or preferred by the consumer. Some of the primary reasons include:

- Offsetting color loss due to light, air, extremes of temperature, moisture, and storage conditions.
- Masking natural variations in color.
- Enhancing naturally occurring colors.
- Providing identity to foods.
- Protecting flavors and vitamins from damage by light.
- Decorative or artistic purposes such as cake icing.

Regulation

Food colorings are tested for safety by various bodies around the world and sometimes different bodies have different views on food color safety. In the United States, FD&C numbers (which generally indicates that the FDA has approved the colorant for use in foods, drugs and cosmetics) are given to approved synthetic food dyes that do not exist in nature, while in the European Union, E numbers are used for all additives, both synthetic and natural, that are approved in food applications.

Most other countries have their own regulations and list of food colors which can be used in various applications, including maximum daily intake limits.

Natural colors are not required to be tested by a number of regulatory bodies throughout the world, including the United States FDA. The FDA lists "color additives exempt from certification" for food in subpart A of the Code of Federal Regulations - Title 21 Part 73. However, this list contains substances which may have synthetic origins.

Natural food dyes

A growing number of natural food dyes are being commercially produced, partly due to consumer concerns surrounding synthetic dyes. Some examples include:

- Caramel coloring (E150), made from caramelized sugar, used in cola products and also in cosmetics.
- Annatto (E160b), a reddish-orange dye made from the seed of the Achiote.
- A green dye made from chlorella algae (chlorophyll, E140)
- Cochineal (E120), a red dye derived from the cochineal insect, *Dactylopius coccus*.
- Betanin extracted from beets.
- Turmeric (curcuminoids, E100)
- Saffron (carotenoids, E160a)

Elderberry juice

To ensure reproducibility, the coloured components of these substances are often provided in highly purified form, and for increased stability and convenience, they can be formulated in suitable carrier materials (solid and liquids)

Impact

The impact of chemical contaminants on consumer health and well-being is often apparent only after many years of prolonged exposure at low levels (e.g. cancer). Chemical contaminants present in foods are often unaffected by thermal processing (unlike most microbiological agents). Chemical contaminants can be classified according to the source of contamination and the mechanism by which they enter the food product.

Questions

1. The presence of harmful chemicals and microorganisms in food that cause consumer illness is referred as

Ans: Food contamination

2. --------------- is an example for environmental contaminants especially in air.

Ans: Radio nuclides

3. Mycotoxins is an example of ------------------- toxins

Ans: naturally occurring

4. ---------------- is a natural or synthetic chemical that is added to products prevent decomposition of microbial growth

Ans: Preservative

Match

5. Emerging food contaminants - to repel insects and termites

6. Safety factor - transfat

7. Processing contaminants - perchlorate

8. Wood preservatives - acceptable daily intake levels

Ans

5. Emerging food contaminants - perchlorate

6. Safety factor - acceptable daily intake levels

7. Processing contaminants - trans fat

8. Wood preservatives - to repel insects and termites

True/False

9. Food coloring is substance that is added to food or drink to change its colour

Ans: True

10. The presence of ingredients from genetically modified organisms in foods is a form of food contamination.

Ans: True

Lecture.16

Smog – definition – classification – particulate pollution – brown air smog (photochemical smog), gray air smog (industrial smog) formation and chemistry

Smog

The term smog was first used in 1905 by Dr. H. A. Des Voeux to describe the conditions of fog that had soot or smoke in it. Smog is a combination of various gases with water vapour and dust. A large part of the gases that form smog is produced when fuels are burnt. Smog forms when heat and sunlight react with these gases and fine particles in the air. Smog can affect outlying suburbs and rural areas as well as big cities. Its occurrences are often linked to heavy traffic, high temperatures, and calm winds. During the winter, wind speeds are low and cause the smoke and fog to stagnate; hence pollution levels can increase near ground level. This keeps the pollution close to the ground, right where people are breathing. It hampers visibility and harms the environment. Heavy smog is greatly decreases ultraviolet radiation. In fact, in the early part of the 20th century, heavy smog in some parts of Europe resulted in a decrease in the production of natural vitamin D leading to a rise in the cases of rickets. Smog causes a misty haze similar to fog, but varies in composition. In fact the word smog has been coined from a combination of the words fog and smoke. Smog refers to hazy air that causes difficult breathing conditions.

The most harmful components of smog are ground-level ozone and fine airborne particles. Ground-level ozone forms when pollutants released from gasoline and diesel-powered vehicles and oil-based solvents react with heat and sunlight. It is harmful to humans, animals, and plants. The industrial revolution in the 19th century saw the beginning of air pollution in Europe on a large scale and the presence of smog mainly in Britain. The industries and the households relied heavily on coal for heating and cooking. Due to the burning of coal for heat during the winter months, emissions of smoke and sulphur dioxide were much greater in urban areas than they were during the summer months. Smoke particles trapped in the fog gave it a yellow/black colour and this smog often settled over cities for many days.

The effects of smog on human health were evident, particularly when smog persisted for several days. Many people suffered respiratory problems and increased deaths were recorded, notably those relating to bronchial causes. A haze of dense harmful smog would often cover the city of London. The first smog-related deaths were recorded in London in 1873, when it killed 500 people. In 1880, the toll was 2000. London had one of its worst experiences with smog in December 1892. It lasted for three days and resulted in about 1000 deaths. London became quite notorious for its smog. By the end of the 19th century, many people visited London to see the fog. Despite gradual improvements in air quality during the 20th century, major smog occurred in London in December 1952. The Great London Smog lasted for five days and resulted in about 4000 more deaths than usual. In response to the Great London Smog, the government passed its first Clean Air Act in 1956, which aimed to control domestic sources of smoke pollution by introducing smokeless zones. In addition, the introduction of cleaner coals led to a reduction in sulphur dioxide pollution. In the 1940s, severe smog began covering the city of Los Angeles in the USA.

Relatively little was done to control any type of pollution or to promote environmental protection until the middle of the 20th century. Today, smoke and sulphur dioxide pollution in cities is much lower than in the past, as a result of legislation to control pollution emissions and cleaner emission technology.

Ground-level ozone

Ground-level ozone is formed through a complex reaction involving hydrocarbons, nitrogen oxides, and sunlight. Ground-level ozone is especially harmful for seniors, children, asthmatics, and people with heart and lung conditions. It aggravates respiratory symptoms and further impairs the ability of these individuals to perform normal activities. It can inflame breathing passages, decreasing the lung's working capacity, and causing shortness of breath, pain when inhaling deeply, wheezing, and coughing. It can cause eye and nose irritation and dry out the protective membranes of the nose and throat and interfere with the body's ability to fight infection, increasing susceptibility to illness.

Particulate pollution

Invisible particles, especially fine particles with diameters less than 10 microns (PM-10) and ultra fine particles with diameter less than 2.5 microns (PM-2.5) pose a significant health hazard, such particles are emitted by incinerations, motor vehicles, radial tires, wind erosion, wood burning places, and industrial power plants. The particulate matter that remains suspended in air is called suspended particulate matter (SPM).

Such tiny particles (i) are not effectively captured by modern air pollution control equipment (ii) are small enough to penetrate the respiratory system's natural defenses against air pollution (iii) can bring with them droplets or other particles of toxic or cancer –causing pollutants that become attached to their surfaces.

Once they are lodged deep within the lungs, these fine particles can cause chronic irritation that can (i) trigger asthma attack (ii) aggravate other lung diseases (iii) cause lung cancer (iv) affects the O_2 carrying capacity of blood.

Photochemical smog (Brown air smog)

Any chemical reaction activated by light is called photochemical reactions. Photochemical smog is a mixture of primary and secondary pollutants. Formed under the influence of sunlight.

Photochemical smog formation

It begins when nitrogen and oxygen in air react at high temperature found inside automobiles engines and boilers in coal burning industrial power plants to produce colourless nitric oxide.

$$N_2 + O_2 \longrightarrow 2\,NO$$

Then the nitric oxide slowly reacts with the oxygen in the troposphere leads to the formation of nitrogen dioxide, a yellowish-brown gas with a choking odour.

$2\ NO + O_2 \longrightarrow 2\ NO_2$

The NO_2 is responsible for the formation of brownish haze that hangs over many cities during the afternoons of sunny days. This is the reason why photochemical smog sometime is called brown air smog.

Some of the NO_2 reacts with water vapour in the atmosphere to form nitric acid vapour and nitric oxide

$3\ NO_2 + H_2O \longrightarrow 2\ HNO_3 + NO.$

When the remaining NO_2 is exposed to ultra violet radiation from the sun, some of it is converted to nitric oxide and oxygen atoms.

$NO_2 + \text{UV radiation} \longrightarrow NO + O$

The highly reactive oxygen atoms then react with $O_2$to produce ozone.

$O_2 + O \longrightarrow O_3$

Both the oxygen atoms and ozone then react with volatile organic compounds (mostly hydrocarbons released by vegetation, vehicles etc) to produce aldehydes. In addition hydrocarbons; oxygen, and nitrogen dioxide react to produce peroxyacyl nitrates (PANs).

$\text{Hydrocarbons} + O_2 + NO_2 \longrightarrow \text{PANs}$

Collectively, NO_2, O_3 and PANs are called photochemical oxidants because they can react with an oxidize certain compounds in the atmosphere. Photochemical smog can irritate respiratory tract and damage crops stress.

Industrial smog: Gray – air smog

Fifty years ago in cities such as London, Chicago, during winter, people in such cities were exposed to industrial smog consisting mostly of (i) sulphur dioxide (ii) suspended droplets of sulphuric acid (iii) a variety of suspended solid particles and droplets.

Chemistry of Industrial smog formation

The carbon in coal and oil is converted to carbon –di- oxide and carbon monoxide when it is burned.

$$C + O_2 \longrightarrow CO_2$$

$$2C + O_2 \longrightarrow 2\,CO$$

Some of the unburned carbon also ends up in the atmosphere as suspended particulate matters (soot).

The sulphur compounds in coal and oil also react with oxygen to produce sulphur dioxide, a colourless, suffocating gas.

$$S + O_2 \longrightarrow SO_2$$

In the troposphere, some of the sulphur dioxide reacts with oxygen to form sulphur trioxide,

$$2SO_2 + O_2 \longrightarrow 2\,SO_3$$

which then reacts with water vapour in the air to produce tiny suspended droplets of sulphuric acid.

$$SO_3 + H_2\,O \longrightarrow H_2SO_4$$

Some of these droplets react with ammonia in the atmosphere to form solid particles of ammonium sulphate.

$$2\,NH_3 + H_2SO_4 \longrightarrow (NH_4)_2\,SO_4$$

The tiny suspended particles of such salts and carbon (soot) give the resulting industrial smog, a gray colour, explaining why it is sometimes called gray air-smog.

Factors influencing the formation of photochemical and industrial smog , the frequency and severity of smog in an area depend on

i. Local climatic and topography.

ii. Population density

iii. The amount of industry

iv. Usage of fuel in industries and transportation

Questions

1. The term ‘Smog’ was first used by --------------------- to describe the conditions of joy.

Ans: Dr.H.A.Des Voeux

2. Heavy smog greatly decreases ----------------- radiation

Ans: ultraviolet

3. The particulate matter that remains suspended in air is called --------------------

Ans: Suspended Particulate Matter (SPM)

4. Photochemical smog is sometime called as ------------- smog

Ans: Brown air

Match the following

5. Ground – level ozone - harmful to asthma patients and children

6. Industrial - ozone

7. Secondary pollutant - Gray – air smog

Ans

5. Ground – level ozone - harmful to asthma patients and children

6. Industrial - Gray – air smog

7. Secondary pollutant - ozone

True / False

8. Population density is one of the factors influencing the formation of photochemical and industrial smog

Ans: True

9. Smog is a combination of snow and fog

Ans: False (smoke)

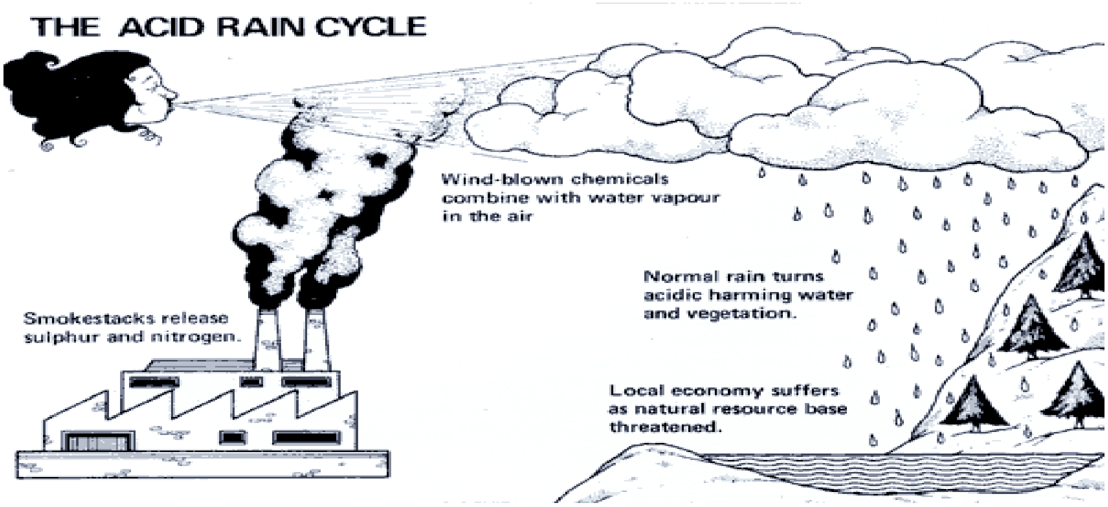
10. In industrial operations, the carbon in coal and oil is converted to carbondioxide only when it is burned

Ans: False (CO_2 and CO)

Lecture.18

Acid rain – source, formation, effect and control measures

Acid rain is rain or any other form of precipitation that is unusually acidic, i.e. elevated levels of hydrogen ions (low pH). It has harmful effects on plants, aquatic animals, and infrastructure. Acid rain is mostly caused by emissions of compounds of sulfur, nitrogen, and carbon which react with the water molecules in the atmosphere to produce acids. However, it can also be caused naturally by the splitting of nitrogen compounds by the energy produced by lightning strikes, or the release of sulfur dioxide into the atmosphere by phenomena of volcanic eruptions.



A major environmental impact of acid deposition is the lowering of pH in lakes and rivers. Most aquatic life is disrupted as the pH drops. Phytoplankton populations are reduced, and much common water – dwelling invertebrates, such as May flies and stone flies, cannot survive when the pH falls below about 6.0. Some sensitive species of fish, including trout and salmon, are harmed when pH levels fall below 5.5. Acidity has a deleterious effect on the reproductive cycle of fish; when the pH is less than 4.9, reproduction of most fish species is unlikely. Acid dead lakes have pH below about 3.5. Acid rain also causes pitting and corrosion of metals and the deterioration of painted surfaces, concrete, limestone, and marble in buildings, monuments, works of art, and other exposed objects.

Once a body of water contains too much acid, the creatures in the water's food chain begin to die. Eggs and larvae are sensitive to low pH and unable to survive. As water becomes more acid, the fertility of eggs is reduced, fewer hatch, and fish may not grow to adult sizes. Eventually, fish or insects, the fish's food, may no longer be able to live in water with a low pH.

The amount of acid in liquids is measured on a scale from 0 to 14. This is called the "pH" scale. A pH of 7.0 (distilled water) is in the middle of the scale and is considered neutral - neither acidic nor alkaline. Things below 7.0 such as lemon juice (pH of 2.0) are acidic. Things above 7.0, like ammonia (pH 11.0) are alkaline. The pH scale is logarithmic. This means that a pH of 6 is ten times more acidic than a pH of 7. A pH of 5 is 100 times more acidic than a pH of 7 and a pH of 4 is 1,000 times more acidic than a pH of 7.

Because carbon dioxide and water found naturally in the atmosphere have a pH of 5.0 to 5.6. Natural rain is slightly acidic. A natural buffering ability present in most soils that contain limestone can neutralize acidity. However, several regions of the country are damaged by acid rain because they have thin soils and granite bedrock. Granite is low in limestone and cannot neutralize (buffer) acid precipitation. Acid rain is a worldwide problem because it can be carried in the atmosphere for great distances before falling back to earth.

Chemical processes

Combustion of fuels creates sulfur dioxide and nitric oxides. They are converted into sulfuric acid and nitric acid.

Gas phase chemistry

In the gas phase sulfur dioxide is oxidized by reaction with the hydroxyl radical via an intermolecular reaction

$SO_2 + OH\cdot \rightarrow HOSO_2\cdot$

Which is followed by:

$HOSO_2\cdot + O_2 \rightarrow HO_2\cdot + SO_3$

In the presence of water, sulfur trioxide (SO_3) is converted rapidly to sulfuric acid:

$SO_3\ (g) + H_2O\ (l) \rightarrow H_2SO_4\ (l)$

Nitrogen dioxide reacts with OH to form nitric acid:

$NO_2 + OH\cdot \rightarrow HNO_3$

Chemistry in cloud droplets

When clouds are present, the loss rate of SO_2 is faster than can be explained by gas phase chemistry alone. This is due to reactions in the liquid water droplets.

Hydrolysis

Sulfur dioxide dissolves in water and then, like carbon dioxide, hydrolyses in a series of equilibrium reactions:

$SO_2\ (g) + H_2O \rightleftharpoons SO_2\cdot H_2O$

$SO_2\cdot H_2O \rightleftharpoons H^+ + HSO_3^-$

$HSO_3^- \rightleftharpoons H^+ + SO_3^{2-}$

Oxidation

There are a large number of aqueous reactions that oxidize sulfur from S (IV) to S (VI), leading to the formation of sulfuric acid. The most important oxidation reactions are with ozone, hydrogen peroxide and oxygen (reactions with oxygen are catalyzed by iron and manganese in the cloud droplets).

Acid deposition types

Wet deposition

Wet deposition of acids occurs when any form of precipitation (rain, snow, etc.) removes acids from the atmosphere and delivers it to the Earth's surface. This can result from the deposition of acids produced in the raindrops or by the precipitation removing the acids either in clouds or below clouds. Wet removal of both gases and aerosols are both of importance for wet deposition.

Dry deposition

Acid deposition also occurs via dry deposition in the absence of precipitation. This can be responsible for as much as 20 to 60% of total acid deposition. This occurs when particles and gases stick to the ground, plants or other surfaces.

Adverse effects

Surface waters and aquatic animals

Both the lower pH and higher aluminum concentrations in surface water that occur as a result of acid rain can cause damage to fish and other aquatic animals. At pHs lower than 5 most fish eggs will not hatch and lower pHs can kill adult fish. As lakes and rivers become more acidic biodiversity is reduced. Acid rain has eliminated insect life and some fish species, including the brook trout in some lakes, streams, and creeks in geographically sensitive areas, such as the Adirondack Mountains of the United States. However, the extent to which acid rain contributes directly or indirectly via runoff from the catchment to lake and river acidity (i.e., depending on characteristics of the surrounding watershed) is variable. The United States Environmental Protection Agency's (EPA) website states: "Of the lakes and streams surveyed, acid rain caused acidity in 75 percent of the acidic lakes and about 50 percent of the acidic streams".

Soils

Soil biology and chemistry can be seriously damaged by acid rain. Some microbes are unable to tolerate changes to low pHs and are killed. The enzymes of these microbes are denatured (changed in shape so they no longer function) by the acid. The hydronium ions of acid rain also mobilize toxins such as aluminium, and leach away essential nutrients and minerals such as magnesium.

$$2\,H^{+}\,(aq) + Mg^{2+}\,(clay) \rightleftharpoons 2\,H^{+}\,(clay) + Mg^{2+}\,(aq)$$

Soil chemistry can be dramatically changed when base cations, such as calcium and magnesium, are leached by acid rain thereby affecting sensitive species, such as sugar maple (*Acer saccharum*).

Forests and other vegetation

Adverse effects may be indirectly related to acid rain, like the acid's effects on soil or high concentration of gaseous precursors to acid rain. High altitude forests are especially vulnerable as they are often surrounded by clouds and fog which are more acidic than rain. Other plants can also be damaged by acid rain, but the effect on food crops is minimized by the application of lime and fertilizers to replace lost nutrients. In cultivated areas, limestone may also be added to increase the ability of the soil to keep the pH stable, but this tactic is largely unusable in the case of wilderness lands. When calcium is leached from the needles of red spruce, these trees become less cold tolerant and exhibit winter injury and even death.

Human health

Scientists have suggested direct links to human health. Fine particles, a large fraction of which are formed from the same gases as acid rain (sulfur dioxide and nitrogen dioxide), have been shown to cause illness and premature deaths such as cancer and other diseases.

Effect of acid rain on statues

Acid rain can also damage buildings and historic monuments, especially those made of rocks such as limestone and marble containing large amounts of calcium carbonate. Acids in the rain react with the calcium compounds in the stones to create gypsum, which then flakes off.

$$CaCO_3\,(s) + H_2SO_4\,(aq) \rightleftharpoons CaSO_4\,(aq) + CO_2\,(g) + H_2O\,(l)$$

The effects of this are commonly seen on old gravestones, where acid rain can cause the inscriptions to become completely illegible. Acid rain also increases the oxidation rate of metals, in particular copper and bronze.

Affected areas

Particularly badly affected places around the globe include most of Europe (particularly Scandinavia with many lakes with acidic water containing no life and many trees dead) many parts of the United States (states like New York are very badly affected) and South Western Canada. Other affected areas include the South Eastern coast of China and Taiwan.

Potential problem areas in the future

Places like much of South Asia (Indonesia, Malaysia and Thailand), Western South Africa (the country), Southern India and Sri Lanka and even West Africa (countries like Ghana, Togo and Nigeria) could all be prone to acidic rainfall in the future.

Prevention methods

Technical solutions

In the United States, many coal-burning power plants use Flue gas desulfurization (FGD) to remove sulfur-containing gases from their stack gases. An example of FGD is the wet scrubber which is commonly used in the U.S. and many other countries. A wet scrubber is basically a reaction tower equipped with a fan that extracts hot smoke stack gases from a power plant into the tower. Lime or limestone in slurry form is also injected into the tower to mix with the stack gases and combine with the sulfur dioxide present. The calcium carbonate of the limestone produces pH-neutral calcium sulfate that is physically removed from the scrubber. That is, the scrubber turns sulfur pollution into industrial sulfates.

In some areas the sulfates are sold to chemical companies as gypsum when the purity of calcium sulfate is high. In others, they are placed in landfill. However, the effects of acid rain can last for generations, as the effects of pH level change can stimulate the continued leaching of undesirable chemicals into otherwise pristine water sources, killing off vulnerable insect and fish species and blocking efforts to restore native life.

Automobile emissions control reduces emissions of nitrogen oxides from motor vehicles.

Easy way to reduce acid rain

- Engines should be tuned properly.
- Reduction of NO_2 and SO_2 at source level.

Questions

<u>Fill ups</u>

1. ----------------- is the form of precipitation that is unusually acidic.

Ans: Acid rain

2. The pH of rain water is --------

Ans: 5.6

3. Acid rain is caused by the emission of ------------- and ------------ oxides into the atmosphere.

Ans: SO_2 and NO_2

4. The ------------------ populations are greatly reduced to aquatic area due to the impact of acid rain.

Ans: phytoplankton

<u>Match the following</u>

5. Wet deposition - form of acid deposition occurs in the absence of precipitation

6. Dry deposition - Dot scrubber

7. Flue gas desulfurixation (FGD) - Form of precipitation removes acids from the atmosphere

Ans

5. Wet deposition - form of precipitation removes acids from the atmosphere

6. Dry deposition - form of acid deposition occurs in the absence of Precipitation

7. Flue gas desulfurixation (FGD) - Dot scrubber

True or False

8. *Acer saccharum* (sugar maple) is an example of acid rain affected sensitive species

Ans: True

9. Acid rain does not have any influence on buildings and historic monuments

Ans: False

10. In coal -burning power plants flue gas desulfurization (FGD) is used to remove sulfur – containing from stack gases

Ans: True

Lecture.19

Global warming: global warning – green house effect – green house gases – latest developments – effect and control measures

Global warming refers to the rising average temperature of Earth's atmosphere and oceans and its projected continuation. In the last 100 years, Earth's average surface temperature increased by about 0.8 °C (1.4 °F) with about two thirds of the increase occurring over just the last three decades. Warming of the climate system is unequivocal, and scientists are more than 90% certain most of it is caused by increasing concentrations of greenhouse gases produced by human activities such as deforestation and burning fossil fuels. These findings are recognized by the national science academies of all the major industrialized countries.

Climate model projections are summarized in the 2007 Fourth Assessment Report (AR4) by the Intergovernmental Panel on Climate Change (IPCC). They indicate that during the 21st century the global surface temperature is likely to rise a further 1.1 to 2.9 °C (2 to 5.2 °F) for their lowest emissions scenario and 2.4 to 6.4 °C (4.3 to 11.5 °F) for their highest. The ranges of these estimates arise from the use of models with differing sensitivity to greenhouse gas concentrations.

An increase in global temperature will cause sea levels to rise and will change the amount and pattern of precipitation, and a probable expansion of subtropical deserts. Warming is expected to be strongest in the Arctic and would be associated with continuing retreat of glaciers, permafrost and sea ice. Other likely effects of the warming include more frequent occurrence of extreme weather events including heatwaves, droughts and heavy rainfall events, species extinctions due to shifting temperature regimes, and changes in agricultural yields. Warming and related changes will vary from region to region around the globe, with projections being more robust in some areas than others. In a 4 °C world, the limits for human adaptation are likely to be exceeded in many parts of the world, while the limits for adaptation for natural systems would largely be exceeded throughout the world. Hence, the ecosystem services upon which human livelihoods depend would not be preserved.

Global warming

Energy from the sun drives the earth's weather and climate, and heats the earth's surface; in turn, the earth radiates energy back into space. Atmospheric greenhouse gases (water vapor, carbon dioxide, and other gases) trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse. Without this natural "**greenhouse effect**," temperatures would be much lower than they are now, and life as known today would not be possible. Instead, thanks to greenhouse gases, the earth's average temperature is a more hospitable 60°F (15.55°C). However, problems may arise when the atmospheric concentration of greenhouse gases increases.

Since the beginning of the industrial revolution, atmospheric concentrations of carbon dioxide have increased nearly 30%, methane concentrations have more than doubled, and nitrous oxide concentrations have risen by about 15%. These increases have enhanced the heat-trapping capability of the earth's atmosphere. Sulfate aerosols, a common air pollutant, cool the atmosphere by reflecting light back into space; however, sulfates are short-lived in the atmosphere and vary regionally.

Reasons for increase in greenhouse gases concentration

The combustion of fossil fuels and other human activities are the primary reason for the increased concentration of carbon dioxide. Plant respiration and the decomposition of organic matter release more than 10 times the CO_2 released by human activities; but these releases have generally been in balance during the centuries leading up to the industrial revolution with carbon dioxide absorbed by terrestrial vegetation and the oceans.

Increasing concentrations of greenhouse gases are likely to accelerate the rate of climate change. Scientists expect that the average global surface temperature could rise 1-4.5°F (0.6-2.5°C) in the next fifty years, and 2.2-10°F (1.4-5.8°C) in the next century, with significant regional variation. Evaporation will increase as the climate warms, which will increase average global precipitation. Soil moisture is likely to decline in many regions, and intense rainstorms are likely to become more frequent. Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Certain human activities, however, add to the levels of most of these naturally occurring gases:

Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned.

Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock.

Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.

Very powerful greenhouse gases that are not naturally occurring include *hydro fluorocarbons* (HFCs), *per fluorocarbons* (PFCs), and *sulfur hexafluoride* (SF_6), which are generated in a variety of industrial processes.

Each greenhouse gas differs in its ability to absorb heat in the atmosphere. HFCs and PFCs are the most heat-absorbent. Methane traps over 21 times more heat per molecule than carbon dioxide, and nitrous oxide absorbs 270 times more heat per molecule than carbon dioxide. Often, estimates of greenhouse gas emissions are presented in units of millions of metric tons of carbon equivalents (MMTCE), which weights each gas by its GWP value, or Global Warming Potential (GWP).

What Are Sinks?

A sink is a reservoir that uptakes a chemical element or compound from another part of its cycle. For example, soil and trees tend to act as natural sinks for carbon – each year hundreds of billions of tons of carbon in the form of CO_2 are absorbed by oceans, soils, and trees.

Global Warming Potentials (100 Year Time Horizon)

Global Warming Potential is a number that refers to the amount of global warming caused by a substance. The GWP is the ratio of the warming caused by a substance to the warming caused by a similar mass of carbon dioxide. Thus, the GWP of CO2 is defined to be 1.0. CFC-12 has a GWP of 8,500, while CFC-11 has a GWP of 5,000. Various HCFCs and HFCs have GWPs ranging from 93 to 12,100. Water, a substitute in numerous end-uses, has a GWP of 0.

Sl.No.	**Gas**	**GWP**
1	Carbon dioxide (CO_2)	1
2	Methane (CH_4)*	21
3	Nitrous oxide (N_2O)	310
4	HFC-23	11,700
5	CF_4	6,500

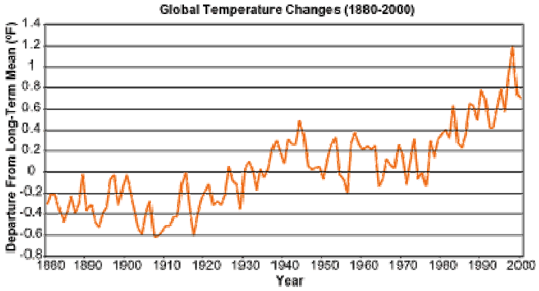
Source: (IPCC 1996)

Effect of Global warming

- Increase in Earths surface temperature
- Melting of glaciers
- Increase in sea level
- Loss of biodiversity
- Affects marine life
- Sinking of cities in coastal region

Control measures

- Massive afforestation programme
- Reducing GHG emissions



Source: U.S. National Climatic Data Center, 2001

Questions

1. ------- is the primary source of heat energy.

Ans: Sun

2. The increase in average temperature of earth's near surface is known as ----------------

Ans: Global warming

3. ----------- in the troposphere does contribute to surface warming

Ans: Ozone

4. -------------- gas is the major contributor to green house effect.

Ans: CO_2

Match the following

5. Green house effect - reservoir that uptakes chemical element from another part of the cycle

6. Mitigation measures - IPCC

7. Kyoto protocol - amount of global warming caused by a substance

8. Working group on climate Change - agreement on reducing GHG emission

9. Global warming potential - Joseph fourier

10. Sinks - carbon capture and storage (CCS) approach

Ans

5. Green house effect - Joseph fourier

6. Mitigation measures - carbon capture and storage (CCS) approach

7. Kyoto protocol - agreement on reducing GHG emission

8. Working group on climate Change - IPCC

9. Global warming potential - amount of global warming caused by a substance

10. Sinks - reservoir that uptakes chemical element from another part of the cycle

Lecture.20

Ozone layer - importance, ozone formation and depletion, ozone depleting substances, chemistry and control measures

Ozone depletion describes two distinct, but related observations: a slow, steady decline of about 4% per decade in the total volume of ozone in Earth's stratosphere (ozone layer) since the late 1970s, and a much larger, but seasonal, decrease in stratospheric ozone over Earth's polar regions during the same period. The latter phenomenon is commonly referred to as the **ozone hole**. In addition to this well-known stratospheric ozone depletion, there are also tropospheric ozone depletion events, which occur near the surface in polar regions during spring.

The detailed mechanism by which the polar ozone holes form is different from that for the mid-latitude thinning, but the most important process in both trends is catalytic destruction of ozone by atomic chlorine and bromine. The main source of these halogen atoms in the stratosphere is photodissociation of chlorofluorocarbon (CFC) compounds, commonly called freons, and of bromofluorocarbon compounds known as halons. These compounds are transported into the stratosphere after being emitted at the surface. Both ozone depletion mechanisms strengthened as emissions of CFCs and halons increased.

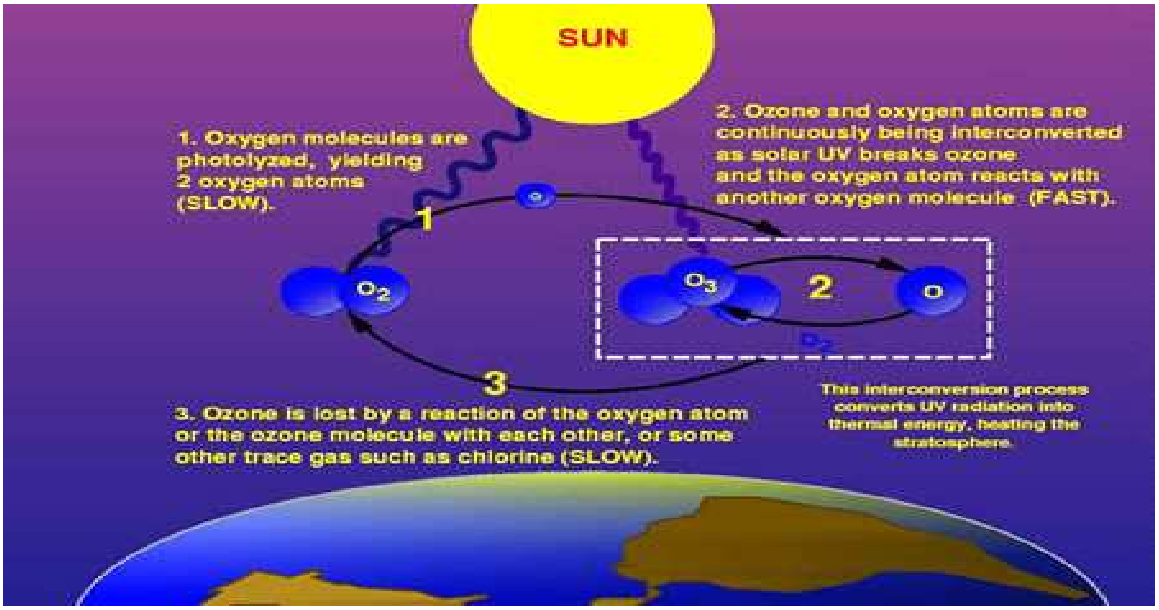
Ozone layer: the region of the stratosphere containing the bulk of atmospheric ozone. The ozone layer lies approximately 15-40 kilometers (10-25 miles) above the Earth's surface, in the stratosphere. Depletion of this layer by ozone depleting substances (ODS) will lead to higher UVB levels, which in turn will cause increased skin cancers and cataracts and potential damage to some marine organisms, plants, and plastics.

UV: ultraviolet radiation

Ultraviolet radiation is a portion of the electromagnetic spectrum with wavelengths shorter than visible light. The sun produces UV, which is commonly split into three bands: UVA, UVB, and UVC. UVA is not absorbed by ozone. UVB is mostly absorbed by ozone, although some reaches the Earth. UVC is completely absorbed by ozone and normal oxygen.

UVB: a band of ultraviolet radiation with wavelengths from 280-320 nanometers produced by the Sun. UVB is a kind of ultraviolet light from the sun (and sun lamps) that has several harmful effects; particularly effective at damaging DNA. It is a cause of melanoma and other types of skin cancer. It has also been linked to damage to some materials, crops, and marine organisms. The ozone layer protects the Earth against most UVB coming from the sun. It is always important to protect oneself against UVB, even in the absence of ozone depletion, by wearing hats, sunglasses, and sunscreen.

Ozone (O_3) - a form of oxygen. It is naturally created in the Stratosphere when ultraviolet radiation breaks down the oxygen molecule (O_2) into two individual oxygen atoms. Each of these atoms combines with an O_2 molecule to form ozone. Essential in one part (stratosphere) and a pollutant in another part of the atmosphere (troposphere)



Ozone shield - the stratosphere (layer above the troposphere) is the location of ozone shield. Ozone in stratosphere forms naturally when oxygen reacts with incoming ultraviolet (UV) radiation (from sun). Stratospheric ozone blocks much of the UV from penetrating to Earth's surface - reflects it out; approximately 99% of all ultraviolet solar radiation is absorbed or screened out in the ozone layer

Ozone is constantly being produced and destroyed in a natural cycle, as shown in the above picture. However, the overall amount of ozone is essentially stable. This balance can be thought of as a stream's depth at a particular location. Although individual water molecules are moving past the observer, the total depeth remains constant. Similarly, while ozone production and destruction are balanced, ozone levels remain stable. This was the situation until the past several decades.

The Ozone Layer protects us from the harmful effects of certain wavelengths of ultra-violet (UV) light from the sun, specifically UV-B. Any significant decrease in ozone in the stratosphere would result in an increase of UV-B radiation reaching the earth surface. Increases in levels of UV-B radiation can result in the increase in skin cancers, suppress the immune system, exacerbate eye disorders including cataracts and affect plants, animals and plastic materials.

Ozone-Depleting Substance(s) (ODS): a compound that contributes to stratospheric ozone depletion. ODS include CFCs, HCFCs, halons, methyl bromide, carbon tetrachloride, and methyl chloroform. ODS are generally very stable in the troposphere and only degrade under intense ultraviolet light in the stratosphere. When they break down, they release chlorine or bromine atoms, which then deplete ozone. Chlorofluorocarbons (CFCs) invented in 1928 found many uses in aerosols, foams, refrigeration, air conditioners, solvents, fire extinguishers etc. These CFCs are long lived; their emissions reach the stratosphere and cause ozone depletion. This ozone depletion has been dramatically confirmed through the Antarctic "Ozone Hole" discovered in 1985 and observations, since then, of ozone depletion in the middle and higher latitudes by the satellite Nimbus-7.

Carbon Tetrachloride (CCl4): a compound consisting of one carbon atom and four chlorine atoms.Carbon tetrachloride was widely used as a raw material in many industrial uses, including the production of CFCs, and as a solvent. Solvent use ended when it was discovered to be carcinogenic. It is also used as a catalyst to deliver chlorine ions to certain processes. Its ozone depletion potential is 1.2.

Chlorofluorocarbon (CFC): a compound consisting of chlorine, fluorine, and carbon CFCs are very stable in the troposphere. They are broken down by strong ultraviolet light in the stratosphere and release chlorine atoms that then deplete the ozone layer. CFCs are commonly used as refrigerants, solvents, and foam blowing agents. The most common CFCs are CFC-11, CFC-12, CFC-113, CFC-114, and CFC-115. The ozone depletion potential (ODP) for each CFC is, respectively, 1, 1, 0.8, 1, and 0.6.

Ozone Depletion Potential (ODP): a number that refers to the amount of ozone depletion caused by a substance. The ODP is the ratio of the impact on ozone of a chemical compared to the impact of a similar mass of CFC-11. Thus, the ODP of CFC-11 is defined to be 1.0. Other CFCs and HCFCs have ODPs that range from 0.01 to 1.0. The halons have ODPs ranging up to 10. Carbon tetrachloride has an ODP of 1.2, and methyl chloroform's ODP is 0.11. HFCs have zero ODP because they do not contain chlorine.

Dobson Unit (DU): a measurement of column ozone levels. If 100 DU of ozone were brought to the Earth's surface, it would form a layer 1 millimeter thick. In the tropics, ozone levels are typically between 250 and 300 DU year-round. In temperate regions, seasonal variations can produce large swings in ozone levels.

Ozone depletion in the stratosphere

The Cause

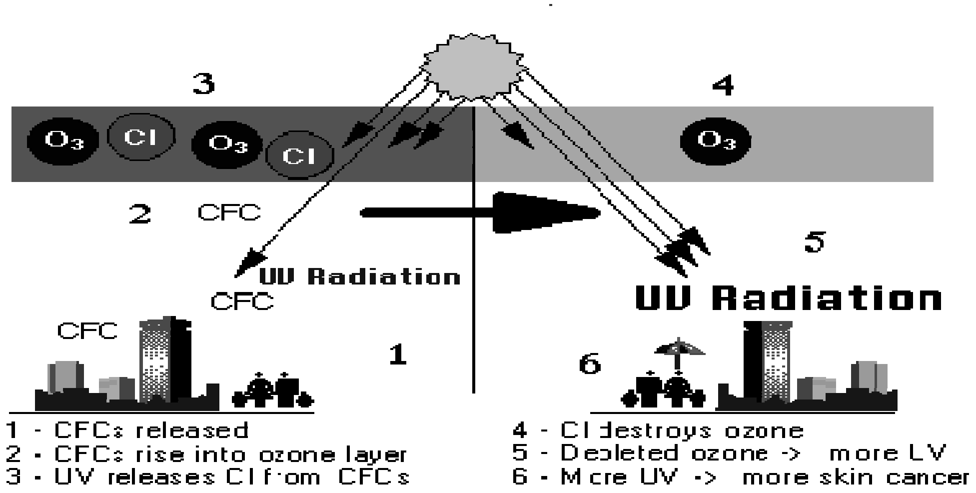
a. Ozone is broken down by human-made pollutants. Primary cause is chlorofluorocarbons (CFCs) which are normally used as propellants in aerosol cans, as coolants in air conditioner (AC) and refrigerators, as foam for insulation and packaging, as sterilizers for hospitals.

b. Also caused by halons (in many fire extinguishers), methyl chloroform (used to degrease metals), and carbon tetrachloride (used to manufacture pesticides and dyes) contain chlorine

c. Oxides of NOx released by super sonic transport system (SST)

The ozone depletion process begins when CFCs and other ozone-depleting substances (ODS) are emitted into the atmosphere

1. Winds efficiently mix the troposphere and evenly distribute the gases. CFCs are extremely stable, and they do not dissolve in rain. After a period of several years, ODS molecules reach the stratosphere, about 10 kilometers above the Earth's surface
2. Strong UV light breaks apart the ODS molecule. CFCs release chlorine atoms, and halons release bromine atoms
3. It is these atoms that actually destroy ozone, not the intact ODS molecule. It is estimated that one chlorine atom can destroy over 100,000 ozone molecules before finally being removed from the stratosphere
4. Large increases in stratospheric chlorine and bromine, however, have upset that balance. In effect, they have added a siphon downstream, removing ozone faster than natural ozone creation reactions can keep up. Therefore, ozone levels fall.



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Since ozone filters out harmful UVB radiation, less ozone means higher UVB levels at the surface. The more depletion, the larger the increase in incoming UVB. UVB has been linked to skin cancer, cataracts, damage to materials like plastics, and harm to certain crops and marine organisms. Although some UVB reaches the surface even without ozone depletion, its harmful effects will increase as a result of this problem.

Health Effects due to ozone depletion

1. Skin Cancer (melanoma and nonmelanoma)
2. Premature aging of the skin and other skin problems
3. Cataracts and other eye damage
4. Immune system suppression
5. Increased eye burning due to photochemical smog in troposphere
6. Decreased yield of crops
7. Damage to aquatic life and alteration in ocean food webs
8. Increased global warming

Other Skin Damage

Other UV-related skin disorders include actinic keratoses and premature aging of the skin. Actinic keratoses are skin growths that occur on body areas exposed to the sun. The face, hands, forearms, and the "V" of the neck are especially susceptible to this type of lesion. Although premalignant, actinic keratoses are a risk factor for squamous cell carcinoma. Look for raised, reddish, rough-textured growths and seek prompt medical attention if you discover them. Chronic exposure to the sun also causes premature aging, which over time can make the skin become thick, wrinkled, and leathery. Since it occurs gradually, often manifesting itself many years after the majority of a person's sun exposure, premature aging is often regarded as an unavoidable, normal part of growing older. With proper protection from UV radiation, however, most premature aging of the skin can be avoided.

Cataracts and Other Eye Damage: Cataracts are a form of eye damage in which a loss of transparency in the lens of the eye clouds vision. If left untreated, cataracts can lead to blindness. Research has shown that UV radiation increases the likelihood of certain cataracts. Although curable with modern eye surgery, cataracts diminish the eyesight of millions of Americans and cost billions of dollars in medical care each year. Other kinds of eye damage include pterygium (i.e., tissue growth that can block vision), skin cancer around the eyes, and degeneration of the macula (i.e., the part of the retina where visual perception is most acute). All of these problems can be lessened with proper eye protection from UV radiation. **World Ozone day is being celebrated every year by 16th of September.**

Questions

1. The decrease in stratospheric ozone over earths Polar Regions in the late 1970's resulted in the formation of --------------

Ans: Ozone hole

2. The main source of halogen atoms in the stratosphere is due to photo dissociation of ------------ compounds.

Ans: chlorofluorocarbon

3. World ozone day --------------------

Ans: September 16

True / False

4. The overall amount of ozone in the stratosphere is determined by a balance photochemical production and recombination

Ans: True

5. Ozone molecules absorbs the UV light between 310 and 200 nm.

Ans: True

6. Ozone is an example for primary pollutant

Ans: False

Match

7. $Cl + O_3$: HCl and $ClONO_2$

8. Reservoir species	:	Cl + $2O_2$
9. ClO + O_3	:	O
10. Atomic oxygen	:	ClO + O_2

Ans

7. Cl + O_3	:	ClO + O_2
8. Reservoir species	:	HCl and $ClONO_2$
9. ClO + O_3	:	Cl + $2O_2$
10. Atomic oxygen	:	O

Lecture.21

Biomagnification – Introduction, definition, process and control

When a living organism cannot metabolize or excrete ingested substance that substance gradually accumulates in the organisms. This phenomenon, called biological accumulation (or bioaccumulation), refers to the process by which a substance first enters into a food chain. The extent to which bioaccumulation will occur depends on an organism's metabolism and on the solubility of the substance first enters a food chain. If the substance is soluble in fat, it will typically accumulate in the fatty tissues of the organism. Bioaccumulation is of particular concern when the substance being concentrated is a toxic environmental pollutant and the organism is of a relatively low trophic level in a food chain.

When many contaminated organisms are consumed by second organism that can neither metabolize nor excrete the substance, the concentration of the substance will build to even higher levels in the second organism. This effect is magnified at each successive trophic level, and the process is called **biological magnification** (or biomagnification) or bioamplification, In other words, biomagnification is the steadily increasing concentration of a substance as it moves from one level of a food chain to the next (for example, from plankton to fish to birds or to humans). Biomagnification is of particular importance when chemicals are concentrated to harmful levels in organisms higher up in the food chain. Even very low concentrations of environmental pollutants can eventually find their way into organisms in high enough doses to cause serious problems.

Biomagnifications occurs only when the pollutants are environmentally persistent (last a long time before breaking down into simpler compounds), mobile, and soluble in fats. If they are not persistent, they will not last long enough in the environment to be concentrated in the food chain (persistent substances are generally not biodegradable). If they are not mobile, that is, not easily transported or moved from place to place in the environment, they are not likely to be consumed by many organisms. Finally, if they are soluble in water rather than fatty tissue, they are much more likely to be excreted by the organism before building up to dangerous levels.

Impact of DDT

The incidence of mercury poisoning in people who consumed contaminated fish in the Minamata Bay region of Japan in the 1950s is just one example of the detrimental effects of biomagnification. Another classic example involves DDT, an abbreviation for the organic chemical dichlorodiphenyltrichloroethane. It is a type of chemical known as chlorinated hydrocarbon, and it takes a long time to break down in the environment. With a "half-life" of 15 years, if 10 kg of DDT were released into the environment in the year 2000, 5 kg would still persist in the year 2015, about 2.5 kg would remain in 2030, and even after 100 years had elapsed, in the year 2100, more than 100 g of the substance would still be detected in the environment. Of course, long before that time span elapsed, some of the DDT could be inadvertently consumed by living organisms as they forage for food, and thereby enter a food chain.

DDT is toxic to insects, but not very toxic to humans. It was much used in World War II to protect U.S. troops from tropical mosquito – borne malaria as well as to prevent the spread of lice and lice-borne disease among civilian populations in Europe. After the war, DDT was used to protect food crops from insects as well as to protect people from insect-borne disease. As one of the first of the modern pesticides, it was overused, and by the 1960s, the problems related to biomagnifications of DDT became very apparent.

Many other substances in addition to mercury and DDT exhibit bioaccumulation and biomagnification in an ecosystem. These include copper, cadmium, lead, and other heavy metals, pesticides other than DDT, cyanide, selenium and PCBs.

Although sometimes used interchangeably with 'bioaccumulation,' an important distinction is drawn between the two, and with bioconcentration, it is also important to distinct between sustainable development and overexploitation in biomagnification.

- **Bioaccumulation** occurs within a trophic level, and is the increase in concentration of a substance in certain tissues of organisms' bodies due to absorption from food and the environment.
- **Bioconcentration** is defined as occurring when uptake from the water is greater than excretion (Landrum and Fisher, 1999)

Thus bioconcentration and bioaccumulation occur within an organism, and biomagnification occurs across trophic (food chain) levels.

Substances that biomagnify

There are two main groups of substances that biomagnify. Both are lipophilic and not easily degraded. Novel organic substances are not easily degraded because organisms lack previous exposure and have thus not evolved specific detoxification and excretion mechanisms, as there has been no selection pressure from them. These substances are consequently known as 'persistent organic pollutants' or POPs.

Metals are not degradable because they are elements. Organisms, particularly those subject to naturally high levels of exposure to metals, have mechanisms to sequester and excrete metals. Problems arise when organisms are exposed to higher concentrations than usual, which they cannot excrete rapidly enough to prevent damage. These metals are transferred in an organic form.

Novel organic substances

- DDT
- PCBs
- Toxaphene
- Monomethylmercury

Inorganic substances

- Arsenic
- Cadmium
- Mercury

Persistent organic pollutant

Persistent organic pollutants (**POP**s) are organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic processes. Because of this, they have been observed to persist in the environment, to be capable of long-range transport, bioaccumulate in human and animal tissue, biomagnify in food chains, and to have potential significant impacts on human health and the environment.

Many POPs are currently or were in the past used as pesticides. Others are used in industrial processes and in the production of a range of goods such as solvents, polyvinyl chloride, and pharmaceuticals. Though there are a few natural sources of POPs, most POPs are created by humans in industrial processes, either intentionally or as byproducts.

Compounds

In May 1995, the United Nations Environment Programme Governing Council (GC) decided to begin investigating POPs, initially beginning with a short list of the following twelve POPs, known as the 'dirty dozen': aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, hexachlorobenzene, mirex, polychlorinated biphenyls, polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and toxaphene.

Since then, this list has generally been accepted to include such substances as carcinogenic polycyclic aromatic hydrocarbons (PAHs) and certain brominated flame-retardants, as well as some organometallic compounds such as tributyltin (TBT).

The groups of compounds that make up POPs are also classed as PBTs (**P**ersistent, Bioaccumulative and Toxic) or TOMPs (Toxic Organic Micro Pollutants.)

Chemical properties

Some of the chemical characteristics of POPs include low water solubility, high lipid solubility, semi-volatility, and high molecular masses. POPs with molecular weights lower than 236 g/mol are less toxic, less persistent in the environment, and have more reversible effects than those with higher molecular masses. POPs are frequently halogenated, usually with chlorine. The more chlorine groups a POP has, the more resistant it is to being broken down over time. One important factor of their chemical properties such as lipid solubility results in the ability to pass through biological phospholipid membranes and bioaccumulate in the fatty tissues of living organisms.

Long-range transport

POPs released to the environment have been shown to travel vast distances from their original source. Due to their chemical properties, many POPs are semi-volatile and insoluble. These compounds are therefore unable to transport directly through the environment. The indirect routes include attachment to particulate matter, and through the food chain. The chemicals' semi-volatility allows them to travel long distances through the atmosphere before being deposited. Thus POPs can be found all over the world, including in areas where they have never been used and remote regions such as the middle of oceans and Antarctica. The chemicals' semi-volatility also means that they tend to volatilize in hot regions and accumulate in cold regions, where they tend to condense and stay. PCBs have been found in precipitation.

The ability of POPs to travel great distances is part of the explanation for why countries that banned the use of specific POPs are no longer experiencing a decline in their concentrations; the wind may carry chemicals into the country from places that still use them.

Health concerns

POP exposure can cause death and illnesses including disruption of the endocrine, reproductive, and immune systems; neurobehavioral disorders; and cancers possibly including breast cancer. Exposure to POPs can take place through diet, environmental exposure, or accidents.

A study published in 2006 indicated a link between blood serum levels of POPs and diabetes. Individuals with elevated levels of persistent organic pollutants (DDT, dioxins, PCBs and Chlordane, among others) in their body were found to be up to 38 times more likely to be insulin resistant than individuals with low levels of these pollutants, though the study did not demonstrate a cause and effect relationship. As most exposure to POPs is through consumption of animal fats, study participants with high levels of serum POPs are also very likely to be consumers of high amounts of animal fats, and thus the consumption of the fats themselves, or other associated factors may be responsible for the observed increase in insulin resistance. Another possibility is that insulin resistance causes increased accumulation of POPs. Among study participants, obesity was associated with diabetes only in people who tested high for these pollutants. These pollutants are accumulated in animal fats, so minimizing consumption of animal fats may reduce the risk of diabetes. According to the US Department of Veterans Affairs, type 2 diabetes is on the list of presumptive diseases associated with exposure to Agent Orange (which contained 2,3,7,8-tetrachlorodibenzodioxin) in the Vietnam War.

Questions

Fill ups

1. The process by which a substance first enters a food chain is called ---------------

Ans: Bioaccumulation

2. Expansion of DDT is ----------------------------

Ans: dichlorodiphenyl trichloroethane

3. The steadily increasing concentration of a substance from one level of food chain to the next is known as ------------------

Ans: Biological magnification / biomagnification

4. The substances that biomagnifies are consequently known as -----------------------

Ans: persistent organic pollutants (POPs)

5. The process occurring when uptake from the water is greater than excretion is -------------

Ans: Bioconcentration

Match the following

6. Inorganic substances of biomagnifications : POPs

7. Toxic organic Micro pollutants : Arsenic

8. United Nation environment programme
Governing council (AC) Dirty dozen : Group of compounds that make up POPs

9. POP exposure : 15 years

10. Half life of DDT : Causes death and disruption of reproduction &
immune systems

Answer

6. Inorganic substances of biomagnifications : Arsenic

7. Toxic organic Micro pollutants : Group of compounds that make up POPs

8. United Nation environment programme
Governing council (AC) Dirty dozen : POPs

9. POP exposure : Causes death and disruption of
reproduction &
Immune systems

10. Half life of DDT : 15 years

Lecture.22

Sewage water source, characteristics, sewage treatment process

Sewage treatment, or **domestic wastewater treatment**, is the process of removing contaminants from wastewater and household sewage, both runoff (effluents) and domestic. It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Its objective is to produce a waste stream (or treated effluent) and a solid waste or sludge suitable for discharge or reuse back into the environment. This material is often inadvertently contaminated with many toxic organic and inorganic compounds.

Origins of sewage

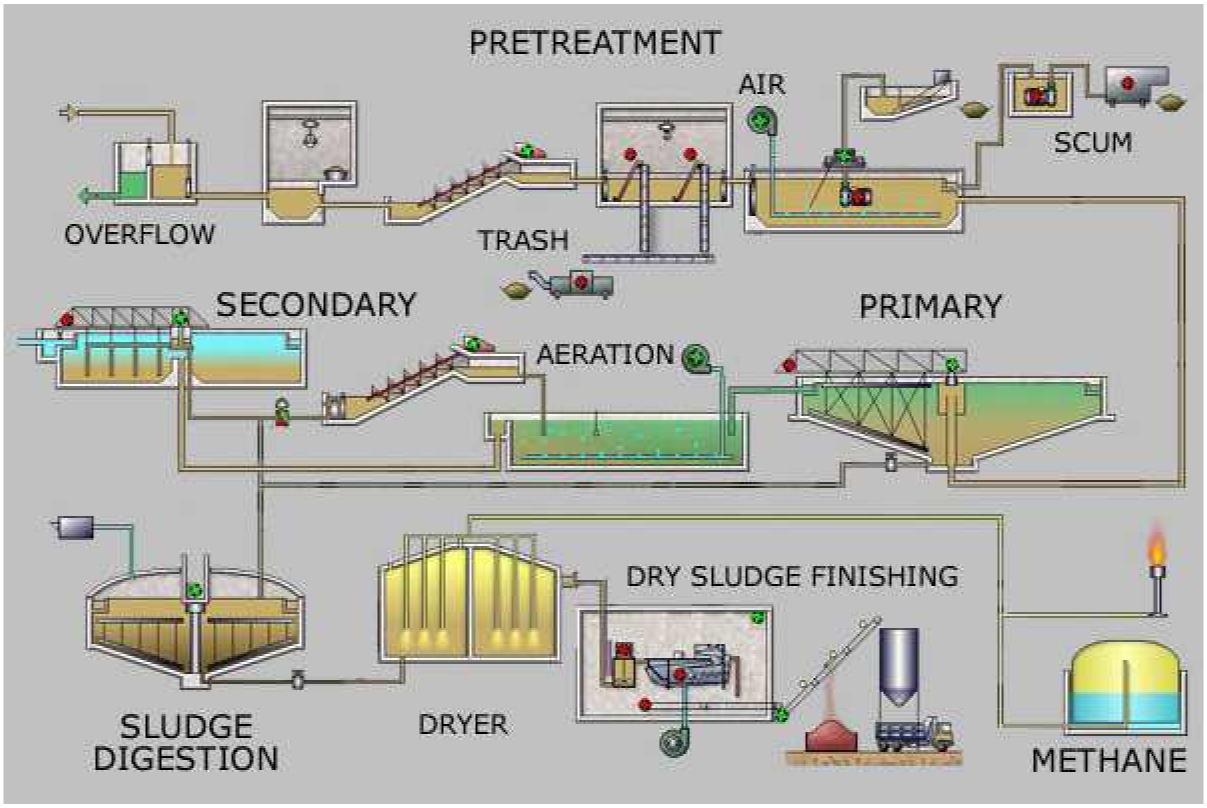
Sewage is created by residences, institutions, and commercial and industrial establishments. Raw influent (sewage) includes household waste liquid from toilets, baths, showers, kitchens, sinks, and so forth that is disposed of via sewers. In many areas, sewage also includes liquid waste from industry and commerce. The separation and draining of household waste into greywater and blackwater is becoming more common in the developed world, with greywater being permitted to be used for watering plants or recycled for flushing toilets. A lot of sewage also includes some surface water from roofs or hard-standing areas. Municipal wastewater therefore includes residential, commercial, and industrial liquid waste discharges, and may include storm water runoff. Sewage systems capable of handling storm water are known as combined systems or combined sewers. Such systems are usually avoided since they complicate and thereby reduce the efficiency of sewage treatment plants owing to their seasonality. The variability in flow also leads to often larger than necessary, and subsequently more expensive, treatment facilities. In addition, heavy storms that contribute more flows than the treatment plant can handle may overwhelm the sewage treatment system, causing a spill or overflow. It is preferable to have a separate storm drain system for storm water in areas that are developed with sewer systems.

As rainfall runs over the surface of roofs and the ground, it may pick up various contaminants including soil particles and other sediment, heavy metals, organic compounds, animal waste, and oil and grease. Some jurisdictions require storm water to receive some level of treatment before being discharged directly into waterways. Examples of treatment processes used for storm water include sedimentation basins, wetlands, buried concrete vaults with various kinds of filters, and vortex separators (to remove coarse solids).

Process overview

Sewage can be treated close to where it is created (in septic tanks, biofilters or aerobic treatment systems), or collected and transported via a network of pipes and pump stations to a municipal treatment plant. Sewage collection and treatment is typically subject to local, state and federal regulations and standards. Industrial sources of wastewater often require specialized treatment processes.

Conventional sewage treatment may involve three stages, called primary, secondary and tertiary treatment. Primary treatment consists of temporarily holding the sewage in a quiescent basin where heavy solids can settle to the bottom while oil, grease and lighter solids float to the surface. The settled and floating materials are removed and the remaining liquid may be discharged or subjected to secondary treatment. Secondary treatment removes dissolved and suspended biological matter. Secondary treatment is typically performed by indigenous, water-borne micro-organisms in a managed habitat. Secondary treatment may require a separation process to remove the micro-organisms from the treated water prior to discharge or tertiary treatment. Tertiary treatment is sometimes defined as anything more than primary and secondary treatment. Treated water is sometimes disinfected chemically or physically (for example by lagoons and microfiltration) prior to discharge into a stream, river, bay, lagoon or wetland, or it can be used for the irrigation of a golf course, green way or park. If it is sufficiently clean, it can also be used for groundwater recharge or agricultural purposes.



Pre-treatment

Pre-treatment removes materials that can be easily collected from the raw wastewater before they damage or clog the pumps and skimmers of primary treatment clarifiers.

Screening

The influent sewage water is strained to remove all large objects carried in the sewage stream. This is most commonly done with an automated mechanically raked bar screen in modern plants serving large populations, whilst in smaller or less modern plants a manually cleaned screen may be used. The raking action of a mechanical bar screen is typically paced according to the accumulation on the bar screens and/or flow rate. The solids are collected and later disposed in a landfill or incinerated.

Grit removal

Pretreatment may include a sand or grit channel or chamber where the velocity of the incoming wastewater is carefully controlled to allow sand, grit and stones to settle.

Primary treatment

In the primary sedimentation stage, sewage flows through large tanks, commonly called "primary clarifiers" or "primary sedimentation tanks". The tanks are large enough that sludge can settle and floating material such as grease and oils can rise to the surface and be skimmed off. The main purpose of the primary sedimentation stage is to produce both a generally homogeneous liquid capable of being treated biologically and a sludge that can be separately treated or processed. Primary settling tanks are usually equipped with mechanically driven scrapers that continually drive the collected sludge towards a hopper in the base of the tank from where it can be pumped to further sludge treatment stages. Grease and oil from the floating material can sometimes be recovered for saponification.

Secondary treatment

Secondary treatment is designed to substantially degrade the biological content of the sewage such as are derived from human waste, food waste, soaps and detergent. The majority of municipal plants treat the settled sewage liquor using aerobic biological processes. For this to be effective, the biota require both oxygen and a substrate on which to live. There are a number of ways in which this is done. In all these methods, the bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon molecules, etc.) and bind much of the less soluble fractions into floc. Secondary treatment systems are classified as

- **fixed-film** or
- **Suspended-growth**.

Fixed-film or attached growth system treatment process including trickling filter and rotating biological contactors where the biomass grows on media and the sewage passes over its surface.

In **suspended-growth** systems, such as activated sludge, the biomass is well mixed with the sewage and can be operated in a smaller space than fixed-film systems that treat the same amount of water. However, fixed-film systems are more able to cope with drastic changes in the amount of biological material and can provide higher removal rates for organic material and suspended solids than suspended growth systems. Roughing filters are intended to treat particularly strong or variable organic loads, typically industrial, to allow them to then be treated by conventional secondary treatment processes. Characteristics include typically tall, circular filters filled with open synthetic filter media to which wastewater is applied at a relatively high rate. They are designed to allow high hydraulic loading and a high flow-through of air. On larger installations, air is forced through the media using blowers. The resultant wastewater is usually within the normal range for conventional treatment processes.

- Activated sludge
- Surface-aerated basins
- Filter beds (oxidizing beds)
- Trickling filter
- Biological aerated filters
- Membrane bioreactors

Secondary sedimentation

The final step in the secondary treatment stage is to settle out the biological floc or filter material and produce sewage water containing very low levels of organic material and suspended matter.

- Rotating biological contactors

Tertiary treatment

The purpose of tertiary treatment is to provide a final treatment stage to raise the effluent quality before it is discharged to the receiving environment (sea, river, lake, ground, etc.). More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also called "effluent polishing".

Filtration

Sand filtration removes much of the residual suspended matter. Filtration over activated carbon removes residual toxins.

Lagooning

Lagooning provides settlement and further biological improvement through storage in large man-made ponds or lagoons. These lagoons are highly aerobic and colonization by native macrophytes, especially reeds, is often encouraged. Small filter feeding invertebrates such as Daphnia and species of Rotifera greatly assist in treatment by removing fine particulates.

Constructed wetlands

Constructed wetlands include engineered reedbeds and a range of similar methodologies, all of which provide a high degree of aerobic biological improvement and can often be used instead of secondary treatment for small communities. One example is a small reedbed used to clean the drainage from the elephants' enclosure at Chester Zoo in England.

Nutrient removal

Wastewater may contain high levels of the nutrients nitrogen and phosphorus. Excessive release to the environment can lead to a buildup of nutrients, called eutrophication, which can in turn encourage the overgrowth of weeds, algae, and cyanobacteria (blue-green algae). This may cause an algal bloom, a rapid growth in the population of algae. The algae numbers are unsustainable and eventually most of them die. The decomposition of the algae by bacteria uses up so much of oxygen in the water that most or all of the animals die, which creates more organic matter for the bacteria to decompose. In addition to causing deoxygenation, some algal species produce toxins that contaminate drinking water supplies. Different treatment processes are required to remove nitrogen and phosphorus.

Nitrogen removal

The removal of nitrogen is effected through the biological oxidation of nitrogen from ammonia (nitrification) to nitrate, followed by denitrification, the reduction of nitrate to nitrogen gas. Nitrogen gas is released to the atmosphere and thus removed from the water.

Nitrification itself is a two-step aerobic process, each step facilitated by a different type of bacteria. The oxidation of ammonia (NH_3) to nitrite (NO_2^-) is most often facilitated by *Nitrosomonas spp*. (nitroso referring to the formation of a nitroso functional group). Nitrite oxidation to nitrate (NO_3^-), though traditionally believed to be facilitated by *Nitrobacter spp*. (nitro referring the formation of a nitro functional group), is now known to be facilitated in the environment almost exclusively by *Nitrospira spp.*

Denitrification requires anoxic conditions to encourage the appropriate biological communities to form. It is facilitated by a wide diversity of bacteria. Sand filters, lagooning and reed beds can all be used to reduce nitrogen, but the activated sludge process (if designed well) can do the job the most easily. Since denitrification is the reduction of nitrate to dinitrogen gas, an electron donor is needed. This can be, depending on the wastewater, organic matter (from faeces), sulfide, or an added donor like methanol. Sometimes the conversion of toxic ammonia to nitrate alone is referred to as tertiary treatment. Many sewage treatment plants use axial flow pumps to transfer the nitrified mixed liquor from the aeration zone to the anoxic zone for denitrification. These pumps are often referred to as Internal Mixed Liquor Recycle pumps (IMLR pumps).

Phosphorus removal

Phosphorus removal is important as it is a limiting nutrient for algae growth in many fresh water systems. It is also particularly important for water reuse systems where high phosphorus concentrations may lead to fouling of downstream equipment such as reverse osmosis.

Phosphorus can be removed biologically in a process called enhanced biological phosphorus removal. In this process, specific bacteria, called polyphosphate accumulating organisms (PAOs), are selectively enriched and accumulate large quantities of phosphorus within their cells (up to 20% of their mass). When the biomass enriched in these bacteria is separated from the treated water, these biosolids have a high fertilizer value.

Phosphorus removal can also be achieved by chemical precipitation, usually with salts of iron (e.g. ferric chloride), aluminum (e.g. alum), or lime. This may lead to excessive sludge productions as hydroxides precipitates and the added chemicals can be expensive. Chemical phosphorus removal requires significantly smaller equipment footprint than biological removal, is easier to operate and is often more reliable than biological phosphorus removal. Once removed, phosphorus, in the form of a phosphate rich sludge, may be stored in a land fill or resold for use in fertilizer.

Disinfection

The purpose of disinfection in the treatment of wastewater is to substantially reduce the number of microorganisms in the water to be discharged back into the environment. The effectiveness of disinfection depends on the quality of the water being treated (e.g., cloudiness, pH, etc.), the type of disinfection being used, the disinfectant dosage (concentration and time), and other environmental variables. Cloudy water will be treated less successfully since solid matter can shield organisms, especially from ultraviolet light or if contact times are low. Generally, short contact times, low doses and high flows all militate against effective disinfection. Common methods of disinfection include ozone, chlorine, or ultraviolet light. Chloramine, which is used for drinking water, is not used in wastewater treatment because of its persistence.

Chlorination remains the most common form of wastewater disinfection in North America due to its low cost and long-term history of effectiveness. One disadvantage is that chlorination of residual organic material can generate chlorinated-organic compounds that may be carcinogenic or harmful to the environment. Residual chlorine or chloramines may also be capable of chlorinating organic material in the natural aquatic environment. Further, because residual chlorine is toxic to aquatic species, the treated effluent must also be chemically dechlorinated, adding to the complexity and cost of treatment.

Ultraviolet (UV) light can be used instead of chlorine, iodine, or other chemicals. Because no chemicals are used, the treated water has no adverse effect on organisms that later consume it, as may be the case with other methods. UV radiation causes damage to the genetic structure of bacteria, viruses, and other pathogens, making them incapable of reproduction. The key disadvantages of UV disinfection are the need for frequent lamp maintenance and replacement and the need for a highly treated effluent to ensure that the target microorganisms are not shielded from the UV radiation (i.e., any solids present in the treated effluent may protect microorganisms from the UV light). In the United Kingdom, light is becoming the most common means of disinfection because of the concerns about the impacts of chlorine in chlorinating residual organics in the wastewater and in chlorinating organics in the receiving water. Edmonton and Calgary, Alberta, Canada also use UV light for their effluent water disinfection.

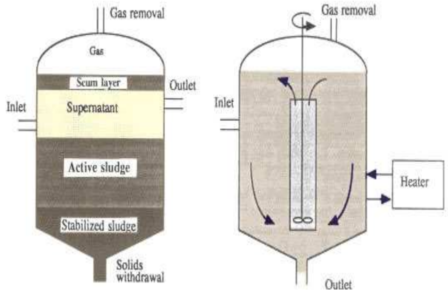
Ozone O_3 is generated by passing oxygen O_2 through a high voltage potential resulting in a third oxygen atom becoming attached and forming O_3. Ozone is very unstable and reactive and oxidizes most organic material it comes in contact with, thereby destroying many pathogenic microorganisms. Ozone is considered to be safer than chlorine because, unlike chlorine which has to be stored on site (highly poisonous in the event of an accidental release), ozone is generated onsite as needed. Ozonation also produces fewer disinfection by-products than chlorination. A disadvantage of ozone disinfection is the high cost of the ozone generation equipment and the requirements for special operators.

Odour removal

Early stages of processing will tend to produce smelly gasses, hydrogen sulfide being most common in generating complaints from nearby areas. Large process plants in urban areas will often contain a foul air removal tower, comprised of air circulators, a contact media with bio-slimes, and circulating fluids to biologically capture and metabolize the obnoxious gasses previously contained by reactor enclosures.

- **Package plants and batch reactors**

Sludge treatment and disposal



The sludges accumulated in a wastewater treatment process must be treated and disposed of in a safe and effective manner. The purpose of digestion is to reduce the amount of organic matter and the number of disease-causing microorganisms present in the solids. The most common treatment options include anaerobic digestion, aerobic digestion, and composting. Incineration is also used albeit to a much lesser degree.

Choice of a wastewater solid treatment method depends on the amount of solids generated and other site-specific conditions. However, in general, composting is most often applied to smaller-scale applications followed by aerobic digestion and then lastly anaerobic digestion for the larger-scale municipal applications.

Anaerobic digestion

Anaerobic digestion is a bacterial process that is carried out in the absence of oxygen. The process can either be thermophilic digestion, in which sludge is fermented in tanks at a temperature of 55°C, or mesophilic, at a temperature of around 36°C. Though allowing shorter retention time (and thus smaller tanks), thermophilic digestion is more expensive in terms of energy consumption for heating the sludge.

Anaerobic Digestion is the most common (mesophilic) treatment of Domestic Sewage in Septic Tanks, which normally retain the sewage, from one day to two days, reducing the B.O.D. by about 35 to 40%. This reduction can be increased by a combination of anaerobic and aerobic by installing '[Aerobic Treatment Units]' (ATUs) in the Septic Tank. One major feature of anaerobic digestion is the production of biogas, which can be used in generators for electricity production and/or in boilers for heating purposes.

Aerobic digestion

Aerobic digestion is a bacterial process occurring in the presence of oxygen. Under aerobic conditions, bacteria rapidly consume organic matter and convert it into carbon dioxide. The operating costs used to be characteristically much greater for aerobic digestion because of the energy used by the blowers, pumps and motors needed to add oxygen to the process. However, since the recent advent of stone fibre filter technology which uses natural air currents for oxygenation, this no longer applies. Aerobic digestion can also be achieved by using jet aerators to oxidize the sludge.

Composting

Composting is also an aerobic process that involves mixing the sludge with sources of carbon such as sawdust, straw or wood chips. In the presence of oxygen, bacteria digest both the wastewater solids and the added carbon source and, in doing so, produce a large amount of heat.

- Incineration
- Sludge disposal
- Treatment in the receiving environment

Questions

1. The process of removing contaminant from waste water and household run off by means suitable treatment is known as -------------------------

Ans: sewage treatment / domestic waste water treatment

2. Conventional sewage treatment may involve ----------------

Ans: Primary secondary and tertiary treatment

3. Sewage systems capable of handling storm water are known as -----------------

Ans: Combined systems / combined sewers

4. The solids collected from the screening are disposed off in a ------------ or ------------

Ans: land fill, incineration

Match

5. Lagoons - Freckling filter

6. Grit removal - Activated sludge

7. Secondary treatment - Disinfection of treated water chemically or physically

8. Filter beds - Pre-treatment process

Ans

5. Lagoons - Disinfection of treated water chemically or physically

6. Grit removal - Pre-treatment process

7. Secondary treatment - Activated sludge

8. Filter beds - Freckling filter

True / False

9. Rotating biological contractors (RBCs) are mechanical secondary treatment system that is capable of withstanding surges in organic load.

Ans: True

10. Anaerobic digestion is a bacterial process occurring in the presence of oxygen

Ans: False

Lecture.22
Sewage water source, characteristics, sewage treatment process

Hazardous Waste is a "solid waste" which because of its quantity, concentration, or physical, chemical, or infectious characteristics may:

- Pose a substantial present or potential hazard to human health or the environment when improperly treated, stored or disposed of, or otherwise mismanaged; or
- Cause or contribute to an increase in mortality, or an increase in irreversible or incapacitating illness.

A "solid waste" is defined as any discarded material that is abandoned by being disposed of, burned or incinerated, recycled or considered "waste-like." A solid waste can physically be a solid, liquid, semi-solid, or container of gaseous material. A waste is classified as a hazardous waste if it has a hazardous characteristic listed below or is listed as a hazardous waste in EPA's page with the list of identifies hazardous wastes. Hazardous Characteristics:

Ignitable Hazardous Waste

- A liquid waste which has a flash point of less than or equal to 140 degrees F (60 degrees C) as determined by an approved test method.

- A non-liquid waste which, under standard conditions, is capable of causing a fire through friction, absorption of moisture or a spontaneous chemical change and when ignited, the waste burns so vigorously and persistently that it creates a hazard.
- An ignitable compressed gas or oxidizer.

Corrosive Hazardous Waste

- An aqueous waste with a pH of less than or equal to 2 or greater than or equal to 12.5 is considered to be a corrosive hazardous waste.
- A liquid waste that corrodes steel at a minimum rate of .25 inch per year as determined by an approved test method.

Reactive Hazardous Waste

- A solid waste that is normally unstable, reacts violently with water, or generates toxic gases when exposed to water or other materials.

Toxic Hazardous Waste

- A waste that contains certain substances determined to be harmful at or in excess of the maximum concentration. Some of those substances include lead, arsenic, and mercury.
- Many things that are thrown out in the rubbish, like some household batteries, car oil, or old paint, can contain harmful chemicals that damage the environment. Find out how to dispose safely of domestic hazardous waste.

Domestic hazardous

What is hazardous waste?

Waste is hazardous when it has properties that might make it harmful to human health or the environment. The term 'hazardous' does not always mean that such waste is immediately harmful, though some can be.

What types of waste are hazardous?

Domestic wastes that may be hazardous include:

- Asbestos

- Pesticides
- Fluorescent tubes
- Oils
- Some paints
- Some household and car batteries
- Discarded electrical equipment such as TVs and computer monitors, fridges and freezers

How to dispose of hazardous waste

Disposal methods

Incineration is a waste treatment technology that involves the combustion of organic materials and / or substances. Incineration and other high temperature waste treatment systems are described as "thermal treatment". Incineration of waste materials converts the waste into incinerator bottom ash, flue gases, particulates, and heat, which can in turn be used to generate electric power. The flue gases are cleaned of pollutants before they are dispersed in the atmosphere.

Incineration with energy recovery is one of several waste-to-energy (WtE) technologies such as gasification, Plasma arc gasification, pyrolysis and anaerobic digestion. Incineration may also be implemented without energy and materials recovery.

In several countries there are still expert and local community concerns about the environmental impact of incinerators. In some countries, incinerators built just a few decades ago often did not include a materials separation to remove hazardous, bulky or recyclable materials before combustion. These facilities tended to risk the health of the plant workers and the local environment due to inadequate levels of gas cleaning and combustion process control. Most of these facilities did not generate electricity.

Incinerators reduce the mass of the original waste by 80–85 % and the volume (already compressed somewhat in garbage trucks) by 95-96 %, depending upon composition and degree of recovery of materials such as metals from the ash for recycling. This means that while incineration does not completely replace land filling, it reduces the necessary volume for disposal significantly. Garbage trucks often reduce the volume of waste in a built-in compressor before delivery to the incinerator. Alternatively, at landfills, the volume of the uncompressed garbage can be reduced by approximately 70% with the use of a stationary steel compressor, albeit with a significant energy cost. In many countries simpler waste compaction is a common practice for compaction at landfills.

Incineration has particularly strong benefits for the treatment of certain waste types in niche areas such as clinical wastes and certain hazardous wastes where pathogens and toxins can be destroyed by high temperatures. Examples include chemical multi-product plants with diverse toxic or very toxic wastewater streams, which cannot be routed to a conventional wastewater treatment plant.

Waste combustion is particularly popular in countries such as Japan where land is a scarce resource. Denmark and Sweden have been leaders in using the energy generated from incineration for more than a century, in localized combined heat and power facilities supporting district heating schemes. In 2005, waste incineration produced 4.8 % of the electricity consumption and 13.7 % of the total domestic heat consumption in Denmark. A number of other European Countries rely heavily on incineration for handling municipal waste, in particular Luxembourg, The Netherlands, Germany and France.

Pyrolysis is the chemical decomposition of condensed substances by heating that occurs spontaneously at high enough temperatures. The word is coined from the Greek-derived elements pyro "fire" and lysys "decomposition".

Pyrolysis is a special case of thermolysis, and is most commonly used for organic materials, being then one of the processes involved in charring. The pyrolysis of wood, which starts above 300 °C, occurs for example in fires or when vegetation comes into contact with lava in volcanic eruptions. In general, pyrolysis of organic substances produces gas and liquid products and leaves a solid residue richer in carbon content. Extreme pyrolysis, which leaves mostly carbon as the residue, is called carbonization.

This chemical process is heavily used in the chemical industry, for example, to produce charcoal, activated carbon, methanol and other chemicals from wood, to convert ethylene dichloride into vinyl chloride to make PVC, to produce coke from coal, to convert biomass into syngas, to turn waste into safely disposable substances, and for transforming medium-weight hydrocarbons from oil into lighter ones like gasoline. These specialized uses of pyrolysis may be called various names, such as dry distillation, destructive distillation, or cracking.

Pyrolysis also plays an important role in several cooking procedures, such as baking, frying, grilling and caramelizing. It is also a tool of chemical analysis, for example in mass spectrometry and in carbon-14 dating. Indeed, many important chemical substances, such as phosphorus and sulfuric acid, were first obtained by this process. Pyrolysis has been assumed to take place during catagenesis, the conversion of buried organic matter to fossil fuels. It is also the basis of pyrography.

Pyrolysis differs from other high-temperature processes like combustion and hydrolysis in that it does not involve reactions with oxygen, water, or any other reagents. However, the term has also been applied to the decompositon of organic material in the presence of superheated water or steam (hydrous pyrolysis), for example in the steam cracking of oil. Deforestation is the permanent destruction of indigenous forests and woodlands. The term does not include the removal of industrial forests such as plantations of gums or pines. Deforestation has resulted in the reduction of indigenous forests to four-fifths of their pre-agricultural area. Indigenous forests now cover 21% of the earth's land surface.

Questions

1. Any discarded material that is abandoned by being disposed of, burned / incinerated, recycled is considered to be ------------------

Ans: Solid waste

2. A solid waste that is unstable and generates toxic gases when exposed to water is called --------

Ans: Reactive Hazardous waste

3. One example of hazardous wastes ----------------

Ans: Hospital wastes

4. The burning of any waste completely into ashes is known as ------------

Ans: Incineration

5. The chemical decomposition of condensed substances by heating at higher temperature is known as ---------------

Ans: Pyrolysis

Match the following

6. Indigenous forests - carbonization
7. Extreme pyrolysis - cutting of trees
8. Uses of pyrolysis - covers 21% of earths land surface
9. Deforestation - electronic wastes
10. Batteries - dry distillation or destructive distillation

Ans

6. Indigenous forests - carbonization
7. Extreme pyrolysis - cutting of trees
8. Uses of pyrolysis - covers 21% of earths land surface
9. Deforestation - electronic wastes
10. Batteries - dry distillation or destructive distillation

Lecture.24

Deforestation – forms, causes – Consequences of Deforestation, conservation strategy

What are forests and woodlands?

In a forest the crowns of individual trees touch to form a single canopy. In a woodland, trees grow far apart, so that the canopy is open.

Of great concern is the rate at which deforestation is occurring. Currently, 12 million hectares of forests are cleared annually. Almost all of this deforestation occurs in the moist forests and open woodlands of the tropics. At this rate all moist tropical forest could be lost by the year 2050, except for isolated areas in Amazonia, the Zaire basin, as well as a few protected areas within reserves and parks. Some countries such as Ivory Coast, Nigeria, Costa Rica, and Sri Lanka are likely to lose all their tropical forests by the year 2010 if no conservation steps are taken.

How does it happen?

Deforestation is an environmental problem that is happening in many places, and affecting the whole world. Deforestation is the destruction or removal of rainforests. Trees are cut down for

Deforestation

logging companies, for animals to have land to graze and so farmers have land for their crops. The removal of the forests may seem like it affects only the immediate surroundings, but it really affects the world as a whole. In regions where deforestation occurs there is an influx in the temperature extremes. There is no shade during the day, and no insulation during the night. Once the trees and shade are gone, the once moist soil soon becomes dry and cracked. This leads to flooding and erosion. There is nothing to absorb the rainfall and no roots to hold the soil in place. Another huge problem of deforestation is its contribution to the greenhouse effect. The greenhouse effect is when gases in the atmosphere trap the sun's heat causing global warming. Since trees are half carbon, all of that carbon is released into the atmosphere when they are burned. Unfortunately carbon dioxide is one of the gases that contribute to the greenhouse effect. Since three quarters of the deforestation is due to the burning of the forests, the burning of trees accounts for a quarter of the carbon dioxide that is released into the atmosphere each year.

There is really no easy solution to deforestation. One possible solution is recycling. If more people recycle, there will be less dependence on disposable products like paper plates and paper towels. If there is no demand for these products there would be a decrease in the need for logging in the rainforests. Another possible solution to deforestation is the increase in the number of tree plantations. The rainforests destroyed by logging could also be replaced by new trees. In South America, the main area where deforestation occurs, there are currently no laws about deforestation. There are talks about a set of laws, but nothing is currently in place. If a law was made requiring loggers to plant new trees in place of the ones they cut down it would help the problem of deforestation.

Deforestation is brought about by the following

- Conversion of forests and woodlands to agricultural land to feed growing numbers of people;
- Development of cash crops and cattle ranching, both of which earn money for tropical countries;

- Commercial logging (which supplies the world market with woods such as meranti, teak, mahogany and ebony) destroys trees as well as opening up forests for agriculture;
- Felling of trees for firewood and building material; the heavy lopping of foliage for fodder; and heavy browsing of saplings by domestic animals like goats.

To compound the problem, the poor soils of the humid tropics do not support agriculture for long. Thus people are often forced to move on and clear more forests in order to maintain production.

Consequences of Deforestation

Alteration of local and global climates through disruption of:

a) The carbon cycle. Forests act as a major carbon store because carbon dioxide (CO_2) is taken up from the atmosphere and used to produce the carbohydrates, fats, and proteins that make up the tree. When forests are cleared, and the trees are either burnt or rot, this carbon is released as CO_2. This leads to an increase in the atmospheric CO_2 concentration. CO_2 is the major contributor to the greenhouse effect. It is estimated that deforestation contributes one-third of all CO_2 releases caused by people.

b) The water cycle. Trees draw ground water up through their roots and release it into the atmosphere (transpiration). In Amazonia over half of all the water circulating through the region's ecosystem remains within the plants. With removal of part of the forest, the region cannot hold as much water. The effect of this could be a drier climate.

- Soil erosion with the loss of a protective cover of vegetation more soil is lost.
- Silting of water courses, lakes and dams This occurs as a result of soil erosion.
- Extinction of species which depend on the forest for survival. Forests contain more than half of all species on our planet - as the habitat of these species is destroyed, so the number of species declines.

- Desertification The causes of desertification are complex, but deforestation is one of the contributing factors

Questions

1. ---------------- are the crowns of individual trees that touch to form a single canopy.

Ans: Forests

2. The activity of cutting of trees for firewood and building material is known as -------------

Ans: **Deforestation**

3. ---------- is the major contributor to the green house effect.

Ans: **CO_2**

4. The green house effect is the trapping of atmospheric gases from the suns heat results in -------

Ans: Global warming

5. Currently ---------------- hectares of forests are cleared annually

Ans: 12 million

Match

6. Logging of commercial woods - Desertification
7. Consequence of deforestation - Planting of indigenous trees
8. World resources institute - Forests
9. Action to minimize deforestation - Teak, ebony and meranti
10. Carbon store - USA

Ans

6. Logging of commercial woods - Teak, ebony and meranti
7. Consequence of deforestation - Desertification

8. World resources institute - USA

9. Action to minimize deforestation - Planting of indigenous trees

10. Carbon store - Forests

Lecture.25

Deforestation – forms, causes – Consequences of Deforestation, conservation strategy

The **Central Pollution Control Board (CPCB) of India**, statutory organisation, was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974. Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.

It serves as a field formation and also provides technical services to the Ministry of Environment and Forests of the provisions of the Environment (Protection) Act, 1986. Principal **Functions** of the CPCB, as spelt out in the Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981, (i) to promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution, and (ii) to improve the quality of air and to prevent, control or abate air pollution in the country.

Air Quality Monitoring is an important part of the air quality management. The **National Air Monitoring Programme** (NAMP) has been established with objectives to determine the present air quality status and trends and to control and regulate pollution from industries and other source to meet the air quality standards. It also provides background air quality data needed for industrial siting and towns planning.

Besides this, CPCB has an automatic monitoring station at ITO Intersection in New Delhi. At this station Respirable Suspended Particulate Matter (RSPM), Carbon Monoxide (CO), Ozone (O_3), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2) and Suspended Particulate Matter (SPM) are being monitored regularly. This information on Air Quality at ITO is updated every week.

Fresh water is a finite resource essential for use in agriculture, industry, propagation of wildlife & fisheries and for human existence. India is a riverine country. It has 14 major rivers, 44 medium rivers and 55 minor rivers besides numerous lakes, ponds and wells which are used as primary source of drinking water even without treatment. Most of the rivers being fed by monsoon rains, which are limited to only three months of the year, run dry throughout the rest of the year often carrying wastewater discharges from industries or cities/towns endangering the quality of our scarce water resources. The parliament of India in its wisdom enacted the Water (Prevention and Control of Pollution) Act, 1974 with a view to maintaining and restoring wholesomeness of our water bodies. One of the mandates of CPCB is to collect, collate and disseminate technical and statistical data relating to water pollution. Hence, **Water Quality Monitoring (WQM)** and Surveillance are of utmost importance.

Functions of the Central Board at the National Level

- Advise the Government of India on any matter concerning prevention and control of water and air pollution and improvement of the quality of air.
- Plan and cause to be executed a nation-wide programme for the prevention, control or abatement of water and air pollution;
- Co-ordinate the activities of the State Board and resolve disputes among them;
- Provide technical assistance and guidance to the State Boards, carry out and sponsor investigation and research relating to problems of water and air pollution, and for their prevention, control or abatement;
- Plan and organise training of persons engaged in programme on the prevention, control or abatement of water and air pollution;
- Organise through mass media, a comprehensive mass awareness programme on the prevention, control or abatement of water and air pollution;
- Collect, compile and publish technical and statistical data relating to water and air pollution and the measures devised for their effective prevention, control or abatement;
- Prepare manuals, codes and guidelines relating to treatment and disposal of sewage and trade effluents as well as for stack gas cleaning devices, stacks and ducts;

- Disseminate information in respect of matters relating to water and air pollution and their prevention and control;
- Lay down, modify or annul, in consultation with the State Governments concerned, the standards for stream or well, and lay down standards for the quality of air; and
- Perform such other function as may be prescribed by the Government of india.

Functions of the Central Board as State Boards for the Union Territories

- Advise the Governments of Union Territories with respect to the suitability of any premises or location for carrying on any industry which is likely to pollute a stream or well or cause air pollutions; Lay down standards for treatment of sewage and trade effluents and for emissions from automobiles, industrial plants, and any other polluting source; Evolve efficient methods for disposal of sewage and trade effluents on land; develop reliable and economically viable methods of treatment of sewage, trade effluent and air pollution control equipment; Identify any area or areas within Union Territories as air pollution control area or areas to be notified under the Air (Prevention and Control of Pollution) Act, 1981; Assess the quality of ambient water and air, and inspect wastewater treatment installations, air pollution control equipment, industrial plants or manufacturing process to evaluate their performance and to take steps for the prevention, control and abatement of air and water pollution.

As per the policy decision of the Government of India, the CPCB has delegated its powers and functions under the Water (Prevention and Control of Pollution) Act, 1974, the Water (Prevention and Control of Pollution) Cess Act, 1977 and the Air (Prevention and Control of Pollution) Act, 1981 with respect to Union Territories to respective local administrations. CPCB along with its counterparts State Pollution Control Boards (SPCBs) are responsible for implementation of legislations relating to prevention and control of environmental pollution.

National Air Quality Monitoring Programme

Central Pollution Control Board is executing a nation-wide programme of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP). The network consists of three hundred and forty two (342) operating stations covering one hundred and twenty seven (127) cities/towns in twenty six (26) states and four (4) Union Territories of the country.

The objectives of the N.A.M.P. are to determine status and trends of ambient air quality; to ascertain whether the prescribed ambient air quality standards are violated; to Identify Non-attainment Cities; to obtain the knowledge and understanding necessary for developing preventive and corrective measures and to understand the natural cleansing process undergoing in the environment through pollution dilution, dispersion, wind based movement, dry deposition, precipitation and chemical transformation of pollutants generated.

Under N.A.M.P., four air pollutants viz ., Sulphur Dioxide (SO_2), Oxides of Nitrogen as NO2, Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM / PM10) have been identified for regular monitoring at all the locations. The monitoring of meteorological parameters such as wind speed and wind direction, relative humidity (RH) and temperature were also integrated with the monitoring of air quality.

The monitoring of pollutants is carried out for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter) with a frequency of twice a week, to have one hundred and four (104) observations in a year. The monitoring is being carried out with the help of Central Pollution Control Board; State Pollution Control Boards; Pollution Control Committees; National Environmental Engineering Research Institute (NEERI), Nagpur. CPCB co-ordinates with these agencies to ensure the uniformity, consistency of air quality data and provides technical and financial support to them for operating the monitoring stations. N.A.M.P. is being operated through various monitoring agencies. Large number of personnel and equipments are involved in the sampling, chemical analyses, data reporting etc. It increases the probability of variation and personnel biases reflecting in the data, hence it is pertinent to mention that these data be treated as indicative rather than absolute.

Water quality

CPCB in collaboration with concerned SPCBs/PCCs established a nationwide network of water quality monitoring comprising 1019 stations in 27 States and 6 Union Territories. The monitoring is done on monthly or quarterly basis in surface waters and on half yearly basis in case of ground water. The monitoring network covers 200 Rivers, 60 Lakes, 5 Tanks, 3 Ponds, 3 Creeks, 13 Canals, 17 Drains and 321 Wells. Among the 1019 stations, 592 are on rivers, 65 on lakes, 17 on drains, 13 on canals, 5 on tanks, 3 on creeks, 3 on ponds and 321 are groundwater stations.

Presently the inland water quality-monitoring network is operated under a three-tier programme i.e. Global Environment Monitoring System (GEMS), Monitoring of Indian National Aquatic Resources System (MINARS) and Yamuna Action Plan (YAP). Water samples are being analysed for 28 parameters consisting of 9 core parameters, 19 other physico-chemical and bacteriological parameters apart from the field observations. Besides this, 9 trace metals and 22 pesticides are also analysed in selected samples. Biomonitoring is also carried out on specific locations. In view of limited resources, limited numbers of organic pollution related parameters are monitored i.e. micro pollutants (Toxic Metals & POPs) are analysed once in a year to assess the water quality. The water quality data are reported in Water Quality Status Year Book.

National Water Quality
Monitoring Network National Water Quality at a Glance

The water quality data on rivers, lakes, ponds, tanks and groundwater locations being monitored under the network is evaluated against the water quality criteria and the monitoring locations in exceedence with respect to one or more parameters are identified as polluted, which requires action for restoration of water quality. The locations on rivers, lakes, ponds, tanks and groundwater not meeting the criteria are summarized ahead.

Questions

1. ------- was entrusted with the powers and functions to promulgate laws in favour to environmental protection.

Ans: CPCB

2. The air prevention and control of pollution act was framed in the year -------

Ans: 1981

3. ----------------- monitoring is an important part of the air quality management.

Ans: Air quality

4. CPCB has an automatic monitoring station at ITO intersection in ----------- in India.

Ans: New Delhi

5. NEERI is functioning at ------------- in India.

Ans: Nagpur

Match the following

6. Inland water quality Monitoring network - 1974
7. Water Act - Determine the status and friends of ambient air quality
8. Objective of NAMP - Global environment monitoring system (GEMS)
9. Meteorological parameter - New Delhi
10. CPCB - wind direction, relative humidity

Ans

6. Inland water quality Monitoring network - Global environment monitoring system (GEMS)

7. Water Act - 1974

8. Objective of NAMP - Determine the status and friends of ambient air quality

9. Meteorological parameter - wind direction, relative humidity

10. CPCB - New Delhi

Lecture.26

Prevention and control of pollution – technological and sociological measures and solution, Indian and global efforts. Environmental act, law, policy and legislation in india

Man has drawn so much from nature for the satisfaction of his needs, desires and ambitions resulting in the immediate need for proper environmental management. The proper environmental management requires that society and man's demands should be so regulated that natural environment is able to sustain the need for development. The question of environmental protection would essentially be a question of re-allocation of priorities among various needs and choosing among diverse means for meeting them. The environmental protection is the concern of everyone. The fundamental question before the world today is whether we can allow the destruction of the environment leading to the destruction of all life on the earth. Hence protection of environment is of paramount importance.

Environmental laws of India

Major legislations directly dealing with the protection of environment in India are

1. The wild life protection Act, 1972.
2. The water (Prevention and control of pollution) Act, 1974.
3. The forest conservation Act, 1980.
4. The air (Prevention and control of pollution) Act, 1981.
5. The Environment (Protection) Act, 1986.
6. The Public Liability Insurance Act, 1991.
7. The National Environment Tribunal Act, 1995.

The wild life protection Act, 1972 provides for rational and modern wildlife management, while the forest protection Act, 1980 has been enacted to check indiscriminate deforestation and diversion of forest land for non-forest purposes. The water and air Acts are the major instruments for the control of water and air pollution and these have provided for the establishment of the Central and State Pollution Control Boards.

Environmental protection under Indian constitution

The 42nd Amendment to the constitution brought about in the year 1974 inserted two new Articles namely.

(I) Art. 48-A under Directive principles of State Policy, making it the responsibility of the State Government to protect and improve the environment and to safeguard the forests and wildlife of the country.

(II) Art. 51-A (g) under Fundamental duties of citizens; making it the fundamental duty of every citizen to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures.

The Environment (Protection) act, (EPA) 1986 is a landmark legislation which provides for a single focus in the country for the protection of environment and aims at plugging the loopholes in the existing legislation. It is a comprehensive legislation to deal with water, air and land pollution and hazardous wastes and handling, storage and transportation of hazardous chemicals and wastes.

Important sections of EPA, 1986

Section 1: define the terms, environment, environmental pollutant, environmental pollution and hazardous substance.

Section 2: Power of Central Government to take measures to protect and improve environment.

Section 3: Appointment of officers and their powers and functions for the purpose of this Act.

Section 4: Power to give directions to the closure, prohibition or regulation of industry, operation or process; or stoppage or regulation of the supply of electricity or water or any other service.

Section 5: Rules to regulate environmental pollution. Rules in respect of

- Standards of quality of air, water or soil for various areas and purposes;
- Maximum allowable limits of concentrations of environmental pollutants (including noise) for different areas;
- Procedures and safeguards for handling hazardous substances.
- Prohibition and restriction on the handling of hazardous substances in different areas.
- Prohibition and restriction on the location of industries and carrying on of processes and operations in different areas;
- Procedures and safeguards for the prevention of accidents which may cause environmental pollution and for providing for remedial measures for such accidents.

The Public liability Insurance Act, 1991, provides for mandatory insurance for the purpose of providing immediate relief to the persons affected by accidents occurring while handling any hazardous substance.

The National Environmental Tribunal Act, 1995, seeks to constitute a tribunal with Benches to award compensation for damage to persons, property and the environment arising out of any activity involving hazardous substances. All these Acts are amended from time to time to rationalize and expand their scope, coverage and penal provisions.

Indian Environmental of laws and legislation

- The Water (Prevention and Control of Pollution) Act, 1974, as amended up to 1988
- The Water (Prevention and Control of Pollution) Rules, 1975
- The Water (Prevention and Control of Pollution) (Procedure for Transaction of Business) Rules, 1975
- The Water (Prevention and Control of Pollution) Cess Act, 1977, as amended by Amendment Act, 1991
- The Water (Prevention and Control of Pollution) Cess Rules, 1978
- The Air (Prevention and Control of Pollution) Act, 1981, as amended by Amendment Act, 1987
- The Air (Prevention and Control of Pollution) Rules,1982
- The Air (Prevention and Control of Pollution) (Union Territories) Rules, 1983
- The Environment (Protection) Act, 1986
- The Environment (Protection) Rules, 1986
- Environmental impact Assessment of Development Projects
- Hazardous Wastes (Management and Handling) Rules, 1989
- Manufacture, Storage and Import of Hazardous Chemical Rules, 1989
- Manufacture, Use, Import, Export and Storage of Hazardous Micro-Organisms Genetically Engineered Organisms or Cells rules, 1989
- Scheme of Labelling of Environment Friendly Products (ECO-MARKS)
- Restricting certain activities Range in special Specified area of Aravalli
- Bio-Medical Waste (Management and Handling) Rules, 1998
- The National Environment Tribunal Act, 1995
- The National Environmental Appellat Authority Act, 1997
- The Environment (Protection) (Second Amendment Rules), 1999 - Emission Standards for New Generator Sets
- The Public Liability Insurance Act, 1991
- The Public Liability Insurance Rules, 1991
- National Forest Policy, 1988

- Forest (Conservation) Act, 1980
- Forest (Conservation) Rules, 1981
- The Eco Sensitive Zone - Pachmarhi, Notification, 1998
- Re-cycled Plastics Manufacture and Usage Rules, 1999
- 2-T Oil (Regulation of Supply and Distribution) Order, 1998
- Coastal Regulation Zone - Notifications
- Environment (Siting for Industrial Projects) Rules, 1999 - Notification
- Taj Trapezium Zone Pollution (Prevent and Control) Authority - Order
- Dumping and Disposal of Flyash - Notification
- Noise Pollution (Regulation and Control) Rules, 2000
- Municipal Solid Wastes (Management & Handling) Rules, 1999 - Notification
- Ozone Depleting Substances (Regulation) Rules, 2000 - Draft Notification

Questions

1. The ------------ amendment to the constitution brought improvement in the environmental protection.

Ans: 42nd

2. In the EPA, 1986, section 6 covers the rules to regulate -------------------

Ans: environmental pollution

3. The water (prevention and control of pollution) rules was framed in the year -----------

Ans: 1975

4. The ------------------------ is landmark for legislation which provides protection of environment in the existing legislation

Ans: environment protection

Match

5. National Environmental Tribunal Act - 1991

6. Wildlife Protection Act - 1980
7. Forest Conservation Act - 1995
8. Water Act - 1975
9. Public Liability Insurance Act - 1974
10. Water (prevention and control of pollution) rules - 1972

Ans

5. National Environmental Tribunal Act - 1995
6. Wildlife Protection Act - 1972
7. Forest Conservation Act - 1980
8. Water Act - 1974
9. Public Liability Insurance Act - 1991
10. Water (prevention and control of pollution) rules - 1975

Lecture.27

Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act

The Environment (Protection) Act

An Act to provide for the protection and improvement of environment and for matters connected there with: Whereas the decisions were taken at the United Nations Conference on the Human Environment held at Stockholm in June, 1972, in which India participated, to take appropriate steps for the protection and improvement of human environment; And whereas it is considered necessary further to implement the decisions aforesaid in so far as they relate to the protection and improvement of environment and the prevention of hazards to human beings, other living creatures, plants and property; Be it enacted by Parliament in the thirty-seventh year of the Republic of India as follows:

Chapter i: Preliminary

1. Short title, extend and commencement

(1) This Act may be called the Environment (Protection) Act, 1986.

(2) It extends to the whole of India.

(3) It shall come into force on such date as the Central Government may, by notification in the Official Gazette, appoint and different dates may be appointed for different provisions of this Act and for different areas.

2. Definitions

In this Act, unless the context otherwise requires,--

(a) "Environment" includes water, air and land and the inter- relationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro-organism and property;

(b) "Environmental pollutant" means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, injurious to environment;

(c) "Environmental pollution" means the presence in the environment of any environmental pollutant;

(d) "handling", in relation to any substance, means the manufacture, processing, treatment, package, storage, transportation, use, collection, destruction, conversion, offering for sale, transfer or the like of such substance;

(e) "hazardous substance" means any substance or preparation which, by reason of its chemical or physico-chemical properties or handling, is liable to cause harm to human beings, other living creatures, plant, micro-organism, property or the environment;

(f) "Occupier", in relation to any factory or premises, means a person who has, control over the affairs of the factory or the premises and includes in relation to any substance, the person in possession of the substance;

(g) "Prescribed" means prescribed by rules made under this Act.

Chapter ii: General powers of the central government

Chapter iii: Prevention, control, and abatement of environmental pollution

Chapter IV: Miscellaneous

The Air (Prevention and control of pollution) act

An Act to provide for the prevention, control and abatement of air pollution, for the establishment, with a view to carrying out the aforesaid purposes, of Boards, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.

Whereas decisions were taken at the United Nations Conference on the Hum an Environment held in Stockholm in June, 1972, in which India participated, to take appropriate steps for the preservation of the natural resources of the earth which, among other things, include the preservation of the quality of air and control of air pollution;

And whereas it is considered necessary to implement the decisions aforesaid in so far as they relate to the preservation of the quality of air and control of air pollution;

Be it enacted by Parliament in the Thirty-second Year of the Republic of India as follows :-

Chapter I: Preliminary

1. Short title, extent and commencement.

(1) This Act may be called the Air (Prevention and Control of Pollution) Act, 1981.

(2) It extends to the whole of India.

(3) It shall come into force on such date[1] as the Central Government may, by notification in the Official Gazette, appoint.

2. Definitions

In this Act, unless the context otherwise requires,-

(a) "Air pollutant" means any solid, liquid or gaseous substance [2][(including noise)] present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment;

(b) "Air pollution" means the presence in the atmosphere of any air

(c) "Approved appliances" means any equipment or gadget used for the bringing of any combustible material or for generating or consuming any fume, gas of particulate matter and approved by the State Board for the purpose of this Act;

(d) "Approved fuel" means any fuel approved by the State Board for the purposes of this Act;

(e) "Automobile" means any vehicle powered either by internal combustion engine or by any method of generating power to drive such vehicle by burning fuel;

(f) "Board" means the Central Board or State Board;

(g) "Central Board- means the [Central Board for the Prevention and Control of Water Pollution] constituted under section 3 of the Water (Prevention and Control of Pollution) Act, 1974;

(h) "Chimney" includes any structure with an opening or outlet from or through which any air pollutant may be emitted,

(i) "Control equipment" means any apparatus, device, equipment or system to control the quality and manner of emission of any air pollutant and includes any device used for securing the efficient operation of any industrial plant;

(j) "Emission" means any solid or liquid or gaseous substance coming out of any chimney, duct or flue or any other outlet;

(k) "Industrial plant" means any plant used for any industrial or trade purposes and emitting any air pollutant into the atmosphere;

(l) "Member" means a member of the Central Board or a State Board, as the case may be, and includes the Chairman thereof,

(m) "Occupier", in relation to any factory or premises, means the person who has control over the affairs of the factory or the premises, and includes, in relation to any substance, the person in possession of the substance.

(n) "Prescribed" means prescribed by rules made under this Act by the Central Government or as the case may be, the State government;

(i) In relation to a State in which the Water (Prevention and Control of Pollution) Act, 1974, is in force and the State Government has constituted for that State a [5][State Board for the Prevention and Control of Water Pollution] under section 4 of that Act, the said State Board; and

(ii) In relation to any other State, the State Board for the Prevention and Control of Air Pollution constituted by the State Government under section 5 of this Act.

Chapter ii: central and state boards for the prevention and control of air pollution

Chapter iii: Powers and functions of boards

Chapter iv: Prevention and control of air pollution

Chapter v: Fund, accounts and audit

Chapter vi: Penalties and procedure

Chapter vii: Miscellaneous

The Water (Prevention & Control of Pollution) Act

The objective of the Act is to prevent and control of water pollution and to maintain or restore wholesome of water. Central and State Governments have constituted Boards for the Act. The Boards composition, terms and conditions of services of members are defined in Section. 3-12. In some States air and water boards are joint boards. The Boards advises the government on any matter concerning the prevention and control of water pollution. It is coordinating the activities and providing technical assistance and guidance. It runs national and state programmes through a mass media. It is collecting, compiling and publishing technical and statistical data, lay down the standard of different constituents of water, management of sewage and trade effluents and giving direction to any pollution units, industry, or person to stop such activity.

The Government have power to restrict any unit, and to take samples of effluents and to get them analysed in Central or State laboratories. Whoever fails to comply with any provision of this Act is punishable with the imprisonment or with fine or with both. Second or third time breaking of the law is further punishable. Under the provision of this Act Central Pollution Control Board was established to fulfill its object.

Wildlife Protection Act

The Wildlife Protection Act of 1972 refers to a sweeping package of legislation enacted in 1972 by the Government of India. Before 1972, India only had five designated national parks. Among other reforms, the Act established schedules of protected plant and animal species; hunting or harvesting these species was largely outlawed.

The Act provides for the protection of wild animals, birds and plants; and for matters connected therewith or ancillary or incidental thereto. It extends to the whole of India, except the State of Jammu and Kashmir which has its own wildlife act. It has six schedules which give varying degrees of protection. Schedule I and part II of Schedule II provide absolute protection - offences under these are prescribed the highest penalties. Species listed in Schedule IV are also protected, but the penalties are much lower. Enforcement authorities have the power to compound offences under this Schedule (i.e. they impose fines on the offenders).

Definitions under the Act (Section 2)

- "Animal" includes amphibians, birds, mammals, and reptiles, and their young, and also includes, in the cases of birds and reptiles, their eggs.

- "Animal article" means an article made from any captive or wild animal, other than vermin, and includes an article or object in which the whole or any part of such animal has been used and an article made therefrom.
- "Hunting" includes

  (a) Capturing, killing, poisoning, snaring, or trapping any wild animal, and every attempt to do so

  (b) Driving any wild animal for any of the purposes specified in sub clause

  (c) Injuring, destroying or taking any body part of any such animal, or in the case of wild birds or reptiles, disturbing or damaging the eggs or nests of such birds or reptiles.

- "Taxidermy" means the curing, preparation or preservation of trophies.
- "Trophy" means the whole or any part of any captive or wild animal (other than vermin) which has been kept or preserved by any means, whether artificial or natural. This includes:

  (a) Rugs, skins, and specimens of such animals mounted in whole or in part through a process of taxidermy

  (b) Antler, horn, rhinoceros horn, feather, nail, tooth, musk, eggs, and nests.

- "Uncured trophy" means the whole or any part of any captive animal (other than vermin) which has not undergone a process of taxidermy. This includes a freshly killed wild animal, ambergris, musk and other animal products.
- "Vermin" means any wild animal specified in Schedule V.
- "Wildlife" includes any animal, bees, butterflies, crustacean, fish and moths; and aquatic or land vegetation which forms part of any habitat.

Hunting (Section 9): This section describes what constitutes hunting and the intent to hunt.

Ownership (Section 40 & 42): Regarding ownership issues and trade licenses.Penalties (Section 51): Penalties are prescribed in section 51. Enforcement can be performed by agencies such as the Forest Department, the Police, the Customs and the Central Bureau of Investigation (CBI). Chargesheets can be filed directly by the Forest Department. Other enforcement agencies, often due to the lack of technical expertise, hand over cases to the Forest Department.

Forest (Conservation) Act

An Act to provide for the conservation of forests and for matters connected therewith or ancillary or incidental thereto. Be it enacted by Parliament in the Thirty-first Year of the Republic of India as follows:-

1. Short title, extent and commencement.

(1) This Act may be called the Forest (Conservation) Act, 1980.

(2) It extends to the whole of India except the State of Jammu and Kashmir.

(3) It shall be deemed to have come into force on the 25th day of October, 1980.

2. Restriction on the de-reservation of forests or use of forest land for non-forest purpose.

Notwithstanding anything contained in any other law for the time being in force in a State, no State Government or other authority shall make, except with the prior approval of the Central Government, any order directing-

(i) That any reserved forest (within the meaning of the expression "reserved forest" in any law for the time being in force in that State) or any portion thereof, shall cease to be reserved;

(ii) That any forest land or any portion thereof may be used for any non-forest purpose;

(iii) That any forest land or any portion thereof may be assigned by way of lease or otherwise to any private person or to any authority, corporation, agency or any other organization not owned, managed or controlled by Government;

(iv) That any forest land or any portion thereof may be cleared of trees which have grown naturally in that land or portion, for the purpose of using it for afforestation.

Explanation - For the purpose of this section, "non-forest purpose" means the breaking up or clearing of any forest land or portion thereof for-

(a) The cultivation of tea, coffee, spices, rubber, palms, oil-bearing plants, horticultural crops or medicinal plants;

(b) Any purpose other than afforestation

but does not include any work relating or ancillary to conservation, development and management of forests and wildlife, namely, the establishment of check-posts, fire lines, wireless communications and construction of fencing, bridges and culverts, dams, waterholes, trench marks, boundary marks, pipelines or other like purposes.

3. Constitution of Advisory Committee

The Central Government may constitute a Committee consisting of such number of persons as h may deem fit to advise that Government with regard to-

(i) The grant of approval. under Section 2; and

(ii) Any other matter connected with the conservation of forests which may be referred to h by the Central Government.

3A. Penalty for contravention of the provisions of the Act

Whoever contravenes or abets the contravention of any of the provisions of Section 2, shall be punishable with simple imprisonment for a period which may extend to fifteen days.

3B. Offences by the Authorities and Government Departments

(1) Where any offence under this Act has been committed

(a) By any department of Government, the head of the department; or

(b) by any authority, every person who, at the time the offence was committed, was directly in charge of, and was responsible to, the authority for the conduct of the business of the authority as well as the authority;

Shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:

Provided that nothing contained in this sub-section shall render the head of the department or any person referred to in clause (b), liable to any punishment if he proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (1), where an offence punishable under the Act has been committed by a department of Government or any authority referred to in clause (b) of sub-section (1) and it is proved that the offence has been committed with the consent or connivance of; or is attributable to any neglect on the part of any officer, other than the head of the department, or in the case of an authority, any person other than the persons referred to in clause (b) of sub-section (1), such officer or persons shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

4. Power to make rules

(1) The Central Government may, by notification in the Official Gazette, makes rules for carrying out the provisions of this Act.

(2) Every rule made under this Act shall be laid, as soon as may be after it is made, before each House of Parliament, while it is in session, for a total period of thirty days which may be comprised in one session or in two or more successive sessions, and if, before the expiry of the session immediately following the session or the successive sessions aforesaid, both Houses agree in making any modification in the rule or both Houses agree that the rule should not be made, the rule shall thereafter have effect only in such modified form or be of no effect, as the case may be; so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule.

5. Repeal and saving

(1) The Forest (Conservation) Ordinance, 1980 is hereby replaced.

(2) Notwithstanding such repeal, anything done or any action taken under the provisions of the said Ordinance shall be deemed to have been done or taken under the corresponding provisions of this Act.

Questions

1. The environment protection act, and decisions were taken at UN conference held at ----

Ans: Stockholm

2. --------------------- according to EPA act means the presence of any environmental pollutant in the environment

Ans: Environmental pollution

3. The substance that is liable to cause harm to human beings is known as -----------------

Ans: hazardous substances

4. The Wildlife Protection Act was extends in the year

Ans: 1972

5. Forest Conservation Act extends to whole of India except the state of ---------------

Ans: Jammu and Kashmir

Match

6. Section 9 of EPA - Important for a period may extend upto 15 days

7. Penalty for contravention of Provision of the Act - Hunting

8. Forest conservation ordinance was replaced - Central Government

9. Vermin - 1980

10. Power to make rules - wild animal specified in schedule V of EPA Act

Lecture.28

International voluntary agencies mandates and activities in environmental conservation

There are a number of international and national organizations, agencies and programmes involved in different areas of environment, forestry, wildlife and other relevant aspects. Some of the important bodies are as follows.

International Bodies

1. Earth scan: An agency, founded by UNEP in 1976 that commissions original articles on environmental matter and sells them as features to newspapers and magazines, especially in developing countries.

2. Convention on International Trade in Endangered Species (CITES): An international forum, whose membership for agreement is open to all countries. For India, the Ministry of Environment and Forests functions as nodal agency for participation in international agreements.

3. Environmental Protection Agency (EPA): This is an independent Federal Agency of the U.S. Government established in 1970. It deals with protection of environment by air, water, solid wastes, radiation, pesticides noise etc.

4. European Economic Community (EEC): It is community of 12 European nations with sound political, economic and legal base. The community has joint agricultural and scientific programmes. It has programmes of framing and implementation of coordinated policy for environmental improvement and conservation of natural resources. CPCB, India has taken up projects on air quality monitoring with assistance of EEC.

5. Human Exposure Assessment Location (HEAL): The project is a part of the Health Related Monitoring Programme by WHO in co-operation with UNEP. This project has three components, viz., (i) air monitoring (ii) water quality monitoring and (iii) food contamination monitoring on a global basis.

6. International Council of Scientific Unions (ICSU): A non-government organization based in Paris, that encourages the exchange of scientific information, initiates programmes requiring international scientific cooperation and studies and reports on matters related to social and political responsibilities in treatment of scientific community.

7. International Union for Conservation of Nature and Natural Resources (IUCN): An autonomous body, founded in 1948 with its Headquarters at Morges, Switzerland, that initiates and promotes scientifically based conservation measures. It also cooperates with United Nations and other intergovernmental agencies and sister bodies of World Wide Fund for Nature (WWF).

8. International Marine Consultative organization (IMCO): It regulates the operation of ship in high seas, from marine water pollution viewpoint.

9. South Asia co-operative Environment Programme (SACEP): This has been recently set up for exchange of professional knowledge and expertise on environmental issues among member countries – Afghanistan, Bangladesh, Bhutan, India, Iran, Pakistan and Sri Lanka.

10. United Nations Educational, Scientific and Cultural Organization (UNESCO). An United Nations agency, found in 1945 to support and implement the efforts of member states to promote education, scientific research and information, and the arts to develop the cultural aspects of world relations. It also holds conferences and seminars, promotes research and exchange of information and provides technical support. Its Headquarters are in Paris. Independently as well as in collaboration with other agencies like UNEP, it supports activities related to environmental quality, human settlements, training to environmental engineers and other socio-cultural programmes related to environment.

11. United Nations Environment Programme (UNEP): A UN agency, responsible for co-operation of inter-governmental measures for environmental monitoring and protection. It was set up in 1972. There is a voluntary United Nations

Environment Fund to finance environmental projects. There is an Environmental Coordination Board, to coordinate the UNEP programmes. Its Headquarters are in Nairobi, Kenya. UNEP was founded to study and formulate international guidelines for management of the environment. UNEP is assisting many such programmes in India.

12. World Commission on environment and Development (WCED): This is a 23 member commission, set up in 1984 in pursuance to a UN General Assembly resolution in 1983 to re-examine the critical environmental and development issues and to formulate proposals for them. This is a call for political action to manage better environmental resources to ensure human progress and survival. The commission makes an assessment of the level of understanding and commitment of individuals, voluntary organizations and governmental bodies on environmental issues.

13. Earthwatch Programme: A world wide programme, established in 1972 under the terms of the Declaration on the Human Environment. It monitors trends in the environment, based on a series of monitoring stations. Its activities are coordinated by UNEP.

14. Project Earth: Developed in collaboration with UNEP to inspire and educate young people worldwide on the crucial issues facing the Earth's Environment.

15. Man and Biosphere Programme (MAB): The programme is the outcome of International Biological Programme (IBP) that has already concluded its activities. MAB was formerly launched by UNESCO in 1971.

Man and the Biosphere Programme (MAB)

MAB is the outcome of the experience of those involved in the International Biological Programme (IBP). It was realized that several problems require collaboration of natural and social scientists, planners and managers and the local people. MAB was conceived at the International Biosphere Conference of UNESCO in 1968 and was officially given shape by General Conference at its 16th Session in 1970. The programme was formally launched by UNESCO in November 1971, when the MAB International

Coordinating Council held its first session and identified 13 project areas of cooperative research. One more project area was added in 1974.

Green peace international

Green peace is a non-profit organization, with a presence in 40 countries across Europe, the Americas, Asia and the Pacific. To maintain its independence, Green peace does not accept donations from governments or corporations but relies on contributions from individual supporters and foundation grants. As a global organization, Green peace focuses on the most crucial worldwide threats to our planet's biodiversity and environment. Head quarters of green peace situated in Amsterdam, The Netherlands. Website www.greenpeace.org Green peace campaign to:

- Stop climate change
- Protect ancient forests
- Save the oceans
- Stop whaling
- Say no to genetic engineering
- Stop the nuclear threat
- Eliminate toxic chemicals
- Encourage sustainable trade

Indian voluntary agencies mandates and activities in environmental conservation

National Organizations

There are a number of governmental as well as non-governmental organizations, agencies and programmes engaged in environmental studies. A number of non-governmental, voluntary organizations have been doing good job in this area. Most of the governmental bodies involved in environmental studies are either put under the administrative control of, or assisted by the Department of Environment, Forests and Wildlife in the Ministry of Environment Forests, Government of India.

Department of Environment, Forests and Wildlife of India

Department of Environment was set up in 1980 to serve as the local point in the administrative structure of the Government for planning, promotion and coordination of environmental programmes. The present integrated Department of Environment, Forests and Wildlife in the Ministry of Environment and Forests was created in September 1985. The Ministry serves as the local point in the administrative structure of the Central Government of the planning, promotion and coordination of environmental and forestry programmes. The Ministry's main activities are, the survey and conservation of flora, forests and wildlife, prevention and control of pollution, afforestation and regeneration of the degraded areas of the environment.

Other National Organization

There are other governmental and non-governmental organizations / agencies involved in environmental issues. Some of the important ones are as follows:

- Advisory Board on Energy (ABE)
- Bombay Natural History Society (BNHS)
- Central Forestry Commission (CFC)
- Department of Non-Conventional Energy Sources (DNES)
- Industrial Toxicology Research Centre (ITRC)
- National Environmental Engineering Research Institute (NEERI)
- National Natural Development Board
- National Natural Research Management System
- National Wetland Management Committee
- State Pollution Control Board (SPCB)

- Tata Energy Research Institute (TERI)
- Several Research Institutes under I.C.A.R. including I.G.F.R.I., Jhansi, Central Soil Salinity Research Institute, Karnal.

Questions

1. ------------------ is an agency founded by UNEP in 1976.

Ans: Earth scan

2. Expand CITES

Ans: Convention on International Trade Endangered Species.

3. ------- is an independent federal agency of U.S Government established in 1970.

Ans: EPA

4. International Council of Scientific Union (ICSU) is located at -------------

Ans: Paris

5. Man and Biosphere programme (MAB) was launched in the year 1971 by -----------

Ans: UNESCO

<u>Match</u>

6. Headquartes of UNEP - 1972

7. Earthwatch - Nairobi, Kenya

8. Green Peace International - organization located in India

9. Tata Energy Research Institute (TERT) - Amsterdam, Netherland

<u>Ans</u>

6. Headquartes of UNEP - Nairobi, Kenya

7. Earthwatch - 1972

8. Green Peace international - Amsterdam, Netherland

9. Tata Energy Research Institute - organization located in India

True / False

10. The integrated Department of environment, forests and wildlife in Ministry of environment and forests was created in September, 1985.

Ans: True

Lecture.29

Important global treaties, agreements & conventions on the environment

Some of the important global treaties, agreements and conventions on the environment are as follows

- 1946 International Whaling Commission (1946 Whaling Convention)
- 1946 International Convention for the Regulation of Whaling
- 1956 Plant Protection Agreement for the South East Asia and Pacific Region
- 1969 Civil Liability Convention, including 1976 Protocol
- 1971 Ramsar Convention on Wetlands
- 1971 Ramsar Convention
- 1971 Fund Convention
- **1972 Stockholm conference**
- 1972 London Convention on Ocean Dumping
- 1972 World Heritage Convention - Web Table of Contents
- 1972 World Heritage Convention
- 1973/78 MARPOL Convention on Prevention of Pollution from Ships
- 1973 CITES Text
- 1973 CITES
- 1976 Convention on Conservation of Nature in the South Pacific
- 1979 South Pacific Forum Fisheries Agency Convention
- 1979 Convention on Migratory Species
- 1979 Migratory Species Convention
- 1982 UN Law of the Sea Convention
- 1982 Convention on the Law of the Sea
- 1982 World Charter for Nature
- 1985 South Pacific Nuclear Free Zone Treaty
- 1985 Ozone Convention
- 1985 Ozone Convention - Montreal Protocol

- 1986 Protocol Concerning Co-operation in Combating Pollution Emergencies in the South Pacific Region [under SPREP]
- 1986 Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (SPREP)
- 1987 Agreement on Implementation of US-South Pacific Treaty on Fisheries
- **Montreal Protocol , 1987**
- 1989 Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific
- 1989 Basel Convention
- 1990 Oil Pollution Preparedness, Response & Cooperation Convention
- 1992 Niue Treaty on Cooperation in Fisheries Surveillance in South Pacific
- 1992 Climate Change Convention (UNFCCC)
- **1992 Rio Declaration on Environment and Development**
- **1992 UNCED Agenda 21 , Earth Summit**
- 1992 UNCED Forest Principles
- 1992 Protocol to the 1969 Civil Liability Convention
- 1992 Protocol to the 1971 Fund Convention
- 1992 Convention on Biological Diversity
- 1992 Biodiversity Convention
- 1992 Climate Change Convention - Kyoto Protocol
- 1993 Agreement establishing SPREP as an Intergovernmental Organization
- 1994 Draft Declaration - Human Rights and the Environment
- 1994 Convention to Combat Desertification
- 1995 Implementation Agreement on Straddling and Highly Migratory Fish Stocks
- 1995 FAO Code of Conduct for Responsible Fisheries and Compliance Agreement
- 1995 Washington Declaration on Land-Based Marine Pollution
- 1995 GPA on Land-Based Marine Pollution
- 1996 Protocol to the 1972 London Convention
- 1996 HNS Convention
- **1997 Kyoto Protocol**

- 1997 Programme for Further Implementation of Agenda 21
- 1997 UN Convention on Non-Navigational Uses of International Watercourses

Questions

1. The Stockholm conference was held in the year ------------

Ans: 1972

2. Ozone convention occurred in the year -------------

Ans: 1985

3. The --------- convention on the environment was particularly occurred on wetlands in 1971.

Ans: Ramsar

4. Kyoto protocol was signed in the year -----------

Ans: 1997

Match

5. Biodiversity convention - 1973
6. Climate change convention (UNFCCC) - 1987
7. Convention to combat Desertification - 1992
8. Montreat protocol - 1992
9. CITES - 1971
10. Ramsar Convention - 1994

Ans

5. Biodiversity convention - 1992
6. Climate change convention (UNFCCC) - 1992

7. Convention to combat Desertification - 1994
8. Montreal protocol - 1987
9. CITES - 1973
10. Ramsar Convention - 1971

Lecture.30

International conferences, convention and summits – major achievements of Montreal protocol, Earth summit

The **Montreal Protocol on Substances that Deplete the Ozone Layer** (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer by phasing out the production of a number of substances believed to be responsible for ozone depletion. The treaty was opened for signature on September 16, 1987, and entered into force on January 1, 1989, followed by a first meeting in Helsinki, May 1989. Since then, it has undergone seven revisions, in 1990 (London), 1991 (Nairobi), 1992 (Copenhagen), 1993 (Bangkok), 1995 (Vienna), 1997 (Montreal), and 1999 (Beijing). It is believed that if the international agreement is adhered to, the ozone layer is expected to recover by 2050. Due to its widespread adoption and implementation it has been hailed as an example of exceptional international co-operation with Kofi Annan quoted as saying that "perhaps the single most successful international agreement to date has been the Montreal Protocol".

Terms and purposes of this treaty

The treaty is structured around several groups of halogenated hydrocarbons that have been shown to play a role in ozone depletion. All of these ozone depleting substances contain either chlorine or bromine (substances containing only fluorine do not harm the ozone layer). For each group, the treaty provides a timetable on which the production of those substances must be phased out and eventually eliminated.

Chlorofluorocarbons (CFCs) Phase-out Management Plan

The stated purpose of the treaty is that the signatory states:

Recognizing that worldwide emissions of certain substances can significantly deplete and otherwise modify the ozone layer in a manner that is likely to result in adverse effects on human health and the environment, Determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination on the basis of developments in scientific knowledge. Acknowledging that special provision is required to meet the needs of developing countries.

Shall accept a series of stepped limits on CFC use and production, including:

- From 1991 to 1992 its levels of consumption and production of the controlled substances in Group I of Annex A do not exceed 150 percent of its calculated levels of production and consumption of those substances in 1986;
- From 1994 its calculated level of consumption and production of the controlled substances in Group I of Annex A does not exceed, annually, twenty-five percent of its calculated level of consumption and production in 1986.
- From 1996 its calculated level of consumption and production of the controlled substances in Group I of Annex A does not exceed zero.

There is a slower phase-out (to zero by 2010) of other substances (Halon 1211, 1301, 2402; CFCs 13, 111, 112, etc) and some chemicals get individual attention (Carbon tetrachloride; 1, 1, 1-trichloroethane). The phasing-out of the less active HCFCs started only in 1996 and will go on until a complete phasing-out is achieved in 2030.

Hydro chlorofluorocarbons (HCFCs) Phase-out Management Plan (HPMP)

Under the Montreal Protocol on Substances that Deplete the Ozone Layer, especially Executive Committee (ExCom) 53/37 and ExCom 54/39, Parties to this Protocol agreed to set year 2013 as the time to freeze the consumption and production of HCFCs. They also agreed to start reducing its consumption and production in 2015. The time of freezing and reducing HCFCs is then known as 2013/2015.

The HCFCs are transitional CFCs replacements, used as refrigerants, solvents, blowing agents for plastic foam manufacture, and fire extinguishers. In term of Ozone Depleting Potential (ODP), in comparison to CFCs that have ODP 0.6 – 1.0, this HCFCs

ODP have less ODP, i.e. 0.01 – 0.5. Whereas in term of Global Warming Potential (GWP), in comparison to CFCs that have GWP 4,680 – 10,720, HCFCs have less GWP, i.e. 76 – 2,270. There are a few exceptions for "essential uses", where no acceptable substitutes have been found (for example, in the metered dose inhalers commonly used to treat asthma and other respiratory problems) or Halon fire suppression systems used in submarines and aircraft (but not in general industry).

The substances in Group I of annex A are

- $CFCl_3$ (CFC-11)
- CF_2Cl_2 (CFC-12)
- $C_2F_3Cl_3$ (CFC-113)
- $C_2F_4Cl_2$(CFC-114)
- C_2F_5Cl (CFC-115)

The provisions of the Protocol include the requirement that the Parties to the Protocol base their future decisions on the current scientific, environmental, technical, and economic information that is assessed through panels drawn from the worldwide expert communities. To provide that input to the decision-making process, advances in understanding on these topics were assessed in 1989, 1991, 1994, 1998 and 2002 in a series of reports entitled Scientific assessment of ozone depletion.

Several reports have been published by various governmental and non-governmental organizations to present alternatives to the ozone depleting substances, since the substances have been used in various technical sectors, like in refrigerating, agriculture, energy production, and laboratory measurements.

History

In 1973 Chemists Frank Sherwood Rowland and Mario Molina, then at the University of California, Irvine, began studying the impacts of CFCs in the Earth's atmosphere. They discovered that CFC molecules were stable enough to remain in the atmosphere until they got up into the middle of the stratosphere where they would finally (after an average of 50–100 years for two common CFCs) be broken down by ultraviolet radiation releasing a chlorine atom. Rowland and Molina then proposed that these chlorine atoms might be expected to cause the breakdown of large amounts of ozone (O_3) in the stratosphere. Their argument was based upon an analogy to contemporary work by Paul J. Crutzen and Harold Johnston, which had shown that nitric oxide (NO) could catalyze the destruction of ozone. (Several other scientists, including Ralph Cicerone, Richard Stolarski, Michael McElroy, and Steven Wofsy had independently proposed that chlorine could catalyze ozone loss, but none had realized that CFCs were a potentially large source of chlorine.) Crutzen, Molina and Rowland were awarded the 1995 Nobel Prize for Chemistry for their work on this problem.

The environmental consequence of this discovery was that, since stratospheric ozone absorbs most of the ultraviolet-B (UV-B) radiation reaching the surface of the planet, depletion of the ozone layer by CFCs would lead to an in increase in UV-B radiation at the surface, resulting in an increase in skin cancer and other impacts such as damage to crops and to marine phytoplankton.

But the Rowland-Molina hypothesis was strongly disputed by representatives of the aerosol and halocarbon industries. The chair of the board of DuPont was quoted as saying that ozone depletion theory is "a science fiction tale...a load of rubbish...utter nonsense". Robert Abplanalp, the president of Precision Valve Corporation (and inventor of the first practical aerosol spray can valve), wrote to the Chancellor of UC Irvine to complain about Rowland's public statements (Roan, p. 56.)

After publishing their pivotal paper in June 1974, Rowland and Molina testified at a hearing before the U.S. House of Representatives in December 1974. As a result significant funding was made available to study various aspects of the problem and to confirm the initial findings. In 1976, the U.S. National Academy of Sciences (NAS) released a report that confirmed the scientific credibility of the ozone depletion hypothesis. NAS continued to publish assessments of related science for the next decade.

Then, in 1985, British Antarctic Survey scientists Farman, Gardiner and Shanklin shocked the scientific community when they published results of a study showing an ozone "hole" in the journal Nature showing a decline in polar ozone far larger than anyone had anticipated.

That same year, 20 nations, including most of the major CFC producers, signed the Vienna Convention, which established a framework for negotiating international regulations on ozone-depleting substances.

But the CFC industry did not give up that easily. As late as 1986, the Alliance for Responsible CFC Policy (an association representing the CFC industry founded by DuPont) was still arguing that the science was too uncertain to justify any action. In 1987, DuPont testified before the US Congress that "we believe that there is no immediate crisis that demands unilateral regulation."

Multilateral Fund

Ratification

As of September 16, 2009, all countries in the United Nations have ratified the original Montreal Protocol, Timor-Leste being the last country to ratify the agreement. Fewer countries have ratified each consecutive amendment. Only 154 countries have signed the Beijing Amendment.

In the United States, the Clean Air Act Amendments of 1990 (P.L. 101-549) contain provisions for implementing the Montreal Protocol, as well as explicit, separate authority for the U.S. Environmental Protection Agency to regulate ozone depleting chemicals.

Ozone-depleting gas trends

Since the Montreal Protocol came into effect, the atmospheric concentrations of the most important chlorofluorocarbons and related chlorinated hydrocarbons have either leveled off or decreased . Halon concentrations have continued to increase, as the halons presently stored in fire extinguishers are released, but their rate of increase has slowed and their abundances are expected to begin to decline by about 2020. Also, the concentration of the HCFCs increased drastically at least partly because for many uses CFCs (e.g. used as solvents or refrigerating agents) were substituted with HCFCs. While there have been reports of attempts by individuals to circumvent the ban, e.g. by smuggling CFCs from undeveloped to developed nations, the overall level of compliance has been high. In consequence, the Montreal Protocol has often been called the most successful international environmental agreement to date. In a 2001 report, NASA found the ozone thinning over Antarctica had remained the same thickness for the previous three years. However in 2003 the ozone hole grew to its second largest size. The most recent (2006) scientific evaluation of the effects of the Montreal Protocol states, "The Montreal Protocol is working: There is clear evidence of a decrease in the atmospheric burden of ozone-depleting substances and some early signs of stratospheric ozone recovery."Unfortunately, the hydrochlorofluorocarbons, or HCFCs, and hydrofluorocarbons, or HFCs, are now thought to contribute to anthropogenic global warming. On a molecule-for-molecule basis, these compounds are up to 10,000 times more potent greenhouse gases than carbon dioxide. The Montreal Protocol currently calls for a complete phase-out of HCFCs by 2030, but does not place any restriction on HFCs. Since the CFCs themselves are equally powerful as greenhouse gases, the mere substitution of HFCs for CFCs does not significantly increase the rate of anthropogenic global warming, but over time a steady increase in their use could increase the danger that human activity will change the climate.

Earth summit

The United Nations Conference on Environment and Development (UNCED), also known as the Rio Summit, Rio Conference, Earth Summit (Portuguese: Eco '92) was a major United Nations conference held in Rio de Janeiro from June 3 to June 14, 1992.

Overview

172 governments participated, with 108 sending their heads of state or government. Some 2,400 representatives of non-governmental organizations (NGOs) attended, with 17,000 people at the parallel NGO "Global Forum", who had Consultative Status.

The issues addressed included:

- systematic scrutiny of patterns of production particularly the production of toxic components, such as lead in gasoline, or poisonous waste including radioactive chemicals
- alternative sources of energy to replace the use of fossil fuels which are linked to global climate change
- new reliance on public transportation systems in order to reduce vehicle emissions, congestion in cities and the health problems caused by polluted air and smog
- the growing scarcity of water

An important achievement was an agreement on the Climate Change Convention which in turn led to the Kyoto Protocol. Another agreement was to "not carry out any activities on the lands of indigenous peoples that would cause environmental degradation or that would be culturally inappropriate".

The Convention on Biological Diversity was opened for signature at the Earth Summit, and made a start towards redefinition of money supply measures that did not inherently encourage destruction of natural eco regions and so-called uneconomic growth.

Twelve cities were also honoured by the Local Government Honours Award for innovative local environmental programs. These included Sudbury, Ontario in Canada for its ambitious program to rehabilitate environmental damage from the local mining industry, Austin, Texas in the United States for its green building strategy, and

Kitakyushu in Japan for incorporating an international education and training component into its municipal pollution control program.

The Earth Summit resulted in the following documents

- Rio Declaration on Environment and Development
- Agenda 21
- Convention on Biological Diversity
- Forest Principles
- Framework Convention on Climate Change (UNFCCC).

Both Convention on Biological Diversity and Framework Convention on Climate Change were set as legally binding agreements.

Critics, however, point out that many of the agreements made in Rio have not been realized regarding such fundamental issues as fighting poverty and cleaning up the environment.

The Green Cross International was founded to build upon the work of the Summit.

Commission for Sustainable Development (CSD)

CSD has served as the UN high-level forum for sustainable development issues since 1992, when it was established by the UN General Assembly to ensure effective follow-up to the Rio Summit. CSD meets annually at UN Headquarters; its focus themes for 2006/2007 are energy for sustainable development, industrial development, air pollution/atmosphere and climate change.

Conference	United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, 3-14 June 1992
Informal name	The Earth Summit
Host Government	Brazil

Number of Governments participating	172, 108 at level of heads of State or Government
Conference Secretary-General	Maurice F. Strong, Canada
Organizers	UNCED secretariat
Principal themes	Environment and sustainable development
NGO presence	Some 2,400 representatives of non-governmental organizations (NGOs); 17,000 people attended the parallel NGO Forum
Resulting document	Agenda 21, the Rio Declaration on Environment and Development, the Statement of Forest Principles, the United Nations Framework Convention on Climate Change and the United Nations Convention on Biological Diversity
Follow-up mechanisms	Follow-up mechanisms: Commission on Sustainable Development; Inter-agency Committee on Sustainable Development; High-level Advisory Board on Sustainable Development
Previous conference	UN Conference on the Human Environment, Stockholm (1972)

Earth Summit

The Earth Summit in Rio de Janeiro was unprecedented for a UN conference, in terms of both its size and the scope of its concerns. Twenty years after the first global environment conference, the UN sought to help Governments rethink economic development and find ways to halt the destruction of irreplaceable natural resources and pollution of the planet. Hundreds of thousands of people from all walks of life were drawn into the Rio process. They persuaded their leaders to go to Rio and join other nations in making the difficult decisions needed to ensure a healthy planet for generations to come.

The Summit's message — that nothing less than a transformation of our attitudes and behaviour would bring about the necessary changes — was transmitted by almost

10,000 on-site journalists and heard by millions around the world. The message reflected the complexity of the problems facing us: that poverty as well as excessive consumption by affluent populations place damaging stress on the environment. Governments recognized the need to redirect international and national plans and policies to ensure that all economic decisions fully took into account any environmental impact. And the message has produced results, making eco-efficiency a guiding principle for business and governments alike.

- Patterns of production — particularly the production of toxic components, such as lead in gasoline, or poisonous waste — are being scrutinized in a systematic manner by the UN and Governments alike;
- Alternative sources of energy are being sought to replace the use of fossil fuels which are linked to global climate change;
- New reliance on public transportation systems is being emphasized in order to reduce vehicle emissions, congestion in cities and the health problems caused by polluted air and smog;
- There is much greater awareness of and concern over the growing scarcity of water.

The two-week Earth Summit was the climax of a process, begun in December 1989, of planning, education and negotiations among all Member States of the United Nations, leading to the adoption of Agenda 21, a wide-ranging blueprint for action to achieve sustainable development worldwide. At its close, Maurice Strong, the Conference Secretary-General, called the Summit a “historic moment for humanity”. Although Agenda 21 had been weakened by compromise and negotiation, he said, it was still the most comprehensive and, if implemented, effective programme of action ever sanctioned by the international community. Today, efforts to ensure its proper implementation continue, and they will be reviewed by the UN General Assembly at a special session to be held in June 1997.

The Earth Summit influenced all subsequent UN conferences, which have examined the relationship between human rights, population, social development, women and human settlements and the need for environmentally sustainable development. The World Conference on Human Rights, held in Vienna in 1993, for example, underscored the right of people to a healthy environment and the right to development, controversial demands that had met with resistance from some Member States until Rio.

Questions

1. A protocol passed to do the Vienna convention for the protection of the ozone layer is -------------

Ans: Montreal protocol

2. Ozone depleting substances contain either ---------------------- or ----------------

Ans: Chlorine, Bromine

3. ----------- and ----------- began the study of impact CFC's in the earth's atmosphere.

Ans: Rowland, Molina

4. ------------------ gas is used as refrigerating agents in refrigerator.

Ans: CFC

<u>Match the following</u>

5. UNCED - Works on earth summit
6. Green cross international - Non-governmental organizations
7. UN conference on the
   Human environment - Stokeholm
8. Stockholders - Rio-de-Janeiro

<u>Ans</u>

5. UNCED - Rio-de-Janeiro
6. Green cross international - works on earth summit

7. UN conference on the
Human environment - Stokeholm
8. Stockholders - Non-governmental organizations

True / Flase

9. Convention on biological diversity and framework convention on climate change were set as legally binding agreements

Ans: True

10. The principle themes of the UNCED was environment and sustainable developments

Ans: True

Lecture.31

Kyoto protocol, Emission trading, CDM, Copenhagen summit - over view

Kyoto Protocol

The **Kyoto Protocol** is a protocol to the United Nations Framework Convention on Climate Change (UNFCCC or FCCC), aimed at combating global warming. The UNFCCC is an international environmental treaty with the goal of achieving "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

The Protocol was initially adopted on 11 December 1997 in Kyoto, Japan and entered into force on 16 February 2005. As of November 2009, 187 states have signed and ratified the protocol.

Under the Protocol, 37 industrialized countries (called "Annex I countries") commit themselves to a reduction of four greenhouse gases (GHG) (carbon dioxide, methane, nitrous oxide, sulphur hexafluoride) and two groups of gases (hydrofluorocarbons and perfluorocarbons) produced by them, and all member countries give general commitments. Annex I countries agreed to reduce their collective greenhouse gas emissions by 5.2% from the 1990 level. Emission limits do not include emissions by international aviation and shipping, but are in addition to the industrial gases, chlorofluorocarbons, or CFCs, which are dealt with under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.

The benchmark 1990 emission levels were accepted by the Conference of the Parties of UNFCCC (decision 2/CP.3) were the values of "global warming potential" calculated for the IPCC Second Assessment Report. These figures are used for converting the various greenhouse gas emissions into comparable CO_2 equivalents when computing overall sources and sinks.

The Protocol allows for several "flexible mechanisms", such as emissions trading, the Clean Development Mechanism (CDM) and joint implementation to allow Annex I countries to meet their GHG emission limitations by purchasing GHG emission reductions credits from elsewhere, through financial exchanges, projects that reduce emissions in non-Annex I countries, from other Annex I countries, or from annex I countries with excess allowances.

Each Annex I country is required to submit an annual report of inventories of all anthropogenic greenhouse gas emissions from sources and removals from sinks under UNFCCC and the Kyoto Protocol. These countries nominate a person (called a "designated national authority") to create and manage its greenhouse gas inventory. Countries including Japan, Canada, Italy, the Netherlands, Germany, France, Spain and others are actively promoting government carbon funds, supporting multilateral carbon funds intent on purchasing carbon credits from non-Annex I countries, and are working closely with their major utility, energy, oil and gas and chemicals conglomerates to acquire greenhouse gas certificates as cheaply as possible. Virtually all of the non-Annex I countries have also established a designated national authority to manage its Kyoto obligations, specifically the "CDM process" that determines which GHG projects they wish to propose for accreditation by the CDM Executive Board.

Background

The prevailing international scientific opinion on climate change is that human activities resulted in substantial global warming from the mid-20th century, and that continued growth in greenhouse gas concentrations caused by human-induced emissions would generate high risks of dangerous climate change.

The Intergovernmental Panel on Climate Change (IPCC) has predicted an average global rise in temperature of 1.4°C (2.5°F) to 5.8°C (10.4°F) between 1990 and 2100.

Ratification process

The Protocol was adopted by COP 3 on 11 December 1997 in Kyoto, Japan. It was opened on 16 March 1998 for signature by parties to UNFCCC.

Countries which are parties to UNFCCC

Article 25 of the Protocol specifies that the Protocol enters into force "on the ninetieth day after the date on which not less than 55 Parties to the Convention, incorporating Parties included in Annex I which accounted in total for at least 55% of the total carbon dioxide emissions for 1990 of the Annex I countries, have deposited their instruments of ratification, acceptance, approval or accession."

The EU and its Member States ratified the Protocol in May 2002. Of the two conditions, the "55 parties" clause was reached on 23 May 2002 when Iceland ratified the Protocol. The ratification by Russia on 18 November 2004 satisfied the "55%" clause and brought the treaty into force, effective 16 February 2005, after the required lapse of 90 days.

As of November 2009, 186 countries and one regional economic organization (the EC) have ratified the agreement, representing over 63.9% of the 1990 emissions from Annex I countries. The most notable non-party to the Protocol is the United States, which is a party to UNFCCC and was responsible for 36.1% of the 1990 emission levels of Annex I countries. The Protocol can be signed and ratified only by parties to UNFCCC, (Article 24) and a country can withdraw by giving 12 months notice. (Article 27)

Objectives

Kyoto is intended to cut global emissions of greenhouse gases. The objective is the "stabilization and reconstruction of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

The objective of the Kyoto climate change conference was to establish a legally binding international agreement, whereby all the participating nations commit themselves to tackling the issue of global warming and greenhouse gas emissions. The target agreed upon was an average reduction of 5.2% from 1990 levels by the year 2012. Contrary to popular belief, the Protocol will NOT expire in 2012. In 2012, Annex I countries must have fulfilled their obligations of reduction of greenhouse gases emissions established for the first commitment period (2008–2012).

Proponents also note that Kyoto is a first step as requirements to meet the UNFCCC will be modified until the objective is met, as required by UNFCCC Article 4.2(d).

The five principal concepts of the Kyoto Protocol are:

- commitments to reduce greenhouse gases that are legally binding for annex I countries, as well as general commitments for all member countries;
- implementation to meet the Protocol objectives, to prepare policies and measures which reduce greenhouse gases; increasing absorption of these gases (for example through geosequestration and biosequestration) and use all mechanisms available, such as joint implementation, clean development mechanism and emissions trading; being rewarded with credits which allow more greenhouse gas emissions at home;
- minimizing impacts on developing countries by establishing an adaptation fund for climate change;
- accounting, reporting and review to ensure the integrity of the Protocol;
- Compliance by establishing a compliance committee to enforce commitment to the Protocol.

2012 emission targets and "flexible mechanisms"

39 of the 40 Annex I countries have ratified the Protocol. Of these 34 have committed themselves to a reduction of greenhouse gases (GHG) produced by them to targets that are set in relation to their 1990 emission levels, in accordance with Annex B of the Protocol. The targets apply to the four greenhouse gases carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, and two groups of gases, hydrofluorocarbons and perfluorocarbons. The six GHG are translated into CO_2 equivalents in determining reductions in emissions. These reduction targets are in addition to the industrial gases, chlorofluorocarbons, or CFCs, which are dealt with under the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.

Under the Protocol, Annex I countries have committed themselves to national or joint reduction targets, (formally called "quantified emission limitation and reduction objectives"- Article 4.1) that range from a joint reduction of 8% for the European Union and others, to 7% for the United States (non-binding as the US is not a signatory), 6% for Japan and 0% for Russia. The treaty permits emission increases of 8% for Australia and 10% for Iceland. Emission limits do not include emissions by international aviation and shipping.

Annex I countries under the Kyoto Protocol, their 2012 commitments (% of 1990) and 1990 emission levels (% of all Annex I countries)

Australia – 108% (2.1% of 1990 emissions)
Austria – 92% (0.4%)
Belarus – 95% (subject to acceptance by other parties)
Belgium – 92% (0.8%)
Bulgaria – 92% (0.6%)
Canada – 94% (3.33%)
Croatia – 95%
Czech Republic – 92% (1.24%)
Denmark – 92% (0.4%)
Estonia – 92%
Finland – 92% (0.4%)
France – 92% (2.7%)
Germany – 92% (7.4%)
Greece – 92% (0.6%)
Hungary – 94% (0.52%)
Iceland – 110% (0.02%)
Ireland – 92% (0.2%)
Italy – 92% (3.1%)
Japan – 94% (8.55%)
Latvia – 92% (0.17%)
Liechtenstein – (0.0015%) 92%
Lithuania – 92%
Luxembourg – 92% (0.1%)
Monaco – 92% (0.0015%)
Netherlands – 92% (1.2%)
New Zealand – 100% (0.19%)
Norway – 99% (0.26%)
Poland – 94% (3.02%)
Portugal – 92% (0.3%)
Romania – 92% (1.24%)
Russian Federation – 100% (17.4%)
Slovakia – 92% (0.42%)
Slovenia – 92%
Spain – 92% (1.9%)
Sweden – 92% (0.4%)
Switzerland – 92% (0.32%)
Turkey
Ukraine – 100%
United Kingdom – 92% (4.3%)
United States of America – 93% (36.1%) (non-party)

(0.28%)			

Annex I countries can achieve their targets by allocating reduced annual allowances to major operators within their borders, or by allowing these operators to exceed their allocations by offsetting any excess through a mechanism that is agreed by all the parties to the UNFCCC, such as by buying emission allowances from other operators which have excess emissions credits.

38 of the 39 Annex I countries have agreed to cap their emissions in this way, two others are required to do so under their conditions of accession into the EU, and one more (Belarus) is seeking to become an Annex I country.

The Protocol provides for several "flexible mechanisms" which enable Annex I countries to meet their GHG emission targets by acquiring GHG emission reductions credits. The credits are acquired by an Annex I country financing projects that reduce emissions in non-Annex I countries or other Annex I countries, or by purchasing credits from Annex I countries with excess credits. The flexible mechanisms are emissions trading, the clean development mechanism (CDM) and joint implementation.

In practice this means that non-Annex I countries have no GHG emission restrictions, but have financial incentives to develop GHG emission reduction projects to receive "carbon credits" that can then be sold to Annex I countries, encouraging sustainable development. In addition, the flexible mechanisms allow annex I countries with efficient, low GHG-emitting industries, and high prevailing environmental standards to purchase carbon credits on the world market instead of reducing greenhouse gas emissions domestically. Annex I countries typically will want to acquire carbon credits as cheaply as possible, while non-Annex I countries want to maximize the value of carbon credits generated from their domestic greenhouse gas projects.

Details of the agreement

According to a press release from the United Nations Environment Programme

"After 10 days of tough negotiations, ministers and other high-level officials from 160 countries reached agreement this morning on a legally binding Protocol under which industrialized countries will reduce their collective emissions of greenhouse gases by 5.2%. The agreement aims to lower overall emissions from a group of six greenhouse gases by 2008–12, calculated as an average over these five years. Cuts in the three most important gases – carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) – will be measured against a base year of 1990. Cuts in three long-lived industrial gases – hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6) – can be measured against either a 1990 or 1995 baseline."

National limitations range from 8% reductions for the European Union and others, to 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland.

The agreement supplements the United Nations Framework Convention on Climate Change (UNFCCC) adopted at the Earth Summit in Rio de Janeiro in 1992, which did not set any limitations or enforcement mechanisms. All parties to UNFCCC can sign or ratify the Kyoto Protocol, while non-parties to UNFCCC cannot. The Kyoto Protocol was adopted at the third session of the Conference of Parties to the UNFCCC (COP 3) in 1997 in Kyoto, Japan. Most provisions of the Kyoto Protocol apply to developed countries, listed in Annex I to UNFCCC.National emission targets exclude international aviation and shipping.

Common but differentiated responsibility

UNFCCC adopts a principle of "common but differentiated responsibilities." The parties agreed that:

- the largest share of historical and current global emissions of greenhouse gases originated in developed countries;
- per capita emissions in developing countries are still relatively low;
- The share of global emissions originating in developing countries will grow to meet social and development needs.

China, India and other developing countries were not included in any numerical limitation of the Kyoto Protocol, because they were not main contributors to the greenhouse gas emissions in the pre-treaty industrialization period. China has since become the largest greenhouse gas emitter. However, even without responsibility under the Kyoto target, developing countries are also committed to share the common responsibility of all countries to reduce emissions.

The protocol defines a mechanism of "compliance" as a "monitoring compliance with the commitments and penalties for non-compliance."

Financial commitments

The Protocol also reaffirms the principle that developed countries have to pay billions of dollars, and supply technology to other countries for climate-related studies and projects. The principle was originally agreed in UNFCCC.

Emissions Trading

Kyoto provides for a 'cap and trade' system which imposes national caps on the emissions of annex I countries. On average, this cap requires countries to reduce their emissions by 5.2% below their 1990 baseline over the 2008 to 2012 period. Although these caps are national-level commitments, in practice, most countries will devolve their emissions targets to individual industrial entities, such as a power plant or paper factory. One example of a 'cap and trade' system is the 'EU ETS'. Other schemes may follow suit in time.

The ultimate buyers of credits are often individual companies that expect emissions to exceed their quota, their assigned allocation units, AAUs or 'allowances' for short. Typically, they will purchase credits directly from another party with excess allowances, from a broker, from a JI/CDM developer, or on an exchange.

National governments, some of whom may not have devolved responsibility for meeting Kyoto obligations to industry, and that have a net deficit of allowances, will buy credits for their own account, mainly from JI/CDM developers. These deals are occasionally done directly through a national fund or agency, as in the case of the Dutch governments ERUPT programmes, or via collective funds such as the World Bank's Prototype Carbon Fund (PCF). The PCF, for example, represents a consortium of six governments and 17 major utility and energy companies on whose behalf it purchases credits.

Since allowances and carbon credits are tradeable instruments with a transparent price, financial investors can buy them on the spot market for speculation purposes, or link them to futures contracts. A high volume of trading in this secondary market helps price discovery and liquidity, and in this way helps to keep down costs and set a clear price signal in CO_2 which helps businesses to plan investments. This market has grown substantially, with banks, brokers, funds, arbitrageurs and private traders now participating in a market valued at about $60 billion in 2007. Emissions Trading PLC, for example, was floated on the London Stock Exchange's AIM market in 2005 with the specific remit of investing in emissions instruments.

Although Kyoto created a framework and a set of rules for a global carbon market, there are in practice several distinct schemes or markets in operation today, with varying degrees of linkages among them.

Kyoto enables a group of several annex I countries to create a market-within-a-market together. The EU elected to be treated as such a group, and created the EU Emissions Trading Scheme (ETS). The EU ETS uses EAUs (EU Allowance Units), each equivalent to a Kyoto AAU. The scheme went into operation on 1 January 2005, although a forward market has existed since 2003.

The sources of Kyoto credits are the Clean Development Mechanism (CDM) and Joint Implementation (JI) projects. The CDM allows the creation of new carbon credits by developing emission reduction projects in non-annex I countries, while JI allows project-specific credits to be converted from existing credits within annex I countries. CDM projects produce Certified Emission Reductions (CERs), and JI projects produce Emission Reduction Units (ERUs), each equivalent to one AAU. Kyoto CERs are also accepted for meeting EU ETS obligations and ERUs will become similarly valid from 2008 for meeting ETS obligations (although individual countries may choose to limit the number and source of CER/JIs they will allow for compliance purposes starting from 2008). CERs/ERUs are overwhelmingly bought from project developers by funds or individual entities, rather than being exchange-traded like allowances.

Since the creation of Kyoto is subject to a lengthy process of registration and certification by the UNFCCC, and the projects themselves require several years to develop, this market is at this point largely a forward market where purchases are made at a discount to their equivalent currency, the EUA, and are almost always subject to certification and delivery (although up-front payments are sometimes made). According to IETA, the market value of CDM/JI credits transacted in 2004 was EUR 245 m; it is estimated that more than EUR 620 m worth of credits were transacted in 2005.

Several non-Kyoto carbon markets are in existence or being planned, and these are likely to grow in importance and numbers in the coming years. These include the New South Wales Greenhouse Gas Abatement Scheme, the Regional Greenhouse Gas Initiative and Western Climate Initiative in the United States and Canada, the Chicago Climate Exchange and the State of California's recent initiative to reduce emissions.

These initiatives taken together may create a series of partly linked markets, rather than a single carbon market. The common theme is the adoption of market-based mechanisms centered on carbon credits that represent a reduction of CO_2 emissions. The fact that some of these initiatives have similar approaches to certifying their credits make it possible that carbon credits in one market may in the long run be tradeable in other schemes. The scheme would broaden the current carbon market far more than the current focus on the CDM/JI and EU ETS domains. An obvious precondition, however, is a realignment of penalties and fines to similar levels, since these create an effective ceiling for each market.

Revisions

The protocol left several issues opens to be decided later by the sixth Conference of Parties (COP). COP6 attempted to resolve these issues at its meeting in the Hague in late 2000, but was unable to reach an agreement due to disputes between the European Union on the one hand (which favoured a tougher agreement) and the United States, Canada, Japan and Australia on the other (which wanted the agreement to be less demanding and more flexible).

In 2001, a continuation of the previous meeting (COP6bis) was held in Bonn where the required decisions were adopted. After some concessions, the supporters of the protocol (led by the European Union) managed to get Japan and Russia in as well by allowing more use of carbon dioxide sinks.

COP7 was held from 29 October 2001 through 9 November 2001 in Marrakech to establish the final details of the protocol.

The first Meeting of the Parties to the Kyoto Protocol (MOP1) was held in Montreal from 28 November to 9 December 2005, along with the 11th conference of the Parties to the UNFCCC (COP11). The 3 December 2007, Australia ratified the protocol during the first day of the COP13 in Bali.

Of the signatories, 36 developed C.G. countries (plus the EU as a party in the European Union)agreed to a 10% emissions increase for Iceland; but, since the EU's member states each have individual obligations, much larger increases (up to 27%) are allowed for some of the less developed EU countries. Reduction limitations expire in 2013.

Enforcement

If the enforcement branch determines that an annex I country is not in compliance with its emissions limitation, then that country is required to make up the difference plus an additional 30%. In addition, that country will be suspended from making transfers under an emissions trading program.

Copenhagen 2009

In 2012 the Kyoto Protocol to prevent climate changes and global warming runs out. To keep the process on the line there is an urgent need for a new climate protocol. At the conference in **Copenhagen** 2009 the parties of the UNFCCC meet for the last time on government level before the climate agreement need to be renewed.

Therefore the Climate Conference in Copenhagen is essential for the worlds climate and the Danish government and UNFCCC is putting hard effort in making the meeting in Copenhagen a success ending up with a **Copenhagen Protocol** to prevent global warming and climate changes.

The Climate Conference will take place in the Bella Center. The conference centre is placed not far from Copenhagen and near the Copenhagen Airport, Kastrup.

Governmental representatives from 170 countries are expected to be in Copenhagen in the days of the conference accompanied by other governmental representatives, NGO's, journalists and others. In total 8000 people are expected to Copenhagen in the days of the climate meeting.

The host of the meeting in Copenhagen is the government of Denmark represented by Connie Hedegaard, the Danish minister of Climate and Energy and Prime Minister Lars Løkke Rasmussen. The official sekretariat is placed in connection to The Prime Ministers Office in Copenhagen. Originally the hosting of the climate conference was initiated by the former Prime Minister Anders Fogh Rasmussen.

The Danish Government has decided that not only the subject of the conference should be focused on the climate but also the conference itself. Among other initiatives the organizers work on mounting of windmill near the Bella Center to produce climate friendly electricity for the conference.

The conference in Copenhagen is the 15th conference of parties (COP15) in the Framework Convention on Climate Change. The recent meeting in United Nations Climate Change Conferences was held in December 2007 in Bali.

The secretary for the climate conferences is the United Nations Framework Convention on Climate Change **UNFCCC** - based in the German city Bonn.

An important part of the scientific background for the political decisions taken on the conferences is made by the Intergovernmental Panel on Climate Change **IPCC,** based in Geneva, Switzerland. The IPCC is established to provide the decision-makers and others interested in climate change with an objective source of information about climate change. IPCC is a scientific intergovernmental body set up by the World Meteorological Organization (WMO) and by the United Nations Environment Programme (UNEP). In 2007 the IPCC received the Nobel Peace Prize).

The Climate Conference in Copenhagen is organized in cooperation between the Ministry of Climate and Energy, Ministry of Foreign Affairs, Ministry of Science, Technology and Innovation, Ministry of Finance and the Prime Minister's Office.

Questions

1. The -----------is an international environmental treaty with goal of achieving stabilization of green house gas concentration

Ans: UNFCCC

2. ------------ is one of the flexible mechanisms that are included is Kyoto protocol

Ans: Emission trading

3. A conference on climate change by the parties of UNFCCC was held at 2009 in ---------

Ans: Copenhagen

4. Intergovernmental panel on climate change (IPCC) headquarters is at -------------

Ans: Geneva

5. The conference in Copsnhagen is the ---------- conference of parties in the framework convention on climate change

Ans: 15th

True/False

6. In 2008, IPCC received Noble peace price

Ans: False (2007)

7. IPCC is a scientific intergovernmental body set up by WMO and UNFCCC

Ans: False (WMO & UNEP)

8. Montreal protocol deals with substances that deplete the ozone layer

Ans: True

9. The recent meeting in UN climate change conferences was held in December, 2007 in Bali

Ans: True

10. National emission targets includes international aviation and shipping

Ans: True

Lecture.32

Environmental Impact Assessment

Environmental Impact Issessment (EIA) is a written analysis or process that describes and details the probable and possible effects of planned industrial or civil project activities on the ecosystem, resources, and environment. The National Environmental Policy Act (NEPA) first promulgated guidelines for environmental impact assessments with the intention that the environment receives proper emphasis among social, economic, and political priorities in governmental decision-making. This act explains the importance of environmental impact assessments for major federal actions affecting the environment. Many states now have similar requirements for state and private activities. Such written assessments are called Environmental Impact Statements or EIS.

Environmental Impact Statement (EIS) is a formal process used to predict how a development project or proposed legislation will affect such natural resources as water, air, land, and wildlife. The environmental impact statement was first introduced in 1969 in the United States as a requirement of the National Environmental Policy Act. Since then, an increasing number of countries have adopted the process, introducing legislation and establishing agencies with responsibility for its implementation.

EISs range from brief statements to extremely detailed multi-volume reports that require many years of data collection and analysis. In general, the environmental impact assessment process requires consideration and evaluation of the proposed project, its impacts, alternatives to the project, and mitigating strategies designed to reduce the severity of adverse effects. The assessments are completed by multidisciplinary teams in government agencies and consulting firms.

The content of the assessments generally follows guidelines in the National Environmental Policy Act. Assessments usually include the following sections:

1) Background information describing the affected population and the environmental setting, including archaeological and historical features, public utilities, cultural and social values, topography, hydrology, geology and soil, climatology, natural resources, and terrestrial and aquatic communities;

2) Description of the proposed action detailing its purpose, location, time frame, and relationship to other projects;

3) The environmental impacts of proposed action on natural resources, ecological systems, population density, distribution and growth rate, land use, and human health. These impacts should be described in detail and include primary and secondary impacts, beneficial and adverse impacts, short and long term effects, the rate of recovery, and importantly, measures to reduce or eliminate adverse effects;

4) Adverse impacts that cannot be avoided are described in detail, including a description of their magnitude and implications;

5) Alternatives to the project are described and evaluated. These must include the "no action" alternative. A comparative analysis of alternative permits the assessment of environmental benefits, risks, financial benefits and costs, and overall effectiveness;

6) The reason for selecting the proposed action is justified as a balance between risks, impacts, costs, and other factors relevant to the project;

7) The relationship between short and long term uses and maintenance is described, with the intent of detailing short and long-term gains and losses;

8) Reversible and irreversible impacts;

9) Public participation in the process is described;

10) Finally, the EIS includes a discussion of problems and issues raised by interested parties, such as specific federal, state, or local agencies, citizens, and activists.

The environmental impact assessment process provides a wealth of detailed technical information. It has been effective in stopping, altering, or improving some projects. However, serious questions have been raised about the adequacy and fairness of the process. For example, assessments may be too narrow or may not have sufficient depth. The alternatives considered may reflect the judgment of decision makers who specify objectives, the study design, and the alternatives considered. Difficult and important questions exist regarding the balance of environmental, economic, and other interests. Finally these issues often take place in a politicized and highly charged atmosphere that may not be amenable to negotiation. Despite these and other limitations, environmental impact assessments help to provide a systematic approach to sharing information that can improve public decision-making.

Questions

1. ------------------------is an written analysis of the possible effects of planned industrial activities on the ecosystem

Ans: Environnemental Impact Assessment (EIA)

2. The formal process used to predict how proposed legislation affect natural resources is known as ------------------

Ans: Environmental Impact Statement

3. The reason for selecting the proposed action is justified as a balance between -------

Ans: risks / impact / costs

4. Environmental impact statement was first introduced in the year -----------

Ans: 1969

5. The -------------------------------- first promulgated guidelines for environmental impact

Ans: National Environmental Policy Act (NEPA)

Match the following

6. EIA introduced by - Archeological and historical features

7. Alternative to the Project - Government agencies and consulting firms

8. Background information - 'No Action'

9. EIA done by - Public decision – making

10. EIA is a systematic Approach to improve - United States.

Ans

6. EIA introduced by - United States

7. Alternative to the Project - 'No Action'

8. Background information - Archeological and historical features

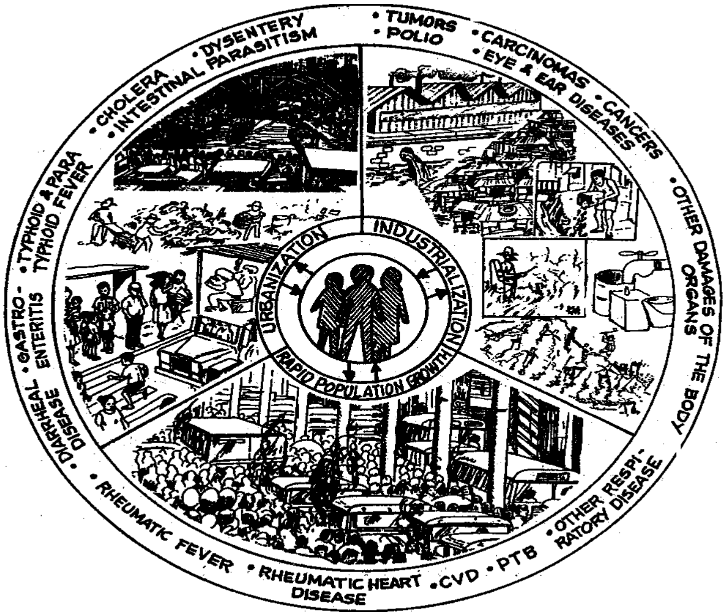
9. EIA done by - Government agencies and consulting firms

10. EIA is a systematic Approach to improve - Public decision – making

Lecture.33

Socio economic factors responsible for environmental degradation

Environmental degradation is a result of the dynamic inters play of socio-economic, institutional and technological activities. Environmental changes may be driven by many factors including economic growth, population growth, urbanization, intensification of agriculture, rising energy use and transportation. Poverty still remains a problem at the root of several environmental problems.



Social Factors

Population

Population is an important source of development, yet it is a major source of environmental degradation when it exceeds the threshold limits of the support systems. Unless the relationship between the multiplying population and the life support system can be stabilized, development programmes, howsoever, innovative are not likely to yield desired results. Population impacts on the environment primarily through the use of natural resources and production of wastes and is associated with environmental stresses like loss of biodiversity, air and water pollution and increased pressure on arable land.

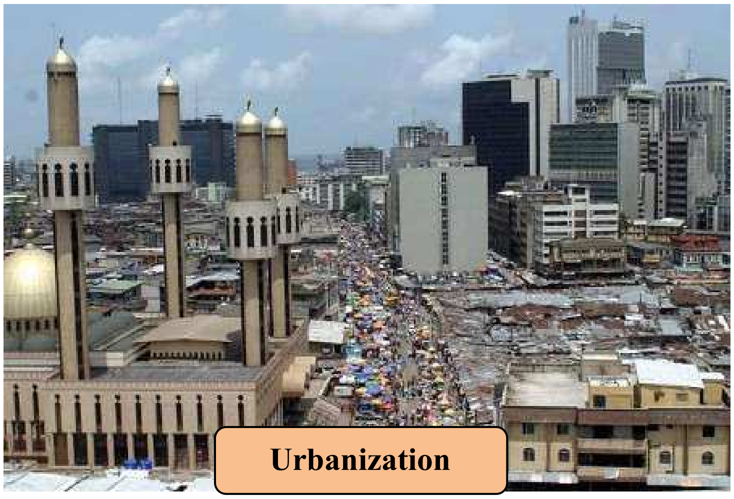
India supports 17 per cent of the world population on just 2.4 per cent of world land area. Its current rate of population growth at 1.85 per cent continues to pose a persistent population challenge. In view of the linkages between population and environment, a vigorous drive for population control need hardly be over emphasized.

Poverty

Poverty is said to be both cause and effect of environmental degradation. The circular link between poverty and environment is an extremely complex phenomenon. Inequality may foster unsustainability because the poor, who rely on natural resources more than the rich, deplete natural resources faster as they have no real prospects of gaining access to other types of resources. Moreover, degraded environment can accelerate the process of impoverishment, again because the poor depend directly on natural assets. Although there has been a significant drop in the poverty ratio in the country from 55 percent in 1973 to 36 percent in 1993-94, the absolute number of poor have, however, remained constant at around 320 million over the years. Acceleration in poverty alleviation is imperative to break this link between poverty and the environment.

Urbanization

Lack of opportunities for gainful employment in villages and the ecological stresses is leading to an ever increasing movement of poor families to towns. Mega cities are emerging and urban slums are expanding. There has been an eightfold increase in urban population over 1901-1991. During the past two decades of 1971-91, India's urban population has doubled from 109 million to 218 million and is estimated to reach 300 million by 2000 AD. Such rapid and unplanned expansion of cities has resulted in degradation of urban environment. It has widened the gap between demand and supply of infrastructural services such as energy, housing, transport, communication, education, water supply and sewerage and recreational amenities, thus depleting the precious environmental resource base of the cities. The result is the growing trend in deterioration of air and water quality, generation of wastes, the proliferation of slums and undesirable land use changes, all of which contribute to urban poverty.



Urbanization

Economic Factors

To a large extent, environmental degradation is the result of market failure, that is, the nonexistent or poorly functioning markets for environmental goods and services. In this context, environmental degradation is a particular case of consumption or production externalities reflected by divergence between private and social costs (or benefits). Lack of well defined property rights may be one of the reasons for such market failure. On the other hand, Market distortions created by price controls and subsidies may aggravate the achievement of environmental objectives. The level and pattern of economic development also affect the nature of environmental problems.

India's development objectives have consistently emphasized the promotion of policies and programmes for economic growth and social welfare. Between 1994-95 and 1997-98, the Indian economy has grown a little over 7 per cent per annum: the growth of industrial production and manufacturing averaging higher at 8.4 per cent and 8.9 percent respectively during these years. The manufacturing technology adopted by most of the industries has placed a heavy load on environment especially through intensive resource and energy use, as is evident in natural resource depletion (fossil fuel, minerals, and timber), water, air and land contamination, health hazards and degradation of natural eco-systems. With high proportion fossil fuel as the main source of industrial energy and major air polluting industries such as iron and steel, fertilizers and cement growing, industrial sources have contributed to a relatively high share in air pollution. Large quantities of industrial and hazardous wastes brought about by expansion of chemical based industry have compounded the wastes management problem with serious environmental health implications.

Transport activities have a wide variety of effects on the environment such as air pollution, noise from road traffic and oil spills from marine shipping. Transport infrastructure in India has expanded considerably in terms of network and services. Thus, road transport accounts for a major share of air pollution load in cities such as Delhi. Port and harbor projects mainly impact on sensitive coastal eco systems. Their construction affects hydrology, surface water quality, fisheries, coral reefs and mangroves to varying degrees.

Direct impacts of agricultural development on the environment arise from farming activities which contribute to soil erosion, land salination and loss of nutrients. The spread of green revolution has been accompanied by over exploitation of land and water resources, and use of fertilizers and pesticides have increased many fold. Shifting cultivation has also been an important cause of land degradation. Leaching from extensive use of pesticides and fertilizers is an important source of contamination of water bodies. Intensive agriculture and irrigation contribute to land degradation particularly salination, alkalization and water logging.

Institutional Factors

The Ministry of Environment & Forests (MOEF) in the Government is responsible for protection, conservation and development of environment. The Ministry works in close collaboration with other Ministries, State Governments, Pollution Control Boards and a number of scientific and technical institutions, universities, non-Governmental organizations etc. Environment (Protection) Act, 1986 is the key legislation governing environment management. Other important legislations in the area include the Forest (Conservation) Act, 1980 and the Wildlife (Protection) Act, 1972. The weakness of the existing system lies in the enforcement capabilities of environmental institutions, both at the centre and the state. There is no effective coordination amongst various Ministries/Institutions regarding integration of environmental concerns at the inception/planning stage of the project. Current policies are also fragmented across several Government agencies with differing policy mandates. Lack of trained personnel and comprehensive database delay many projects. Most of the State Government institutions are relatively small suffering from inadequacy of technical staff and resources. Although overall quality of Environmental Impact Assessment (EIA) studies and the effective implementation of the EIA process have improved over the years, institutional strengthening measures such as training of key professionals and staffing with proper technical persons are needed to make the EIA procedure a more effective instrument for environment protection and sustainable development.

Questions

1. Unplanned expansion of cities has resulted in degradation of ------- environment

Ans: Urban

2. Environmental degradation is a result of the dynamic interplay of socio-economic, institutional and technological activities

Ans: True

3. Poverty is said to be both cause and effort of environmental degradation

Ans: True

4. Overpopulation is the leading environment problem

Ans: True

5. Lack of well defined property rights may be one of the reasons for market failure.

Ans: True

6. Market distortions created by price controls and subsidies may aggravate the achievement of environmental objection

Ans: True

7. Indirect impact of agricultural development on environment arise from farming activities

Ans: False (Direct impact)

Match the following

8. Environmental changes - loss of biodiversity increased pressure on arable land

9. Population impacts on the Environment - break link between poverty and environment

10. Acceleration in poverty Alleviation - Urbanization, intensification of agricultural lands

Lecture.28

International voluntary agencies mandates and activities in environmental conservation

Essential Concepts

Overpopulation is a leading environmental problem,

- exponential population growth and development leads to faster depletion of resources,
- population grows exponentially,
- why population prediction is difficult,
- Population is not evenly distributed throughout the world.

Population

Lifestyle affects resource use

The characterization of overpopulation as the cause of many environmental problems may be an oversimplification.Consumption of natural resources also plays an important role in straining the environment. On a global scale, it is probably pretty intuitive to students that the presence of more people in the world causes a bigger strain on natural resources. What may not be intuitive is the concept of sustainability. What does sustainability mean?

Sustainability *"the simple principle of taking from the earth only what it can provide indefinitely, thus leaving future generations no less than we have access to ourselves."* Many other organizations define it in differently; however, the crux of the definition is the same. Sustainability involves living within the limits of the resources of the Earth, understanding connections among economy, society, and environment, and equitable distribution of resources and opportunities.

It is the last part of the definition that joins population growth, particularly in developed countries, and resource use. Developed countries, in general, have and use more of the Earth's resources. Population growth in developed countries puts a greater strain on global resources and the environment than growth in less developed nations. For example, in 1997, the U.S. generated 27.5% of the world's total CO_2 emissions; more than five times that of India (5% of the world's total), a country with 4-5 times the population of that U.S (Texas A&M's LABB). In fact, the way of life in the United States, on average, requires approximately 5 times the resources available on Earth today (Earthday Network).

Some of the factors that may modify the birth and death rates in a region are

Age structure of the population - the number of women of child bearing age affects the rate of population growth.

Total fertility rate - Total fertility rate (TFR) is the average number of children that each woman will have in her lifetime and affects the birth rate.

Health care - the quality and availability of health care in an area can affect both death rate (by increasing average life expectancy) and birth rate (babies are more likely to survive past childhood). Access to immunizations, family planning and birth control are also important to the overall picture of population growth.

Education - Birth rates tend to fall in countries where the population has access to education

Jobs - Birth rates also fall off when unemployment is low.

Standard of living - Birth rates are lower where standards of living and quality of life are high. Unfortunately, standards of living are difficult to raise in areas where population growth is high - this creates a negative feedback loop that is difficult for some countries to get out of.

Immigration/emigration - the number of people entering or leaving a country (area) actually changes the N_0 and changes population in a more complex way than by altering birth rate or death rate.

Development and industrialization - these two factors alter population growth in complex ways. They can affect an area's income and, thus, its access to many of the factors listed above. Higher income/more developed countries have lower birth and death rates

Disease - in a given year (or even decade) epidemics of infectious diseases can increase death rate dramatically, particularly for a specific area. For example, the bubonic plague decimated Europe in the 14th century - the population of Europe was cut nearly in half by 1400.

War/political upheaval - War and political upheaval can also increase death rates.

Climate - Natural disasters such as drought or flooding can affect food resources and the population will be affected accordingly.

Population status

- World Population [2000 A.D] ; 7 Billion {700 Crore}
- India's Population[2000 A.D] ; 1 Billion {100 Crore}

- India’s Population[2004] ; 102.8 Crore
- India’s Population is expected to exceed China’s population in 2035.
- Expected Population of India in 2035 ; 146 Crores
- Current Annual Growth Rate ; 1.94

Most populous States in India

U.P	166 million
Maharashtra	97 million
Bihar	83 million
West Bengal	80 million
Tamil Nadu	63 million

Lakshadweep has the lowest population of 61000

Literacy Rate in Tamil Nadu	73.45 %
Literacy Rate in India	64.8 %
CBR in Tamil Nadu	19/1000population

As the New Century begins, Natural Resources are under increasing pressure, threatening Public Health and Development.

Many areas are afflicted by,

- Water shortages
- Soil exhaustion
- Loss of forests
- Air and water pollution
- Degradation of coastlines etc.

As the world's population grows, improving living standards without destroying the Environment is a Global challenge. Most developing countries with rapid population growth face the urgent need to improve living standards. As we exploit the nature to meet the present needs, we are destroying the resources needed for the future.

Environment Getting Worse

In the past decade in every environmental sector, conditions have either failed to improve, or they are worsening.

Public Health

- Unclean water along with poor sanitation kills over 12 million people each year. Water pollution is a serious problem everywhere.
- Air pollution kills nearly 3 million people. Air pollution, already a serious problem in cities, is becoming worse as urban population grown and the number of motor vehicles rises.
- Heavy metals and other contaminants also causes health problems

Food Supply

- In most developing countries, the population has been growing faster than food supplies.
- Population pressures have degraded some 2 billion hectares of cultivable land- an area the size of USA and Canada put together.

Freshwater

- Supply of fresh water is limiting, since the demand is soaring as population grows and per-capita use rises.
- By 2025, when world population is projected to be 8 billion, nearly 48 countries containing 3 billion people will face freshwater shortages

Coastlines and Oceans

- Half of all coastal ecosystems are pressured by high population densities and urban development
- A tide of pollution is rising in the world's seas
- Ocean fisheries are being overexploited and fish catches are down

Forests

- Nearly half of the world's original forest cover has been lost.
- Each year millions of hectares of forests are cut, bulldozed or burned
- Forests provide over 400 billion US$ to the world economy annually and are vital to maintaining healthy ecosystems
- Current demand for forest products may exceed the limit of sustainable consumption by 25%

Bio-diversity

- Earth's biological diversity is crucial to the continued vitality of Agriculture and Medicine, and perhaps even to life on Earth itself
- Human activities are pushing many thousands of plant and animal Species into extinction
- Two of every three species is estimated to be in decline

Global climate change

- The Earth's surface is warming due to greenhouse gas emissions, largely from burning fossil fuels.
- If the global temperature rises as projected, sea levels would rise by several meters, causing widespread flooding.
- Global warming also cause droughts and disrupt agriculture

Poverty

- During the 1990's the people in poverty increased by about 1 billion
- By 2000 that number had risen to about 3 billion- almost half of the world's population

Stabilizing Population

- The last four decades have witnessed a profound change in Fertility rates and world population growth.
- Demographic Transition: The transition from high fertility and high mortality to low fertility and low mortality has been substantially completed in the developed world and is underway in most of the developing world.
- But in many countries of Africa and Asia, population continues to growing at 2% a year or faster and the average women, bears 4-6 children.
- Even small increases in the fertility rates- which could occur if commitment to providing family planning services, information, supplies, etc were to diminish- would mean faster population growth.
- Worries about a "population bomb" may have lessened as fertility rates have fallen, but the world's population is
- Projected to continue expanding until the middle of the century.
- While population growth has slowed, the absolute number of people continues to increase-by about 1 billion every 13 years.
- Slowing population growth would help improve living standards and would buy time to protect natural resources.
- In the long run, to sustain higher living standards, world population size must stabilize.

Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action.

Environmental education embraces all disciplines, and covers all levels and types of education including life-long learning. It is planned and implemented through several programmes and Sectors within the organization, notably the Science Sector and the Education Sector.

Approach to EE favours enhancement of critical thinking, problem-solving and effective decision-making skills as well as teaching individuals to make informed and responsible decisions. For this reason, it is essential to foster links between EE in the formal curriculum and projects in non-formal education. Projects such as the establishment of environmental clubs in schools, greening of school-yards, environmental awards, journalistic activities and others, are essential to sensitize young people to their immediate environmental as well as many other complex issues related to sustainable development.

The environment is an integral part of science and technology education. Thus, the Section for Science and Technology Education works on concrete societal issues related to the environment, health and development, focusing on formal and non formal EE in secondary as well as technical & vocational education, and collaborates with other divisions and Sectors which focus on other levels of education. Activities are also developed in collaboration with relevant IGOs, NGOs and governmental organizations.

Questions

1. One of the leading environmental problem in India is -------------------

Ans: Overpopulation

2. Group of metals having high and above causes health problems are generally grouped as ------

Ans: Heavy metals

3. Air pollution kills more percentage of people compared to water and soil pollution.

Ans: True

4. Supply of fresh water is limiting since the demand is soaring as population grows and per-capita use rises.

Ans: True

5. Half of all coastal ecosystem are pressured by high population demities and urban development.

Ans: True

6. -------------------- is a learning process that increases peoples knowledge and awareness about the environment.

Ans: **Environmental education**

7. The earth's surface is warming due to GHG emissions largely from burning fossil fuels

Ans: True

8. Global warming also cause droughts and disrupts agriculture

Ans: True

9. Lakshadweep has the lowest population state among Indian states or union territories

Ans: True

10. TFR is the average number of children that each woman will have in her life time and it does not affects the birth rate

Ans: False

Major air pollutants: Sources and Effects

Pollutant	**Sources**	**Effects**
Ozone. A gas that can be found in two places. Near the ground (the troposphere), it is a major part of smog. The harmful ozone in the lower atmosphere should not be confused with the protective layer of ozone in the upper atmosphere (stratosphere), which screens out harmful ultraviolet rays.	Ozone is not created directly, but is formed when nitrogen oxides and volatile organic compounds mix in sunlight. That is why ozone is mostly found in the summer. Nitrogen oxides come from burning gasoline, coal, or other fossil fuels. There are many types of volatile organic compounds, and they come from sources ranging from factories to trees.	Ozone near the ground can cause a number of health problems. Ozone can lead to more frequent asthma attacks in people who have asthma and can cause sore throats, coughs, and breathing difficulty. It may even lead to premature death. Ozone can also hurt plants and crops.
Carbon monoxide. A gas that comes from the burning of fossil fuels, mostly in cars. It cannot be seen or smelled.	Carbon monoxide is released when engines burn fossil fuels. Emissions are higher when engines are not tuned properly, and when fuel is not completely burned. Cars emit a lot of the carbon monoxide found outdoors. Furnaces and heaters in the home can emit high concentrations of carbon monoxide, too, if they are not properly maintained.	Carbon monoxide makes it hard for body parts to get the oxygen they need to run correctly. Exposure to carbon monoxide makes people feel dizzy and tired and gives them headaches. In high concentrations it is fatal. Elderly people with heart disease are hospitalized more often when they are exposed to higher amounts of carbon monoxide.
Nitrogen dioxide. A reddish-	Nitrogen dioxide mostly	High levels of nitrogen

brown gas that comes from the burning of fossil fuels. It has a strong smell at high levels.	comes from power plants and cars. Nitrogen dioxide is formed in two ways—when nitrogen in the fuel is burned, or when nitrogen in the air reacts with oxygen at very high temperatures. Nitrogen dioxide can also react in the atmosphere to form ozone, acid rain, and particles.	dioxide exposure can give people coughs and can make them feel short of breath. People who are exposed to nitrogen dioxide for a long time have a higher chance of getting respiratory infections. Nitrogen dioxide reacts in the atmosphere to form acid rain, which can harm plants and animals.
Particulate matter. Solid or liquid matter that is suspended in the air. To remain in the air, particles usually must be less than 0.1-mm wide and can be as small as 0.00005 mm.	Particulate matter can be divided into two types—coarse particles and fine particles. Coarse particles are formed from sources like road dust, sea spray, and construction. Fine particles are formed when fuel is burned in automobiles and power plants.	Particulate matter that is small enough can enter the lungs and cause health problems. Some of these problems include more frequent asthma attacks, respiratory problems, and premature death.
Sulfur dioxide. A corrosive gas that cannot be seen or smelled at low levels but can have a “rotten egg” smell at high levels.	Sulfur dioxide mostly comes from the burning of coal or oil in power plants. It also comes from factories that make chemicals, paper, or fuel. Like nitrogen dioxide, sulfur dioxide reacts in the atmosphere to form acid rain	Sulfur dioxide exposure can affect people who have asthma or emphysema by making it more difficult for them to breathe. It can also irritate people's eyes, noses, and throats. Sulfur dioxide can harm trees and crops, damage buildings, and make

	and particles.	it harder for people to see long distances.
Lead. A blue-gray metal that is very toxic and is found in a number of forms and locations.	Outside, lead comes from cars in areas where unleaded gasoline is not used. Lead can also come from power plants and other industrial sources. Inside, lead paint is an important source of lead, especially in houses where paint is peeling. Lead in old pipes can also be a source of lead in drinking water.	High amounts of lead can be dangerous for small children and can lead to lower IQs and kidney problems. For adults, exposure to lead can increase the chance of having heart attacks or strokes.
Toxic air pollutants. A large number of chemicals that are known or suspected to cause cancer. Some important pollutants in this category include arsenic, asbestos, benzene, and dioxin.	Each toxic air pollutant comes from a slightly different source, but many are created in chemical plants or are emitted when fossil fuels are burned. Some toxic air pollutants, like asbestos and formaldehyde, can be found in building materials and can lead to indoor air problems. Many toxic air pollutants can also enter the food and water supplies.	Toxic air pollutants can cause cancer. Some toxic air pollutants can also cause birth defects. Other effects depend on the pollutant, but can include skin and eye irritation and breathing problems.
Stratospheric ozone depleters. Chemicals that can destroy the ozone in the stratosphere. These	CFCs are used in air conditioners and refrigerators, since they work	If the ozone in the stratosphere is destroyed, people are exposed to more

chemicals include chlorofluorocarbons (CFCs), halons, and other compounds that include chlorine or bromine.	well as coolants. They can also be found in aerosol cans and fire extinguishers. Other stratospheric ozone depleters are used as solvents in industry.	radiation from the sun (ultraviolet radiation). This can lead to skin cancer and eye problems. Higher ultraviolet radiation can also harm plants and animals.
Greenhouse gases. Gases that stay in the air for a long time and warm up the planet by trapping sunlight. This is called the "greenhouse effect" because the gases act like the glass in a greenhouse. Some of the important greenhouse gases are carbon dioxide, methane, and nitrous oxide.	Carbon dioxide is the most important greenhouse gas. It comes from the burning of fossil fuels in cars, power plants, houses, and industry. Methane is released during the processing of fossil fuels, and also comes from natural sources like cows and rice paddies. Nitrous oxide comes from industrial sources and decaying plants.	The greenhouse effect can lead to changes in the climate of the planet. Some of these changes might include more temperature extremes, higher sea levels, changes in forest composition, and damage to land near the coast. Human health might be affected by diseases that are related to temperature or by damage to land and water.

Pollutants: Source and Effects

Source	Pollutants	Effect
Yard care/ Landscape Pollutants	• Fertilizers, weed killer, insecticide, fungicides, and grass, tree and shrub clippings wash to stormdrains or soak into groundwater when it rains	• Phosphorus and nitrogen from fertilizers cause algal blooms, which depletes water of oxygen, killing fish and aquatic life • Pesticides and herbicides can be harmful to humans and aquatic organisms (some are carcinogenic or attack the nervous system) • Loose grass clippings and leaves clog drainage systems and/or cause algal blooms in water
Automobile pollutants	• Oil, antifreeze, brake fluid, grease and metals on streets and driveways run off pavement to stormdrains or soak into groundwater • Nitrogen and other contaminants emitted from automobiles settle in water • Oil, grease, transmission fluids, etc. spilled from automobiles, trucks, buses, planes, etc. wash to stormdrain or creek	• Oil, petroleum products and other toxins from automobiles kill fish, plants, aquatic life and even people (contaminate drinking water). Used oil from a single oil change can ruin a million gallons of water-a year's supply for 50 people. • Some of these toxins and metals are absorbed in various aquatic life and can cause medical problems to humans when contaminated fish and shellfish are consumed. • Pollutants such as heavy metals and automobile fluids are toxic to aquatic life (interferes with photosynthesis, respiration, growth and reproduction).
Organic waste-once part of a living animal (feces or food)	• Failing sewer systems spilling out raw sewage after a heavy rain • Leaking or failing septic systems • Pet wastes not collected and disposed of appropriately • Pathogens from rotting food or dead animals • Discharge from food-processing plants, meat-packing houses, dairies and other industrial sources • Organic waste from fibers originating from textile and plant processing plants • Wastewater treatment plants	• Fecal coliform bacteria in pet droppings and septic tank overflows can cause infections and diseases by getting into drinking water and recreation areas • Pathogens from food and dead animals may also cause infections and diseases if they enter water sources • Phosphorus and nitrogen from organic material cause algal blooms, which depletes water of oxygen, killing fish and aquatic life

Household chemicals	• Improperly disposed paint, solvents and other chemicals runoff or soak into the ground • Household and commercial cleaning agents wash into water and stormdrains • Washing car	• Paint, cleaning supplies and other toxic materials contaminate drinking water and kill fish, animals and plants • Detergents cause explosive plant and algae growth, which depletes water of oxygen, killing fish and animals as well as creating a terrible smell
Trash	• Litter washed into stormdrains, creeks, and groundwater	• Looks and smells unpleasant; can harm wildlife
Sediment	• Soil and sediment absorb toxins and transport them to creek beds and groundwater • Construction of new buildings, homes and streets causes excessive erosion • Paved roads cannot absorb chemicals, soil and suspended particles in runoff	• Sediment settles to the bottom of a creek or lake and prevents sunlight from reaching plants, clogs fish gills, chokes other organisms and can smother fish spawning and nursery areas
Pool chemicals	• Swimming pool water illegally discharged to a creek	• Chlorine kills aquatic life
Toxic runoff/ petrochemicals	• Grease and other toxins from restaurants, vehicles, machinery, cleaning products, garbage and toxic waste not disposed of properly • Fuel and oil spilled on the pavement washes to storm drains and/or bodies of water • Chemical spills or medical waste improperly managed	• Oil, petroleum products and other toxins from automobiles kill fish, plants, aquatic life and even people. One quart of oil will contaminate thousands of gallons of water because it doesn't dissolve • These toxins as well as trace metals and degreasing agents used on automobiles contaminate drinking water and can cause major illness • Some of these toxins and metals absorbed in various aquatic life cause medical problems in people when contaminated fish and shellfish are eaten.

Water quality standards

Water quality standards are benchmarks established to assess whether the quality of rivers and lakes is adequate for fish and other aquatic life, recreation, drinking, agriculture, industry and other uses.

International standard for drinking water quality (WHO)

Sl.No	Parameter	Units	Maximum permissible limit
1	pH	-	6.5-9.2
2	Ar	mg L^{-1}	0.05
3	NH_3	mg L^{-1}	0.5
4	BOD	mg L^{-1}	6.0
5	Ca	mg L^{-1}	100
6	Cd	mg L^{-1}	0.01
7	Cr	mg L^{-1}	0.05
8	Cu	mg L^{-1}	1.5
9	Cl	mg L^{-1}	500
10	Cyanide	mg L^{-1}	0.05
11	COD	mg L^{-1}	10
12	Fe	mg L^{-1}	1.0
13	Pb	mg L^{-1}	0.1
14	Mg	mg L^{-1}	150
15	Mn		0.5
16	Hg	mg L^{-1}	0.001
17	Nitrate and Nitrite	mg L^{-1}	45
18	Phenol	mg L^{-1}	0.002
19	PAH	mg L^{-1}	0.2
20	Pesticides	mg L^{-1}	-

21	*E. coli*	-	10/100ml
22	Total hardness	mg L^{-1}	500
23	TDS	mg L^{-1}	500

Irrigation Water Quality Standards (for discharge)

S.No.	Parameter	Inland surface water
1.	Colour and odour	colorless and odorless
2.	Suspended Solids, mg/l, Max	100
3.	Particle size of suspended solids	Shall pass 850 micron IS Sieve
4.	Dissolved solids (inorganic), mg/l	2100
5.	pH value	5.5 to 9.0
6.	Temperature ^{o}C, Max	Shall not exceed 40 in any section of the stream within 15 meters down stream from the effluent outlet
7.	Oil and grease, mg/l, max	10
8.	Total residual chlorine, mg/l, Max.	1.0
9.	Ammonical nitrogen (as N), mg/l, Max.	50
10.	Total Kjeldahl nitrogen (as N), mg/l, Max.	100
11.	Free Ammonia (as NH_3), mg/l, Max.	5.0
12.	Biochemical Oxygen Demand (5 days at 20^{o}C) Max.	30
13.	Chemical Oxygen Demand, mg/l, Max.	250
14.	Arsenic (as As), mg/l, Max.	0.2
15.	Mercury (as Hg), mg/l, Max.	0.01
16.	Lead (as Pb), mg/l, Max.	0.1
17.	Cadmium (as Cd), mg/l, Max.	2.0

18.	Hexavalent chromium (as Cr+6) mg/l, Max.	0.1
19.	Total chromium as (Cr), mg/l, Max.	2.0
20.	Copper (as Cu), mg/l, Max.	3.0
21.	Zinc (as Zn), mg/l, Max.	5.0
22.	Selenium (as Se), mg/l, Max.	0.05
23.	Nickel (as Ni), mg/l, Max.	3.0
24.	Boron (as B), mg/l, Max.	2.0
25.	Percent Sodium, Max.	---
26.	Residual sodium carbonate, mg/l, Max.	---
27.	Cyanide (as CN), mg/l, Max.	0.2
28.	Chloride (as Cl), mg/l, Max.	1000
29.	Fluoride (as F), mg/l, Max.	2.0
30.	Dissolved Phosphates (as P), mg/l, Max.	5.0
31.	Sulphate (as SO_4), mg/l, Max.	1000
32.	Sulphide (as S), mg/l, Max.	2.0
33.	Pesticides	Absent
34.	Phenolic compounds (as C_6H_5OH), mg/l, Max.	1.0
35.	Radioactive materials	
	(a)Alpha emitters MC/ml, Max. (b) Beta emitters uc/ml, Max.	10^{-7} 10^{-6}

Exercise.1

Visit to near by water (pond/river) ecosystem to study biotic and abiotic components

Make a visit to nearby pond/river ecosystem and observe the biotic and abiotic components.

Exercise.2

Documentation of biotic and abiotic components of pond/river ecosystem

Document the biotic and abiotic components of pond/river ecosystem based on the knowledge gained and observation made during your visit.

Exercise.3

Estimation of dissolved oxygen content of river/pond water

The amount of oxygen dissolved in water or the oxygen freely available in water. Dissolved oxygen (D.O.) levels are considered a most important indicator of water body's ability to support desirable aquatic life. The measurement of dissolved oxygen indicates the purity of water and is important for maintaining aerobic conditions in the receiving waters and in the aerobic treatment of sewage and industrial waste water. Further D.O. determination is the basis for Biological Oxygen Demand Test, which is used to evaluate pollution strength of waste waters and rate of biochemical oxidation. Insufficient oxygen in water may result in increased anaerobic microbial activity and thus release methane, sulphur dioxide into the atmosphere. The D.O. level of the water body for the survival of the fish is 6 mg L^{-1}.

Sample collection and preservation

Samples have to be collected in BOD bottles. Fill the bottles without entrapment of air. Sample collected in the field and brought to the lab is likely to undergo a change in DO value because of changes in temperature and biological reactions with time. Therefore, to obtain correct DO value, the sample must be 'fixed' immediately after collection.

Fixing is done by adding 2 ml each of manganese sulphate solution and alkali iodide azide reagent to the sample in the bottles. Preserve the fixed samples by keeping at 4^{o}C in dark.

Principle

The Winkler method is followed to estimate the DO value. This method is based on the fact that when manganese sulphate is added to the sample containing alkaline potassium iodide, manganese hydroxide is formed, which is oxidized by the dissolved oxygen of the sample to basic manganic oxide. On addition of sulphuric acid, the basic manganese oxide liberates iodine equivalent to that of dissolved oxygen originally presents in the sample. The liberated iodine is titrated with standard of sodium thiosulphate using starch as an indicator.

$MnSO_4 + 2\ KOH \rightarrow Mn(OH)_2 + K_2SO_4$

$2\ Mn(OH)_2 + O_2 \rightarrow 2\ MnO(OH)_2$

(Dissolved oxygen) (Basic Manganic oxide)

$MnO(OH)_2 + 2\ H_2SO_4 \rightarrow MnO(SO_4)_2 + 3\ H_2O$ (Manganic sulphate)

$MnO(SO_4)_2 + 2\ KI \rightarrow MnSO_4 + K_2SO_4 + I_2$

$2\ Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2\ NaI$

Reagents

(1) Manganous sulphate solution : Dissolve 48 g of $MnSO_4 . 4H_2O$ in 100 ml of distilled water. Filter the solution if it is not clear.

(2) Alkali-iodide-azide reagent:

(a) Dissolve 175 g KOH (or) 125 g NaOH and 37.5 g potassium iodide (or) 33.7 g NaI in distilled water and dilute to 250 ml.

(b) Dissolve 2.5 g sodium azide in 10 ml distilled water.

(c) Pour the azide solution to the alkali iodide solution and mix well.

(3) Starch indicator: Dissolve 1 g starch in a beaker containing water. Stir it with a glass rod to make it as a thin paste. Pour this paste in about 100 ml boiling distilled water and boil for two minutes and cool.

(4) Concentrated Sulphuric acid.

(5) Sodium thiosulphate solution 0.1 N: Dissolve 24.82 g sodium thiosulphate ($Na_2S_2O_3. 5H_2O$) in boiled and cooled distilled water and make up to 1000 ml in a volumetric flask. Standardize it against potassium dichromate solution (0.1 N).

Standardization of thiosulphate using standard potassium dichromate

Dissolve 1.2257 g potassium dichromate (previously dried at 103^{o}C for 1 hour, in distilled water and make up to 250 ml in a volumetric flask. This is exactly 0.1 N solution. Place 100 ml of boiled, cooled, distilled water in a 500 ml of conical flask. Add 3 g of KI, 2 g $NaHCO_2$ and shake until the salts dissolve. Add 6 ml conc. Sulphuric acid.

Pipette 25 ml 0.1 N $K_2Cr_2O_7$ solution into the flask. Cover the flask with a watch glass and keep it in the dark for 5 min. Rinse the watch glass and dilute the solution to 250 ml with boiled, cooled distilled water. Titrate the liberated iodine with the sodium thiosulphate solution in the burette. When the solution acquires yellowish green colour, add 1 ml starch indicator. Blue shade will be obtained. Rinse the sides of the flask and continue the titration until one drop changes the colour from greenish blue to light green. Calculate the normality of sodium thiosulphate solution.

Procedure

- Fill the BOD bottle with sample up to the rim.
- Add 2 ml of Manganous sulphate solution immediately followed by 2 ml of alkali-iodide-azide solution.
- Stopper the bottle without entrapment of air and mix by inverting the bottle at least for about 10 min.
- Then add 2.0 ml of conc. H_2SO_4 by the sides of the bottle to dissolve the precipitate formed.
- Take 100 ml of sample into a conical flask.
- Titrate the liberated iodine with the standardized thiosulphate in the burette.
- Add 2 ml of starch solution when the colour of the solution turns straw yellow. Continue the titration by adding the thiosulphate solution in drops till the disappearance of the blue colour.
- Repeat the experiment to obtain concordant titre values.

Calculation

1000 ml of 1 N thiosulphate = 8 g oxygen

$$\text{Dissolved oxygen (mg L}^{-1}\text{)} = \frac{\text{TV} \times \text{N} \times 8 \times 1000}{\text{V}}$$

Where,

V = Volume of sample in ml

TV = Titre value (thiosulphate) in ml

N = Normality of thiosulphate used for titration

Result

Exercise.4

Estimation of biological oxygen demand of river/pond water

Biological oxygen demand is the amount of oxygen required by the bacteria or microorganisms to decompose the organic matter present in the waste water. It is the important parameter for checking the quality of waste water and other water body. A high value of BOD indicates that there is high amount of pollutant in the water. The maximum permissible level of BOD for drinking water is 6 mg L^{-1} or ppm and 30 mg L^{-1} for irrigation water.

Principle

BOD is evaluated by measuring oxygen concentration in samples iodometrically before and after incubation in the dark at 20°C for 5 days. Preliminary dilution and aeration of sample are usually necessary to ensure that not all the oxygen is consumed during incubation. Samples absorbing more than 6 mg/l of dissolved oxygen should be diluted with dilution water. Generally sewage is used as a standard seed material.

Reagents

(1) All the reagents used for D.O test.

(2) Water for dilution

Take 2 litres distilled water in 3 litres bottle. Shake this partially filled bottle for about ten minutes so that the distilled water gets saturated with atmospheric oxygen or using aerated, the distilled water can be aerated for 1 or 2 days. Then add to this 2 ml of phosphate buffer (pH 7.0) solution, 2 ml of $MgSO_4$ solution, 2 ml $CaCl_2$ solution and 2 ml of ferric chloride solution.

(a) Phosphate buffer solution: Dissolve 8.5 g of KH_2PO_4, 21.75 g K_2HPO_4 and 1.7 g NH_4Cl in 500 ml distilled water. Dilute this solution to 1 litre.

(b) Ferric chloride:

Dissolve 0.25 g $FeCl_3.6H_2O$ in water and dilute the solution to 1 litre.

(c) Calcium chloride:

Dissolve 0.25 g $CaCl_2$ in 1 litre of distilled water.

(d) Magnesium sulphate solution:

Dissolve 22.5 g $MgSO_4.7H_2O$ in 1 litre of distilled water.

Procedure

BOD determination without dilution

If the sample is fairly clean, it can be used as such for BOD determination. Sample with very low bacterial content may not get stabilized in 5 days. These samples require seeding with a small known volume of domestic sewage water. When it is done, a seed correction in the measure BOD value is made. The value for correction is determined by measuring the BOD value of sewage water used for seeding.

Fill two BOD bottles up to the rim.

- After 15 min., tightly stopper these bottles.
- Make sure that there are no air bubbles inside the bottles.
- Use the sample in one bottle for initial dissolved oxygen measurement.
- Place the other bottle in an incubator at 20°C for 5 days.
- After 5 days, determine the dissolved oxygen in the incubated bottle.

BOD determination with dilution

This method is used when the BOD value exceeds 5. Determine the DO of the diluted sample using one of the bottles immediately. Incubate the other bottle for 5 days at 20°C and determine the DO.

Calculation

(a) Without dilution $BOD = DOI - DO_F \text{ x } 1000 \text{ mg } L^{-1}$

(b) With dilution

$$BOD = \frac{DO_I - DO_F}{F} \text{ x } 1000 \text{ mg } L^{-1}$$

Where,

DO_I = DO of diluted water sample before incubation

DO_F = DO of diluted water sample after incubation

$$F = \frac{\text{Volume (ml) of sample} + \text{Volume (ml) of dilution water added}}{\text{Volume (ml) of sample}}$$

Note: If you use seeding, subtract the BOD of seeding sample with total BOD.

Dilution of sample required for various ranges of BOD

Expected BOD of sample ($mg\ L^{-1}$)	Volume of sample (ml/l) of mixture	Dilution factor
0-6	1000	1
4-12	500	2
10-30	200	5
20-60	100	10
40-120	50	20
100-300	20	50
200-600	10	100
400-1200	5	200
1000-3000	2	500
2000-6000	1	1000
More than 6000	0.5	2000

Result

Exercise.5

Study of bioindicators of pond/river ecosystem

Biological testing involves the use of plant, animal, and/or microbial indicators to monitor the health of an aquatic ecosystem. Observe the water biota in polluted and unpolluted water environment. Collect water samples and do the coliform test.

Domestic sewage disposal carries to spread of enteric diseases and the Coliforms are the indicators of water pollution. The coliforms are ***E. coli, Enterobacter aerogenus, Salmonella, Shigella, Streptococci*** and ***Aeromonas***. The presence of these organisms in water system indicates the contamination of human and animal wastes.

Materials required

Lactose broth, test tubes, Durham's tubes, pipettes, Eosin-Methylene Blue agar, Brilliant green and phenol red.

Procedure

Presumptive Test

- Inoculate the 1.0 ml, 0.1 ml, 0.01 ml water samples to each of 5 test tubes containing SSLB (Single strength lactose broth) and place the Durham's tube in an inverted position.

- Incubate the tubes at 37° C and observe the test tubes for gas formation at 24 hours and 48 hours.

- If gas is formed in 24 hours indicate positive test or not until 48 hours, it is doubtful, and go for confirmative test. If no gas is formed even after 48 hours it is negative. Count the number of positive test tubes and determined the MPN index by referring the table.

Confirmative Test

- Take a loop full of culture from the Lactose broth tube from the higher dilution which showed positive test and streak on EMB agar plate.

- Incubate the plates at 37° C for 24 hours. Observe the typical ***E. coli*** colonies of greenish metallic seen.

Completed Test

- Pick up the suspicious colony from above test and inoculate to brilliant green lactose broth and incubate at 37° C.
- Observe the gas formation.
- Coliforms are confirmed by gas formation and gram staining.

Lactose Broth

Beef extract	:	3 g
Peptone	:	5 g
Lactose	:	5 g
Distilled water	:	1000 ml

Eosin Methylene Blue Agar Medium

Peptone	:	10 g
Lactose	:	5 g
Sucrose	:	5 g
K_2HPO_4	:	2 g
Eosin	:	0.4 g
Methylene Blue	:	0.6 g
Agar	:	15 g

Results

MPN Table

MPN index 95 % confidence limits for various combination of positive results when five tubes are used dilution (10 ml, 1.0 ml, 0.1 ml):

Combination of positives	MPN Index per 100 ml	95 % Confidence Limits	
		Lower	Upper
0-0-0	<2	-	-
0-0-1	2	1	10
0-1-0	2	1	10
0-2-0	4	1	10
1-0-0	2	1	11
1-0-1	4	1	15
1-1-0	4	1	15
1-1-1	6	2	18
1-2-0	6	2	18
2-0-0	4	1	17
2-0-1	7	2	20
2-1-0	7	2	21
2-1-1	9	3	24
2-2-0	9	3	25
2-3-0	12	5	29
3-0-0	8	3	24
3-0-1	11	4	29
3-1-0	11	4	29
3-1-1	14	6	35
3-2-0	14	6	35
3-2-1	17	7	40
4-0-0	13	5	33
4-0-1	17	7	45
4-1-0	17	7	46
4-1-1	21	9	55
4-1-2	26	12	63

4-2-0	22	9	56
Combination of positives	MPN Index per 100 ml	95 % Confidence Limits	
		Lower	Upper
4-2-1	26	12	65
4-3-0	27	12	67
4-3-1	33	15	7
4-4-0	34	16	80
5-0-0	23	9	86
5-0-1	30	10	110
5-0-2	40	20	140
5-1-0	30	10	120
5-1-1	50	20	150
5-1-2	60	30	180
5-2-0	50	20	170
5-2-1	70	30	210
5-2-2	90	40	250
5-3-0	80	30	250
5-3-1	110	40	300
5-3-2	140	60	360
5-3-3	170	80	410
5-4-0	130	50	390
5-4-1	170	70	480
5-4-2	220	100	580
5-4-3	280	120	690
5-4-4	350	160	820
5-5-0	240	100	940
5-5-1	300	100	1300
5-5-2	500	200	2000
5-5-3	900	300	2900
5-5-4	1600	600	5300
5-5-5	1600	-	-

Exercise.6

Visit to nearby terrestrial (forest) ecosystem to study biotic and abiotic components

Make a visit to nearby forest ecosystem and observe the biotic and abiotic components.

Exercise.7

Estimation of organic carbon content of forest/grassland soil

Estimation of Organic Carbon and Organic matter in Soil

Materials needed

A. Potassium dichromate solution (N): Dissolve 49.04 g of potassium dichromate in distilled water to prepare 11 of solution.

B. Sulphuric acid (concentrated)

C. Phosphoric acid (concentrated)

D. Sodium fluride : Dry, powdered

E. Diphenylamine indicator: Dissolve 0.25 g of diphenylamine in 10 ml of distilled water and add gradually 50 ml of concentrated sulphuric acid.

F. Ferrous ammonium sulphate solution (0.5 N): Add 20 ml of concentrated sulphuric acid to 800 ml of distilled water and dissolve in it 196.1g of ferrous ammonium sulphate. Further add distilled water to make the volume 1 lit.

Procedure

- Take 0.5 g of soil in a 500 ml conical flask.
- Add 10 ml of potassium dichromate solution and gradually add 20 ml of sulphuric acid.
- Wait for about half an hour and then add 200 ml of distilled water, 10 ml of phosphoric acid, 0.2 g of sodium fluoride and 1 ml of diphenylamine indicator.
- Titrate the contents against ferrous ammonium sulphate solution. At the end point, the dull green colour changes through turbid blue to the brilliant green.
- Run a distilled water blank simultaneously.

Calculation

Weight of sample taken = 0.5 g

Volume of 1N $K_2Cr_2O_7$ used = 10 ml

Volume of 0.5N FAS consumed for
blank titration = ‘b’ ml

Volume of 0.5 N FAS consumed for
sample titration = ‘a’ ml

1 ml of 1N $K_2Cr_2O_7$ = 0.03 g of C

% organic carbon = $10 - (10 \times \frac{a}{b}) \times 0.03 \times \frac{100}{w}$

w = weight of sample taken

% organic matter = …… x OC

Result

Exercise.8

Visit to near by grassland ecosystem to study biotic and abiotic components

Make a visit to nearby grassland ecosystem and observe the biotic and abiotic components.

Exercise.9

Study of population indices of a grassland ecosystem

Locate a polluted and an unpolluted area where observe all the living organisms and plants. Compare the biota and offer your comments. Also study the plant population and its indices using quadrate method.

Population: Total number of individuals of the same species.

Vegetation: It is the continuous, sum total of the growth of various forms of plant populations in the area.

Community: An assemblage of species with similar environmental conditions. It is an organized unit of different species.

Eco-system: A specific and self-contained area in which all species, plants and animals interact with each other and are interdependent upon each other as well as the environment in which they live.

Methods of studying population and community:

(A) **Floristic methods**: Studying by listing various genera of species present in a community.

(B) **Physiognomic methods**: Studying in terms of their life forms, general stature, spread etc.

(C) **Phytosociological methods**: Studying all types of characters.

(i) Quadrat method
(ii) Line transect method
(iii) Point frame method.

Phytosociological methods

Quadrate Method: Quadrat (or) sampling unit is an area of definite size may be a circle, or a square or a rectangle.

Types of quadrats

- **List quadrat** : Species present in an area are simply listed.
- **List-count quadrat**: Besides listing, numerical counts of individuals are also made.
- **Chart quadrat:** Detailed scale study of growth and distribution of each species in space is recorded on graph paper by use of a pantograph at intervals of months or years.
- **Experimental permanent quadrat:** An undisturbed area is studied for vegetational changes over a long period, to study periodic changes in the community.

Steps involved in quadrat methods

1. to determine the minimum size of the quadrate by species-area-curve method;
2. to determine the minimum number of quadrates to be laid;
3. record of the species ie. listing, counting of the individuals of each species.

Step-I

- with three nails and string piece make a ‘L’ shaped structure in the field;
- with another piece of string and nail make a square of an area 10 x 10 sq. cm.;
- note down the various species present within the area;
- now increase the area to 20 x 20 sq. cm and note down the number of species present in this area;
- thus go on increasing the area ie., 30 x 30 sq. cm., 40 x 40 sq. cm. and so on, each time record the number of species occurring in that area;
- continue the process till there is no further increase in the total number of species with the increasing size of the quadrat;
- in the graph sheet, plot number of species on the y-axis against the areas on the x-axis, the curve obtained is called species-area-curve;
- note the point at which this curve starts flattening up, from this point find out the minimum size of the quadrat to be used for the study.

Step-II

- lay down 25-50 quadrats of the definite size at random in the field at different sites;
- list down the different species in each quadrat in the table;
- with the help of the data in the table find out the accumulating total of the number of species for each quadrat;
- in the graph sheet,plot the number of quadrats on x-axis against accumulating total number of species on y-axis;
- a curve would be obtained and the point at which curve starts flattening up would give the minimum number of quadrats to be laid down in the field.

Step-III

- lay down the required number of quadrats of appropriate size in the area to be studied;
- in each quadrat note down the various species present and also count the total number of individuals of each species.

Observations and Calculations

Density

It represents the numerical strength of species in the community. Number of individuals of the species in any unit area is its density. It gives an idea about the degree of competition. It is expressed as number of individuals per unit area.

$$\text{Density} = \frac{\text{Total number of individuals of the species in all the quadrats}}{\text{Total number of quadrats studied}}$$

Frequency Number of sampling units (as %) in which the particular species occurs;

No. of quadrats in which the species occurred

$$\text{Frequency} = \frac{\qquad}{\text{Total number of quadrats studied}}$$

Raunkiaer's frequency class table

Frequency	Frequency class
0-20	A
21-40	B
41-60	C
61-80	D
81-100	E

Abundance: Represents the number of individuals of any species per sampling unit of occurrence.

$$\text{Abundance} = \frac{\text{Total number of individuals of the species in all the quadrats}}{\text{Total number of quadrats in which the species occurred}}$$

Dominance: Expressed on the basis of density, frequency and abundance values.

$$\text{Relative density} = \frac{\text{Density of the individual species x 100}}{\text{Total density of all the species}}$$

$$\text{Relative frequency} = \frac{\text{Frequency of the individual species x 100}}{\text{Total frequency of all the species}}$$

$$\text{Relative abundance} = \frac{\text{Abundance of the individual species x 100}}{\text{Total abundance of all the species}}$$

Result

Estimation of Population and Community Structure in an Ecosystem

S. No.	Plant species	Number of individual							Total number of individuals	No. of quadrats in which species occurred	Total No. of quadrats studied	F	D	A	RF	RD	RA
		Q_1	Q_2	Q_3	Q_4	Q_5	Q_6	Q_7									

Q - Quadrat F - Frequency D - Density
A - Abundance
RF - Relative Frequency RD - Relative Density RA-Relative Abundance

Exercise.10

Study of pollution indicator plants, insects, birds and animals

Document various pollution indicator plants, insects, birds and animals.

Exercise.11

Visit to near by industry to study pollution abatement techniques

Make a visit to near by Industry and study the methodologies they are adopting to manage their factory wastes.

Exercise.12

Collection, processing and storage of industrial effluent samples

The objective of sampling is to collect a portion of material small enough in volume to be conveniently transported and handled in the laboratory while still accurately representing the material being sampled. This ensures that the relative proportions or concentrations of all components present in the original material are present in the sample.

Number of Samples

Typically, an area is divided into a series of blocks, and sampling sites are identified either in the centre of each unit or the intersection of each unit. Depending on the size of the project and the predicted distribution of the parameter or constituent of interest, the intensity of sampling can be selected. In projects dealing with environmental pollution of a small area, sampling stations usually need to be located very close, particularly in areas with many contaminant sources. In an environmental survey, the goal is to check the extent of pollution and the presence and abundance of specific pollutants. Samples taken within a grid block is representative of the pollution for the area surrounding the sampling point.

As there are random variations in both analytical procedures as well as occurrence of a constituent at a point, a single sample may be insufficient. First assess the overall standard deviation; approximately 20-30 samples have to be taken, for most physical and chemical analyses, a 2L sample is sufficient.

Size of the sampling area

The number and distance between sampling stations also depend on the physical size of the study area and how large an area each sample has to represent. In addition, the density of sampling stations is determined by the variability or gradients in the processes, which control the distribution of the investigated parameter.

Collection of Samples

Sample seals and labels

Gummed paper labels or tags are generally adequate. Labels should include name of the collector, date, hour, exact location, water temperature, water level, stream flow, post -

sampling handling, etc. Labels should be filled before or at the time of sampling with waterproof ink. The seals should have collector's name and date and time of sampling. The seal should be fixed before it leaves the hands of the sampler.

Field log book

This should include purpose of sampling, location of sampling point, name and address of the field contact producer of the material being sampled and address (If different from the location) and type of sample. If the sample is wastewater stream identify the process that is producing the waster water. Suspected sample composition including concentrations, number and volume of sample taken, description of sampling point and sampling method, date and time of collection, collector's identification number and sample distribution with transport particulars. Protect the log book and keep it in safe place.

Chain-of-custody record

This should accompany each sample or groups of samples. The record includes sample number, signature of the collector, date, time, and address of collection, sample type, signatures of persons involved in the chain of possession and inclusive of the dates of possession.

Sample analysis request sheet

Most of the information from the logbook is included in this sheet and such a form should also have portion to be filled up by the personnel involved in the laboratory such as name of the person receiving the sample, laboratory sample number, date of sample receipt and determinations to be performed.

Sample delivery to the laboratory

This should be done as soon as possible to the sample custodian.

Receipt and logging of the sample

After examining the information accompanying the sample and verification regarding any tampering after collection the sample should be stored in a secured place.

Assignment of samples for analysis

The laboratory supervisor usually does this. In the laboratory, the supervisor and the analyst are responsible for its care and custody.

Types of samples

Grab or catch samples

A sample collected at a particular time and place can only represent the composition of the source at that time and place. If the source is known to be fairly constant in composition over a considerable period of time or over considerable distances in all directions, then the sample may be said to represent a longer time period or a larger volume or both than the specific point at which it was collected. The sampling intervals can be based on the frequency with which the changes can be expected.

Composite samples

In most cases it refers to a mixture of grab or catch samples. As an alternative to separate analysis of large number of samples, a composite sample can result in saving a lot of money and time in the laboratory. A composite sample representing a 24th period is considered standard for most determinations. To evaluate the effects of special, variable or irregular discharges and operations, collect composite samples representing the period during which such discharges occur. If the components or characteristics of the sample are suspected to change with storage it is better to avoid composite sampling. In such cases, determinations should be done on individual samples as early as possible after collection and preferably at the sampling point itself.

Integrated Samples

For certain purposes, the information needed best by analyzing mixtures of grab samples collected from different points simultaneously or as quickly as possible. Such mixtures are called integrated samples. The need for such a method arises when sampling occurs in a stream that varies in composition across its width and depth. Preparation of integrated samples however requires special equipment to collect a sample from a known depth without contaminating the overlying water.

Sample containers

There are two basic choices in containers, glass or plastic. In both cases a tightly fitting screw-cap top is essential. Glass bottles are suitable for many purposes. The notable exception is storage of water to be analyzed for heavy metals. In this case adsorption or ion exchange on the glass surface can invalidate their use. Borosilicate glass is best. Soft glass (soda-lime glass) should not be used when sodium is to be determined. Presently plastic bottles have replaced glasses for storage of water samples. Compared to glass, plastic bottles are inexpensive, less fragile and less ion exchange problem. In contrast most plastics have a porosity which permits samples to evaporate slightly over long storage period. The second choice among plastic is high-density linear polyethylene. Compared to other plastic containers, these are rugged and reduce evaporation and ion exchange problems. Containers made of fluorinated polymers such as polytetrafluoroethlene (TFE) can be preferred for sampling organics.

Cleaning of containers

Plastic bottles including Teflon may contain impurities which will result in sample contamination. Metallic impurities due to fabrication process causes positive contamination in trace metal analysis of the additives used as stabilizers may leach out and causes negative or pseudo contamination.

The method of cleaning depends on the use to which the bottles will be put. At the very least, however, most inorganic analysis applications require that the containers be washed with detergent rinsed thoroughly with tap water and finally distilled or deionized water. In most cases, a non-ionic detergent used in hot water is best.

When heavy metals are to be analyzed, an acid soaking following by detergent wash is essential. When an acid treatment is needed, there is no general agreement in the literature as to type or strength of acid and the method of treatment. The present authors use warm 1:1 nitric or hydrochloric acid. This mixture is added, followed by a period of vigorous shaking and subsequently the container is rinsed thoroughly with deionized water.

Sample storage before analysis

Certain cations are subject to loss by adsorption on or ion exchange with the walls of glass containers (E.g. Al, Cd, Cr, Cu, Fe, Pb ,Mn. Ag and Zn). These are best collected in a separate clean bottle and acidified with HNO_3 to a pH below 2.0 to minimize precipitation and adsorption to container walls. The sample should be kept as cool as possible without freezing to minimize the potential for volatilization or bio- degradation. If immediate analysis is not possible, sample should be stored at 4^oC. Chemical preservative should be used with caution and should not interfere with constituents; if they are used they should be added to the sample bottle initially, before sampling. Methods of preservations are generally intended to reduce the biological action, hydrolysis, volatilization and complexion of chemical compounds.

Exercise.13
Analysis of temporary and total hardness of effluent sample by titration

Hardness

Hardness refers to the bicarbonates, chlorides and sulphates of calcium, magnesium and sodium. Calcium and magnesium are the principal cations imparting hardness; however, to lesser extent cations like iron, manganese and strontium are also responsible for it. Hardness when caused because of bicarbonates and carbonates of these cations is called temporary hardness, since it can be removed by boiling. Sulphates and chlorides of these cations cause permanent hardness, which is not removed by simple boiling of water. In general practice, the hardness is measured as concentration of only calcium and magnesium (as $CaCO_3$) which are far high in concentration over the other cations.

Hardness of water prevents lather formation with soap, therefore, hard water is not suitable for bathing and washing. Hard waters have high boiling point and so are not good for cooking also.

Materials required

(i) Laboratory glassware; (ii) reagents as given below:

(a) Ammonia buffer solution: Dissolve 13.5 g of ammonium chloride in 114 ml of concentrated ammonium hydroxide and add distilled water to make the volume 200 ml. Adjust the pH to 10.

(b) Erichrome black-T indicator: Dissolve 0.5 g of Erichrome Black-T dye and 4.5 g hydroxyl ammonium hydrochloride in 100 ml of 80% ethyl alcohol.

(c) EDTA solution (0.02 N): Dissolve 7.446 g of disodium salt of EDTA in distilled water to prepare 1 litre of solution. Store in a polyethylene bottle.

Procedure

- Take 50 ml of sample in a porcelin basin and add 1 ml of ammonia buffer solution and 4-5 drops Erichrome Black-T indicator.
- Titrate against EDTA solution until the wine red colour of solution turns blue

Calculation

$$\text{Total hardness (mg/L as } CaCO_3) = \frac{TV \times N \times 50 \times 1000}{V}$$

Where, TV = Volume of titrant (ml)
V = Volume of sample (ml)
N = Normality of EDTA

Note: Permanent hardness of water can be calculated after boiling water sample for about 15 minutes allow it to cool and follow the above said procedure.

Temporary hardness = Total Hardness - Permanent hardness

Result

Exercisec.14

Estimation of chlorides in effluent sample

Chlorides

Chloride is a free ions is one of the major inorganic anions in water and waste water. The salty taste produced in potable water is due to the presence of chloride ions**.** Inland natural waters, in general have low chloride concentration, often less than that of bicarbonates and sulphates. However, inland saline waters, coastal, estuarine and seawater are characterized by moderate to very high chloride content. In natural fresh waters high concentration of chlorides is considered to be an indicator of pollution due to organic wastes of animal origin (animal excreta has high quantity of chlorides along with nitrogenous wastes). Industrial effluents may increase the chloride content in natural waters. Chloride content above 250 mg/L makes water salty in taste; however, a level up to 1000 mg/L is safe for human consumption.

Materials required

Laboratory glasswares and (ii) reagents, as given below:

(A) Silver nitrate solution (0.02 N): Dissolve 3.387 g of silver nitrate in distilled water and dilute to 1 ml. Stored the solution in a dark glass bottle.

(B) Potassium chromate indicator: Dissolve 10 g of potassium chromate in about 20 ml of distilled water. Add a few drops of 0.02 N silver nitrate soluting to produce a red precipitate let stand it for about 12 hours. Filter and dilute the filterate to 1l with distilled water.

Procedure

- Take 10 ml of sample in a flask and add 5-6 drops of potassium chromate indicator. The colour of sample becomes yellow.
- Titrate against silver nitrate solution until a persistent brick red colour appears (end point).

Calculation

$$\text{Chloride (mg L}^{-1}\text{)} = \frac{\text{TV x N x 35.457 x 1000}}{\text{V}}$$

Where,

TV = Volume of titrant (ml); N = Normality of titrant (0.02 N) and

V = Volume of sample (ml)

The salinity of water, on the basis of its empirical relationship with chloride content, may be calculated as follows:

Salinity (g/l) = 0.03 + 1.03 + 1.805 (chloride in mg/l)

Result

Exercisec.15

Determination of total dissolved solids (tds) in effluent samples

Estimation of total dissolved solids (TDS)

Total dissolved solids denote the various kinds of minerals present in water including salts and minerals. It does not contain any gas or colloids. The maximum permissible limit of TDS for any industrial effluents is 2100 mg L^{-1}.

Principle

The total dissolved solids can be determined by evaporating and drying a known volume of filtered sample.

Apparatus and Reagents

Evaporating dish and boiling water bath.

Procedure

- Take an evaporating dish of suitable dimension, dry it and weigh accurately.
- Filter the about 100 ml of effluent sample through pre-dried and weighed Whatman No.1 filter paper.
- Evaporate the clear filtrate in the evaporating dish on a boiling water bath to constant weights.
- Cool and take the final weight of the dried residue.

Calculation

$$\text{TDS (mg / L)} = \frac{(B - A)}{V} \times 10^6$$

Where, A = Weight of the evaporating dish alone (g)
B = Weight of the evaporating dish + dried residue (g)
V = Volume of the sample taken for filtration (ml)

Results

Exercise.16

Determination of chemical oxygen demand (cod) in effluent sample

Chemical oxygen demand

Chemical oxygen demand is the oxygen requirement of a sample for oxidation of both organic and inorganic matter under specified conditions. The major advantage of the COD test is the short time (2 hours) required to carry out rather than the longer 5 days procedure for BOD. This test is recommended as a supplement to BOD test. In COD test, the sample is subjected to a oxidation by which both biologically oxidizable and biologically inert organic matter is oxidized. The COD of the effluent or water will always be higher than BOD value.

Principle

The organic matter of the sample is oxidized to water, CO_2 and ammonia by refluxing with a known excess of potassium dichromate in a sulphuric acid solution. The excess dichromate is titrated with ferrous ammonium sulphate solution.

$$6\ Fe^{2+} + Cr_2O_7^{2-} + 14H \quad \rightarrow \quad 6\ Fe^{3+} + 2Cr^{3+} + 7H_2O$$

Silver sulphate is added as a catalyst to promote oxidation of certain classes of organic compounds such as straight chain aliphatic compounds like acetic acid, amino acids etc. Mercuric sulphate is added to eliminate the interference due to chlorides.

Reagents required

(i) Mercuric sulphate crystals.

(ii) **Sulphuric acid – silver sulphate reagent**

Dissolve 10.1 g silver sulphate (Ag_2SO_4) in 1000 ml sulphuric acid.

(iii) Potassium dichromate 0.24 N

Dissolve 12.258 g potassium dichromate (previously dried at 103°C for 2 hours) in distilled water and make up to 1000 ml in a volumetric flask.

1.0 ml of 0.025 N $K_2Cr_2O_7$ = 2.0 mg oxygen

(iv) Ferroin indicator

Dissolve 625 g ferrous sulphate ($FeSO_4.7H_2O$) and 1.485 g of 1.10 phenanthroline monohydrate together in distilled water and dilute to 100 ml.

(v) Ferrous ammonium sulphate 0.1 N:

Dissolve 39.29 g ferrous ammonium sulphate $Fe(NH_4)_2.6H_2O$ in distilled water. Add 20 ml conc. Sulphuric acid, cool and make up to 1000 ml in a volumetric flask. Standardize it against 0.25 N potassium dichromate as follows:

Pipette out 10 ml of 0.25 N potassium dichromate solution in a 250 ml conical flask. Dilute to 100 ml and add 30 ml conc. Sulphuric acid and cool to room temperature. Add 2 to 5 drops of ferroin indicator and titrate with ferrous ammonium sulphate solution. The end point is the colour change from blue green to reddish brown.

Procedure

- Pipette out 20 ml of sample into a 500 ml reflux flask.
- Pipette into this 25 ml of standardized dichromate solution.
- Add carefully with gentle mixing, 75 ml conc. Sulphuric acid – silver sulphate reagent.
- Drop carefully 2 to 3 boiling chips into the flask and then attach a reflux condenser. Reflux the mixture for 2 hours with a small Bunsen flame / heating mantle.
- Cool the flask and rinse the inside of the condenser with a small quantity of distilled water allows the washings to run into the flask.
- Dilute appropriately with distilled water. The final volume after dilution should be about 2.5 times the volume of sample + dichromate + H_2SO_4.
- Then add 2-3 drops of ferroin indicator and titre the unreacted dichromate with standardized ferrous ammonium sulphate in the burette. The end point is the sharp change of colour from blue green to reddish brown.
- Simultaneously run a blank using distilled water in place of sample.

Calculation

$$\text{COD (mg L}^{-1}\text{)} = \frac{\text{(B-T) x N x 8 x 1000}}{\text{Volume of the sample (ml)}}$$

Where,

B = Blank titre value in ml

T = Sample titre value in ml

N = Normality of ferrous ammonium sulphate solution

Result

Exercise.17

Practical examination

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