BCOM 210

Environment Management (NUES)

Unit I

Ecosystems and how they work: Types of Eco-Systems, Geosphere – Biosphere and Hydrosphere introduction. Major issues of Biodiversity, Conservation of Bio-Diversity **Concept of sustainability and international efforts for environmental protection**: Concept of Sustainable Development, Emergence of Environmental Issues, Stockholm Conference on Environment, 1972 and Agenda 21. International Protocols, WTO, Kyoto Protocol, International Agreement on Environmental Management.

Unit II

Pollution and Public Policy

Water Pollution: Water Resources of India, Hydrological Cycle, Methods of Water Conservation and Management, River Action Plan, Ground and Surface Water Pollution; Waste Water Management.

Air Pollution: Air Pollution and Air Pollutants, Sources of Air Pollution and its Effect on Human Health and Vegetations. Green House Effect, Global Warming and Climate Change.

Solid Waste: Management – and Various Method Used, Composting, Land Fill Sites etc. Hazardous Waste Management, Biomedical Waste Management.

Unit III

Environmental Impact Assessment (EIA) and Environmental Management System (EMS):

Introduction to EIA, its Impact, Notification of MOEF, Introduction to ISO 9000 and 4000 Standards, .Introduction to Indian Environmental laws: Legal framework: , the Indian Penal Code, Role of Judiciary in Environmental Protection, Wild Life (Protection) Act, 1972, Water (Prevention and Control of Pollution) Act, 1974, Environment (Protection) Act, 1986, Air (Prevention & Control of Pollution) Act, 1981, Delhi Environment Law.

UNIT IV

Field work / Case Studies: Visit to a related site – river / urban / rural or industrial and Demonstration project including water bodies.

UNIT 1

Ecosystem: An ecosystem is a biological environment consisting of all the living organisms or biotic component, in a particular area, and the nonliving, or abiotic component, with which the organisms interact, such as air, soil, water and sunlight. An ecosystem (short for "ecological system") is generally defined as a community of organisms living in a particular environment and the physical elements with which they interact.

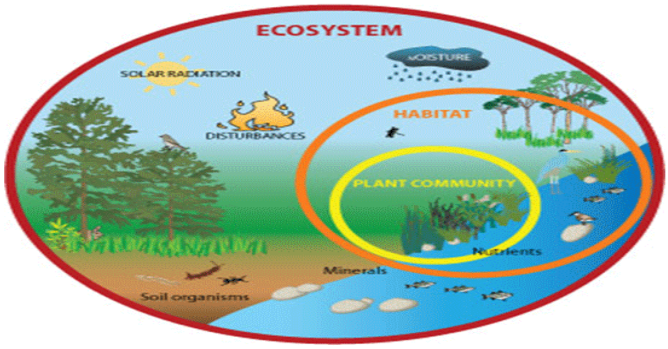
An ecosystem is an open functional unit that results from the interactions of **abiotic** (soil, water, light, inorganic nutrients and weather), **biotic** (plants, animals, and microorganisms usually categorized as either producers or consumers), and cultural (anthropogenic) components. An ecosystem can be as small as a field or as large as the ocean. It is used to describe the world's major different habitat types.

Terrestrial ecosystems include: arctic and alpine ecosystems, dominated by tundra with scarce vegetation; forest ecosystems, which can be subdivided into a whole range of types including tropical rainforests, Mediterranean evergreen forests, boreal forests, and temperate coniferous, deciduous and mixed forests; grasslands and savannas; and deserts and semi-arid ecosystems.

Freshwater ecosystems include lakes, rivers, and marshlands. Marine ecosystems comprise an enormous range, from coral reefs, mangroves, sea-grass beds, and other shallow coastal water ecosystems, to open-water ones, including the mysterious, little-known ecosystems of the abyssal plains and trenches of the world's oceans.

Ecosystems sustain human societies and allow them to prosper, due to the nutritional, environmental, cultural, recreational and aesthetic resources they provide. We all depend directly or indirectly on the products and services of ecosystems, including crops, livestock, fish, wood, clean water, oxygen, and wildlife.

Ecosystem = an Ecological system;
= A community and its physical environment
treated together as a functional system.



An Ecosystem

Kinds of Ecosystems;

Ecosystem means environment of biology which consists all organisms that live in particular region and in environment's physical and nonliving components like air water sunlight and soil. The living organisms interact with the atmosphere's nonliving components.

Ecosystem, basically, is of 2 types: **aquatic and terrestrial**. Sub ecosystem comes under them.

Terrestrial-Ecosystem – It is found in every place except water-bodies. It is classified broadly into following sub-parts:

Forest-ecosystem – In this type of ecosystem we can see plenty of plants as well as numerous organisms. So life's density in it is quite high. Forest ecosystem is further divided into following forests:

a) Tropical-evergreen – It receives rainfall at an average varying from inches 80–400 yearly. Vegetation is very dense having trees of different lengths.
b) Tropical-deciduous – Has dense shrubs and bushes as well as trees with levels broad.
c) Temperate-evergreen – Have fewer trees with leaves spiked for minimizing transpiration.
d) Temperature-deciduous – Found in regions where temperature is moist with enough rainfall.

Desert-ecosystem – Is found in those regions which receives rainfall annually >25cm. almost 17% of planet's land is occupied by it. Plants have leaves having spines for conserving water. To xeric conditions, animals found here are also adapted. Trees are very rare here.

Grassland-ecosystem – We find it in regions both tropical and temperate of world. Comprises mainly grasses having trees and shrubs in small amount. It is of two types: Savanna & Prairies.

Mountain-ecosystem – Here wide variety of animals and plants are available. Higher slopes have treeless vegetation and lower region is covered of coniferous-forest.

Aquatic Ecosystem – It is situated inside water-bodies. It is of 2 types:

a) **Marine-ecosystem** – It covers about 71 percent of surface of Earth and has 97 percent of water of planet. Its various divisions are:
   - Oceanic
   - Inter-tidal
   - Salt-marshes
   - Estuaries
   - Coral-reefs

b) **Freshwater-ecosystem** – Covers only 0.8percent of surface of earth and 0.009percent of whole water. It is of 3 types:

- Lentic
- Wetlands
- Lotic, the ecosystem of a river, stream or spring.

Artificial, ecosystems created by humans. Central to the ecosystem concept is the idea that living organisms interact with every other element in their local environment. Eugene Odum, a founder of ecology, stated: "Any unit that includes all of the organisms (i.e.: the "community") in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (i.e.: exchange of materials between living and nonliving parts) within the system is an ecosystem.

Etymology: The term ecosystem was coined in 1930 by Roy Clapham to mean the combined physical and biological components of an environment. British ecologist Arthur Tansley later refined the term, describing it as "The whole system, including not only the organism-complex, but also the whole complex of physical factors forming what we call the environment". Tansley regarded ecosystems not simply as natural units, but as mental isolates. Tansley later defined the spatial extent of ecosystems using the term ecotope.
Examples of ecosystems

- Agroecosystem
- Aquatic ecosystem
- Chaparral
- Coral reef
- Desert
- Forest
- Farm
- Greater Yellowstone Ecosystem
- Human ecosystem
- Large marine ecosystem
- Littoral zone
- Lotic
- Marine ecosystem
- Pond ecosystem
- Prairie
- Rainforest
- Riparian zone
- Savanna
- Steppe
- Subsurface Litho autotrophic Microbial Ecosystem
- Taiga
- Tundra

- Urban ecosystem

GEOSPHERE- Biosphere and Hydrosphere introduction

Geosphere refers to the solid parts of the Earth and is used along with atmosphere, hydrosphere, and biosphere to describe the systems of the Earth. Since 'geo' means 'ground,' the **geosphere** describes all of the rocks, minerals and ground that are found on and in Earth. This includes all of the mountains on the surface, as well as all of the liquid rock in the mantle below us and the minerals and metals of the outer and inner cores. The continents, the ocean floor, all of the rocks on the surface, and all of the sand in the deserts are all considered part of the geosphere.

***Hydrosphere*:** This includes all of the rivers, lakes, streams, oceans, groundwater, polar ice caps, glaciers and moisture in the air (like rain and snow). The hydrosphere is found on the surface of Earth, but also extends down several miles below, as well as several miles up into the atmosphere. Most of Earth's water is salty and in the oceans - about 97%. Two-thirds of the remaining 3% is frozen in glaciers and polar ice caps. Only 1% of the hydrosphere is liquid freshwater, and even most of this exists as groundwater down in the soil.

Biosphere: This includes all of the plants, animals, bacteria, fungi and single-celled organisms found on Earth. Most of this life exists no deeper than about 10 feet into the ground or about 600 feet above it. Because each individual is so small in relation to the overall planet, organisms are often grouped into biomes, which are regional communities characterized by vegetation and climate. You are likely already familiar with some of these, like deserts, grasslands and rainforests. The carbon cycle, usually linked with the Earth's biosphere, includes deep storage of carbon in the form of fossil fuels like coal, oil, and gas as well as carbonate rocks like limestone. The carbon cycle is one of several biogeochemical cycles, which all involve the geosphere, the biosphere, and other spheres of the Earth system.

BIODIVERSITY & MAJOR ISSUES

The variety of life on Earth, its biological diversity is commonly referred to as biodiversity. The number of species of plants, animals, and microorganisms, the enormous diversity of genes in these species, the different ecosystems on the planet, such as deserts, rainforests and coral reefs are all part of a biologically diverse Earth. Appropriate conservation and sustainable development strategies attempt to recognize this as being integral to any approach. Almost all cultures have in some way or form recognized the importance that nature, and its biological diversity has had upon them and the need to maintain it. Yet, power, greed and politics have affected the precarious balance.

Why Is Biodiversity Important?

Biodiversity boosts ecosystem productivity where each species, no matter how small, all have an important role to play.

For example, a larger number of plant species means a greater variety of crops; greater species diversity ensures natural sustainability for all life forms; and healthy ecosystems can better withstand and recover from a variety of disasters. And so, while we dominate this planet, we still need to preserve the diversity in wildlife.

Biodiversity is the degree of variation of life forms within a given species, ecosystem, biome, or an entire planet. Biodiversity is a measure of the health of ecosystems. Biodiversity is in part a function of climate. In terrestrial habitats, tropical regions are typically rich whereas Polar Regions support fewer species.

The period since the emergence of humans has displayed an ongoing biodiversity reduction and an accompanying loss of genetic diversity. Named the Holocene extinction, the reduction is caused primarily by human impacts, particularly habitat destruction. Conversely, biodiversity impacts human health in a number of ways, both positively and negatively.

Legal status: Biodiversity is taken into account in some political and judicial decisions:

The relationship between law and ecosystems is very ancient and has consequences for biodiversity. It is related to private and public property rights. It can define protection for threatened ecosystems, but also some rights and duties (for example, fishing and hunting rights).

Law regarding species is more recent. It defines species that must be protected because they may be threatened by extinction. The U.S. Endangered Species Act is an example of an attempt to address the "law and species" issue.

Laws regarding gene pools are only about a century old. Domestication and plant breeding methods are not new, but advances in genetic engineering have led to tighter laws covering distribution of genetically modified organisms, gene patents and process patents. Governments struggle to decide whether to focus on for example, genes, genomes, or organisms and species.

Global agreements such as the Convention on Biological Diversity, give "sovereign national rights over biological resources" (not property). The agreements commit countries to "conserve biodiversity", "develop resources for sustainability" and "share the benefits" resulting from their use. Biodiverse countries that allow bioprospecting or collection of natural products, expect a share of the benefits rather than allowing the individual or institution that discovers/exploits the resource to capture them privately. Bioprospecting can become a type of biopiracy when such principles are not respected.

Biodiversity Conservation:

Conservation is the protection, preservation, management, or restoration of wildlife and natural resources such as forests and water. Through the conservation of biodiversity the survival of many species and habitats which are threatened due to human activities can be ensured. Other reasons for conserving biodiversity include securing valuable Natural Resources for future generations and protecting the well being of eco-system functions. **Conservation can broadly be divided into two types**:

In-situ: Conservation of habitats, species and ecosystems where they naturally occur. This is in-situ conservation and the natural processes and interaction are conserved as well as the elements of biodiversity.

Ex-situ: The conservation of elements of biodiversity out of the context of their natural habitats is referred to as ex-situ conservation. Zoos, botanical gardens and seed banks are all example of ex-situ conservation.

In-situ conservation is not always possible as habitats may have been degraded and there may be competition for land which means species need to be removed from the area to save them.

In-situ and Ex-situ Conservation Methods:

In Situ Conservation Methods

In-situ conservation, the conservation of species in their natural habitats, is considered the most appropriate way of conserving biodiversity. Conserving the areas where populations of species exist naturally is an underlying condition for the conservation of biodiversity. That's why protected areas form a central element of any national strategy to conserve biodiversity.

Ex Situ Conservation Methods

Ex-situ conservation is the preservation of components of biological diversity outside their natural habitats. This involves conservation of genetic resources, as well as wild and cultivated or species, and draws on a diverse body of techniques and facilities. Some of these include:

- Gene banks, e.g. seed banks, sperm and ova banks, field banks;
- In vitro plant tissue and microbial culture collections;
- Captive breeding of animals and artificial propagation of plants, with possible reintroduction into the wild; and
- Collecting living organisms for zoos, aquaria, and botanic gardens for research and public awareness.

Ex-situ conservation measures can be complementary to in-situ methods as they provide an "insurance policy" against extinction. These measures also have a valuable role to play in recovery programmes for endangered species. The Kew Seed Bank in England has 1.5 per cent of the world's flora - about 4,000 species - on deposit.
In agriculture, ex-situ conservation measures maintain domesticated plants which cannot survive in nature unaided.
Ex-situ conservation provides excellent research opportunities on the components of biological diversity. Some of these institutions also play a central role in public education and awareness raising by bringing members of the public into contact with plants and animals

they may not normally come in contact with. It is estimated that worldwide, over 600 million people visit zoos every year.
Ex situ conservation measures should support in-situ conservation measures (in-situ conservation should be the primary objective).

Which areas to conserve?

Hotspots of biodiversity: A popular approach for selecting priority areas has been to select hotspots of diversity. Since it is not possible to conserve all biodiversity due to lack of resources and the need to use land for human activities, areas are prioritised to those which are most in need of conservation. 'Hotspot' a term used to define regions of high conservation priority combining high richness, high endemism and high threat.

Threatened Species: Over the last 200 years many species have become extinct and the extinction rate is on the increase due to the influence of human activity. The status of species has been assessed on a global scale by the World Conservation Union.

Threatened Habitats: Habitat destruction comes in many forms from clear felling of forests to simple changes in farming practices that change the overall surrounding habitat. If a habitat is degraded or disappears a species may also become threatened. The UK is in danger of losing diverse habitats ranging from lowland calcareous grassland to mudflats and wet woodland.

Flagship and keystone species: Conservation efforts are often focused on a single species. This is usually for two reasons.

1) Some species are key to the functioning of a habitat and their loss would lead to greater than average change in other species populations or ecosystem processes. These are known as keystone species.

2) Humans will find the idea of conserving one species more appealing than conserving others. For example it would be easier to persuade people that it is necessary to conserve tigers that it is to persuade people to conserve the Zayante band-winged grasshopper. Using a flagship species such as a tiger will attract more resources for conservation which can be used to conserve areas of habitat.

Complementarity: Complementarity is a method used to select areas for conservation. These methods are used to find areas that in sum total have the highest representation of diversity. For example using complementarity methods, areas could be selected that would contain the most species between them but not necessarily be the most species rich areas individually and take into account pressures of development.

Distinguishing higher from lower priority areas for urgent conservation is the purpose of such area- selection methods. However, an acceptance of priorities must recognise that this idea also implies that some areas will be given lower priority. This is not to say that they have no conservation values rather that in relation to agreed goals the actions are not as urgent.

SUSTAINABLE DEVELOPMENT:

Sustainable development, as defined by the Brundtland Commission (1987) is "***development that meets the needs of the present without compromising the ability of future generations to meet their own needs***". By definition, then, sustainable development is development that takes the impact on the environment into account and tries to minimize environmental damage. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: The concept of needs , in particular the essential needs of the world's poor, to which overriding priority should be given; and The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

All definitions of sustainable development require that we see the world as a system —a system that connects space; and a system that connects time. When you think of the world as a system over space, you grow to understand that air pollution from North America affects air quality in Asia, and that pesticides sprayed in Argentina could harm fish stocks off the coast of Australia. And when you think of the world as a system over time, you start to realize that the decisions our grandparents made about how to farm the land continue to affect agricultural practice today; and the economic policies we endorse today will have an impact on urban poverty when our children are adults.

Literally, sustainable means 'that can be kept going or maintained'. Development means "the action or process of growing or cause of gradual growth. Concept of sustainable development is therefore, commonly understood as that development which meets the need of the present generation without compromising the needs of the future generations.

The world is not going to come to an end with us and hence we do not need to eat way all the resources in the name of development just because we can. Sustainable growth in context of environment means having common elements of covering the well-being of the society of human beings, the well-being of the environment and the well being of environment and sustainability over time.

1. **Equal**: Equality is essential for a sustainable development. This concept promotes equality between ages, genders, classes, races, continents and countries.
2. **Social Development**: Concept of sustainable development emphasizes on not only economic development, but also on social development and the need to conserve our environment and natural resources too.
3. **Inclusive approach**: Any growth that is exclusive is not right. Sustainable development has to be inclusive. It is based on the improved quality of life for everyone, mainly the deprived and the poverty- stricken people of the world.
4. **Human-Environment Harmony**: It understands that the needs of human beings and the requirements of the environment are interdependent and acknowledges this fact.

5. **Co-operation**: Sustainable development is possible only if the developed world and the developing world co-operate and the former support the latter in their endeavours whenever they can, through subsidies, for instance.

Why do we need sustainable development?

The human population is rising day by day. Their demands too are on rise. There is a need of natural resources to meet these demands. What we have done till now is followed an economic growth pattern that is short-term. In the process, we have misused the resources of nature and exploited them recklessly. As a result, we are short of these resources. The Earth that we live on is not capable of providing for the resources to meet our accelerating needs. We face the consequences if this imbalance in the form of climate changes in our everyday life. The magnitude of such challenges might just accelerate for our future generation. Hence we need a development plan that's long term, even if slow and gives us time to replace the resources we consume through measures like planting a tree, etc. This is not only for our own good; we also need this for the sake of our future generation as well as to maintain a healthy environment.

How can we go about sustainable development?

For meeting our present needs as well as saving for our future generation, we need a proper and need- based, not greed-based consumption pattern. ***The following aspects are essential for the same.***

Sustainability: This of course, is a priority and we should make sure that we are not mortgaging the choices of the future generation.

Strengthening: We should build on human capacities to develop and conserve at the same time.

Sharing: Equitable distribution of wealth and resources is vital for a sustainable development. Basic needs for all, without any discrimination should be ensured.

Social responsibility: Our consumption patterns should be guided by a sense of social responsibility. We should strive for such a consumption that does not compromise the well-being of others. We should, therefore, avoid all such development patterns that will ignite environmental degradation resulting from economic decisions we make today and which jeopardizes the situation for our posterity.

Emergence of Environmental Issues

Environmental issues are harmful effects of human activity on the biophysical environment. Environmentalism, a social and environmental movement, addresses environmental issues through advocacy, education and activism.

The carbon dioxide equivalent of greenhouse gases (GHG) in the atmosphere has already exceeded 400 parts per million (NOAA) (with total "long-term" GHG exceeding 455 parts

per million). (Intergovernmental Panel on Climate Change Report) This level is considered a tipping point. "The amount of greenhouse gas in the atmosphere is already above the threshold that can potentially cause dangerous climate change.

Major current environmental issues may include climate change, pollution, environmental degradation, and resource depletion etc. The conservation movement lobbies for protection of endangered species and protection of any ecologically valuable natural areas.

Environmental issues are addressed at a regional, national or international level by government organizations.

The largest international agency, set up in 1972, is the United Nations Environment Programme. The International Union for Conservation of Nature brings together 83 states, 108 government agencies, 766 Non-governmental organizations and 81 international organizations and about 10,000 experts and scientists from countries around the world. International non-governmental organizations include Greenpeace, Friends of the Earth and World Wide Fund for Nature. Governments enact environmental policy and enforce environmental law and this is done to differing degrees around the world.

Solutions

Sustainability is the key to prevent or reduce the effect of environmental issues. There is now clear scientific evidence that humanity is living unsustainably, and that an unprecedented collective effort is needed to return human use of natural resources to within sustainable limits. For humans to live sustainably, the Earth's resources must be used at a rate at which they can be replenished.

Concerns for the environment have prompted the formation of Green parties, political parties that seek to address environmental issues. Initially these were formed in Australia, New Zealand and Germany but are now present in many other countries.

AGENDA 21

•It is a programme run by the United Nations (UN) related to sustainable development. It is a comprehensive blueprint of action to be taken globally, nationally and locally by organisations of the UN, governments, and major groups in every area in which humans impact on the environment. The number 21 refers to the 21st century.

•The full text of Agenda 21 was revealed at the 1992 United Nations Conference on Environment and Development (Earth Summit), held in Rio de Janeiro on June 14th where 179 governments voted to adopt the programme. The final text was the result of drafting, consultation and negotiation, beginning in 1989 and culminating at the two-week conference

Structure and Contents -Agenda 21 - There are 40 chapters in Agenda 21, divided into four sections. The document was over 900 pages:

Section I: Social and Economic Dimensions

•including combating poverty, changing consumption patterns, population and demographic dynamics, promoting health, promoting sustainable settlement patterns and integrating environment and development into decision-making.

Section II: Conservation and Management of Resources for Development

•including atmospheric protection, combating deforestation, protecting fragile environments, conservation of biological diversity (biodiversity), and control of pollution.

Section III: Strengthening the Role of Major Groups

•including the roles of children and youth, women, NGOs, local authorities, business and workers.

Section IV: Means of Implementation

•including science, technology transfer, education, international institutions and mechanisms and financial mechanisms.

Agenda 21: Preamble

•Agenda 21 addresses the pressing problems of today and also aims at preparing the world for the challenges of the next century. It reflects a global consensus and political commitment at the highest level on development and environment cooperation. Its successful implementation is first and foremost the responsibility of Governments. National strategies, plans, policies and processes are crucial in achieving this. International cooperation should support and supplement such national efforts. In this context, the United Nations system has a key role to play. Other international, regional and sub regional organizations are also called upon to contribute to this effort. The broadest public participation and the active involvement of the non-governmental organizations and other groups should also be encouraged.

• The developmental and environmental objectives of Agenda 21 will require a substantial flow of new and additional financial resources to developing countries, in order to cover the incremental costs for the actions they have to undertake to deal with global environmental problems and to accelerate sustainable development. Financial resources are also required for strengthening the capacity of international institutions for the implementation of Agenda 21. An indicative order-of-magnitude assessment of costs is included in each of the programme areas. This assessment will need to be examined and refined by the relevant implementing agencies and organizations.

Agenda 21 adopted at the conference, represents a global consensus and political commitment at the highest level on socio-economic development and environmental cooperation. The foremost responsibility for leading this change was placed on national governments. Each government was expected to design national strategies, plans, and policies for sustainable development — a national Agenda 21 — in consonance with the country's particular situation, capacity and priorities. This was to be done in partnership with

international organizations, business, regional, state and local governments, non-government organizations and citizens groups. The Agenda also recognized the need for new assistance for developing countries to support the incremental cost of actions to deal with global environmental problems, and to accelerate sustainable development.

INTERNATIONAL PROTOCOLS

International environmental protocols came to feature in environmental governance after trans-boundary environmental problems became widely perceived in the 1960s. Following the Stockholm Intergovernmental Conference in 1972, creation of international environmental agreements proliferated.

An **environmental protocol** is a type of international law, "an intergovernmental document intended as legally binding with a primary stated purpose of preventing or managing human impacts on natural resources."

The world's existing political systems pose barriers to the creation of environmental protocols. First, maintenance of sovereignty means that no country can be forced to participate, only urged to do so. Consequently, as French states, "International law has the force of moral suasion, but few real teeth." Second, North-South conflict can block cooperation: the countries in the global South generally see the countries of the North as needing to take responsibility for environmental degradation and make significant changes in their way of living, neither of which the North deems reasonable.

Finally, countries may lack motivation to change their environmental policies due to conflict with other interests, especially economic prosperity. If environmental protocols will cause economic difficulties or harm to a country, it may shirk the protocols while other countries adhere to them, creating a classic free-rider problem. Additionally, environmental protocols may be criticized for scientific uncertainty, or at least a lack of synthesis of scientific information, which may be used for "blocking interests and doing mischief."

Due to these barriers, environmental protocols become an obvious target for several criticisms, such as being slow to produce the desired effects (due to the convention-protocol-ratification-implementation process), tending to the lowest common denominator, and lacking monitoring and enforcement. They can also be criticized for taking an incremental approach where sustainable development principles suggest that environmental concern should be mainstreamed.

Protocols can take flexible approaches to improve effectiveness. One example is the use of sanctions: under the Montreal Protocol, signatories were forbidden to purchase chlorofluorocarbons from nonsignatories, in order to prevent any windfall benefits.[4] Funding has also been used to overcome North-South conflict: members of the Montreal Protocol created a fund of $240 million to redistribute the costs of transition. Differential obligations as seen in the Kyoto Protocol can also encourage wider participation.

While protocols appear to be the ultimate top-down mode of governance, having "scant provisions for public participation," it is widely thought that the influence of transnational networks has been growing Public opinion is relevant, as concern must exist to prompt action and dedication of government resources. Non-governmental organizations also fulfill certain

roles, from gathering information and devising policies to mobilising support. Science plays an important part, although Susskind asserts that sometimes this role is diminished by uncertainty, disagreement, and the rise of "adversary science." The business community can also be involved with positive outcomes.

How we view the effectiveness of protocols depends on what we expect from them. With little administrative force or actual power, protocols succeed in increasing government concern, enhancing the contractual environment, and heightening capacity through transfer of assets. Yet as long as sovereignty is intact, environmental protocols will not affect changes in the face of state or public apathy, guarantee national action, or materialize overnight.

KYOTO PROTOCOL

- The Kyoto Protocol is a protocol to the international Framework Convention on Climate Change with the objective of reducing Greenhouse gases that cause climate change. It was agreed on 11 December 1997 at the 3rd Conference of the Parties to the treaty when they met in Kyoto, and entered into force on 16 February 2005.
- It is an agreement made under the United Nations Framework Convention on Climate Change (UNFCCC). Countries that ratify this protocol commit to reduce their emissions of carbon dioxide and five other greenhouse gases, or engage in emissions trading if they maintain or increase emissions of these gases.

Aim of Kyoto Protocol:

- Aim to reduce collective emission of green house gases and prevent global warming.
- The Kyoto Protocol is an agreement under which industrialized countries will aim to reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990 (but note that, compared to the emissions levels that would be expected by 2010 without the Protocol, this limitation represents a 29% cut). The goal is to lower overall emissions of six greenhouse gases - carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, hydrofluorocarbons, and perfluorocarbons - averaged over the period of 2008-2012. National limitations range from 8% reductions for the European Union and some others to 7% for the US, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland.

WTO & ENVIROMENT PROTECTION:

- The WTO has no specific agreement dealing with the environment. However, the WTO agreements confirm governments' right to protect the environment, provided certain conditions are met, and a number of them include provisions dealing with environmental concerns. The objectives of sustainable development and environmental protection are important enough to be stated in the preamble to the Agreement Establishing the WTO.
- The standing forum dedicated to dialogue between governments on the impact of trade policies on the environment, and of environment policies on trade.

- Under the Doha Development Agenda, the regular committee is also looking at the effects of environmental measures on market access, the intellectual property agreement and biodiversity, and labelling for environmental purposes.
- Moreover, the institutional machinery working under WTO for investigating the trade and environment interface, and making positive suggestions towards the objective of sustainable development, is the committee on Trade and Environment (CTE).

STOCKHOLM CONFERENCE, 1972

The United Nations Conference on the Human Environment, having met at ***Stockholm from 5 to 16 June 1972***, having considered the need for a common outlook and for common principles to inspire and guide the peoples of the world in the preservation and enhancement of the human environment, proclaims that:

1. Man is both creature and moulder of his environment, which gives him physical sustenance and affords him the opportunity for intellectual, moral, social and spiritual growth. In the long and tortuous evolution of the human race on this planet a stage has been reached when, through the rapid acceleration of science and technology, man has acquired the power to transform his environment in countless ways and on an unprecedented scale. Both aspects of man's environment, the natural and the man-made, are essential to his well-being and to the enjoyment of basic human rights the right to life itself.
2. The protection and improvement of the human environment is a major issue which affects the well- being of peoples and economic development throughout the world; it is the urgent desire of the peoples of the whole world and the duty of all Governments.
3. Man has constantly to sum up experience and go on discovering, inventing, creating and advancing. In our time, man's capability to transform his surroundings, if used wisely, can bring to all peoples the benefits of development and the opportunity to enhance the quality of life. Wrongly or heedlessly applied, the same power can do incalculable harm to human beings and the human environment. We see around us growing evidence of man-made harm in many regions of the earth: dangerous levels of pollution in water, air, earth and living beings; major and undesirable disturbances to the ecological balance of the biosphere; destruction and depletion of irreplaceable resources; and gross deficiencies, harmful to the physical, mental and social health of man, in the man-made environment, particularly in the living and working environment.
4. In the developing countries most of the environmental problems are caused by under-development. Millions continue to live far below the minimum levels required for a decent human existence, deprived of adequate food and clothing, shelter and education, health and sanitation. Therefore, the developing countries must direct their efforts to development, bearing in mind their priorities and the need to safeguard and improve the environment. For the same purpose, the industrialized countries should

make efforts to reduce the gap themselves and the developing countries. In the industrialized countries, environmental problems are generally related to industrialization and technological development.

5. The natural growth of population continuously presents problems for the preservation of the environment, and adequate policies and measures should be adopted, as appropriate, to face these problems. Of all things in the world, people are the most precious. It is the people that propel social progress, create social wealth, develop science and technology and, through their hard work, continuously transform the human environment. Along with social progress and the advance of production, science and technology, the capability of man to improve the environment increases with each passing day.
6. A point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences. Through ignorance or indifference we can do massive and irreversible harm to the earthly environment on which our life and well being depend. Conversely, through fuller knowledge and wiser action, we can achieve for ourselves and our posterity a better life in an environment more in keeping with human needs and hopes. There are broad vistas for the enhancement of environmental quality and the creation of a good life. What is needed is an enthusiastic but calm state of mind and intense but orderly work. For the purpose of attaining freedom in the world of nature, man must use knowledge to build, in collaboration with nature, a better environment. To defend and improve the human environment for present and future generations has become an imperative goal for mankind-a goal to be pursued together with, and in harmony with, the established and fundamental goals of peace and of worldwide economic and social development.
7. To achieve this environmental goal will demand the acceptance of responsibility by citizens and communities and by enterprises and institutions at every level, all sharing equitably in common efforts. Individuals in all walks of life as well as organizations in many fields, by their values and the sum of their actions, will shape the world environment of the future. Local and national governments will bear the greatest burden for large-scale environmental policy and action within their jurisdictions. International cooperation is also needed in order to raise resources to support the developing countries in carrying out their responsibilities in this field. A growing class of environmental problems, because they are regional or global in extent or because they affect the common international realm, will require extensive cooperation among nations and action by international organizations in the common interest. The Conference calls upon Governments and peoples to exert common efforts for the preservation and improvement of the human environment, for the benefit of all the people and for their posterity.

Principles of the conference:

- **Principle 1**: Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and

well-being, and he bears a solemn responsibility to protect and improve the environment for present and future generations. In this respect, policies promoting or perpetuating apartheid, racial segregation, discrimination, colonial and other forms of oppression and foreign domination stand condemned and must be eliminated.

- **Principle 2**: The natural resources of the earth, including the air, water, land, flora and fauna and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate.
- **Principle 3**: The capacity of the earth to produce vital renewable resources must be maintained and, wherever practicable, restored or improved.
- **Principle 4**: Man has a special responsibility to safeguard and wisely manage the heritage of wildlife and its habitat, which are now gravely imperilled by a combination of adverse factors. Nature conservation, including wildlife, must therefore receive importance in planning for economic development.
- **Principle 5**: The non-renewable resources of the earth must be employed in such a way as to guard against the danger of their future exhaustion and to ensure that benefits from such employment are shared by all mankind.
- **Principle 6**: The discharge of toxic substances or of other substances and the release of heat, in such quantities or concentrations as to exceed the capacity of the environment to render them harmless, must be halted in order to ensure that serious or irreversible damage is not inflicted upon ecosystems. The just struggle of the peoples of ill countries against pollution should be supported.
- **Principle 7**: States shall take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.
- **Principle 8**: Economic and social development is essential for ensuring a favourable living and working environment for man and for creating conditions on earth that are necessary for the improvement of the quality of life.
- **Principle 9**: Environmental deficiencies generated by the conditions of under-development and natural disasters pose grave problems and can best be remedied by accelerated development through the transfer of substantial quantities of financial and technological assistance as a supplement to the domestic effort of the developing countries and such timely assistance as may be required.
- **Principle 10**: For the developing countries, stability of prices and adequate earnings for primary commodities and raw materials are essential to environmental management, since economic factors as well as ecological processes must be taken into account.
- **Principle 11**: The environmental policies of all States should enhance and not adversely affect the present or future development potential of developing countries, nor should they hamper the attainment of better living conditions for all, and appropriate steps should be taken by States and international organizations

with a view to reaching agreement on meeting the possible national and international economic consequences resulting from the application of environmental measures.

- **Principle 12**: Resources should be made available to preserve and improve the environment, taking into account the circumstances and particular requirements of developing countries and any costs which may emanate- from their incorporating environmental safeguards into their development planning and the need for making available to them, upon their request, additional international technical and financial assistance for this purpose.
- **Principle 13**: In order to achieve a more rational management of resources and thus to improve the environment, States should adopt an integrated and coordinated approach to their development planning so as to ensure that development is compatible with the need to protect and improve environment for the benefit of their population.
- **Principle 14**: Rational planning constitutes an essential tool for reconciling any conflict between the needs of development and the need to protect and improve the environment.
- **Principle 15**: Planning must be applied to human settlements and urbanization with a view to avoiding adverse effects on the environment and obtaining maximum social, economic and environmental benefits for all. In this respect projects which are designed for colonialist and racist domination must be abandoned.

Sustainable Development: Experience has shown that sustainable development requires a commitment to sound economic policies and management, an effective and predictable public administration, the integration of environmental concerns into decision-making and progress towards democratic government, in the light of country-specific conditions, which allows for full participation of all parties concerned. These attributes are essential for the fulfilment of the policy directions and objectives listed below.

Objectives: In the years ahead, and taking into account the results of the Uruguay Round of multilateral trade negotiations, Governments should continue to strive to meet the following objectives:

(a) To promote an open, non-discriminatory and equitable multilateral trading system that will enable all countries - in particular, the developing countries - to improve their economic structures and improve the standard of living of their populations through sustained economic development;

(b) To improve access to markets for exports of developing countries;

(c) To improve the functioning of commodity markets and achieve sound, compatible and consistent commodity policies at national and international levels with a view to optimizing the contribution of the commodity sector to sustainable development, taking into account environmental considerations;

(d) To promote and support policies, domestic and international, that makes economic growth and environmental protection mutually supportive.

International Issues: Multilateral Environmental Agreements

The need for international action: Most environmental problems have a transboundary nature and often a global scope, and they can only be addressed effectively through international co-operation. For this reason, the EC Treaty establishes that one of the key objectives of Community policy on the environment is to promote measures at international level to deal with regional or worldwide environmental problems. The Community takes an active part in the elaboration, ratification and implementation of multilateral environmental agreements. The EC Treaty explicitly foresees the possibility for the European Community to participate in international environmental agreements, together with its Member States.

International Agreements in the 6th Environment Action Programme: There is an essential international dimension to the four priority areas listed in the 6th Environment Action Programme of the EU: climate change, nature and biodiversity, environment and health and quality of life and natural resources and wastes. In all these cases, the EU's strategic objectives can only be achieved if a series of key international environmental agreements are actively supported and properly implemented, both at Community level and worldwide. The Action Programme contains also a specific provision on international action, which recalls the objective of aiming for swift ratification, effective compliance and enforcement of all international conventions and agreements relating to the environment where the Community is a Party.

The EC is a Party to many International Environmental Agreements: The Community has already ratified many international environmental agreements, whether at global level (multilateral agreements negotiated under the auspices of the UN), at regional level (e.g. in the context of UN/ECE or the Council of Europe), and sub-regional level (for instance for the management of seas or transboundary rivers). Likewise, the matters addressed by these agreements are very wide, and include among other the following areas: biodiversity and nature protection, climate change, protection of the ozone layer, desertification, management of chemicals and waste, transboundary water and air pollution, environmental governance (including impact assessments, access to information and public participation), industrial accidents, maritime and river protection, environmental liability.

In all these fields, Europe is a leading proponent of international environmental action and co-operation, and an active player committed to promote worldwide the concept of sustainable development.

- Air: Geneva Convention on Long-range Transboundary Air Pollution (CLRTAP)(1979) and its protocols
- Biotechnology: Cartagena Biosafety Protocol (2000) to the Rio CBD Convention on Biological Diversity (1992)

- Chemicals:
  - PIC Rotterdam Convention on Prior Informed Consent (1998)
  - POP Stockholm Convention on Persistent Organic Pollutants (2001)
- Civil Protection and Environmental Accidents:
  - Helsinki Convention on Industrial Accidents (1992)
  - Barcelona Convention (1976) as amended and its protocols
  - Helsinki Convention on the Baltic Sea (1992)
  - OSPAR Convention(1992)
  - Bonn Agreement (1983)
  - Lisbon Agreement (1990)
- Climate Change and Ozone Depletion: UNFCCC Framework Convention on Climate Change (1992) and Kyoto protocol (1997) Vienna Convention for the Protection of the Ozone Layer (1985) and Montreal protocol as amended
- Governance
  - Aarhus Convention (1998) on access to environmental information
  - Espoo Convention on Environmental Impact Assessment (1991)
- Industry: Helsinki Convention on Industrial Accidents (1992)
- Land use: Alpine Convention (1991)
- Nature and biodiversity:
  - Rio CBD Convention on Biological Diversity (1992) and Cartagena Biosafety Protocol (2000)
  - Bonn CMS Convention on the Conservation of Migratory Species (1979)
  - Bern Convention on European Wildlife and Habitats (1979)
  - Convention for the protection of Vertebrate Animals used for Experimental and other Scientific Purposes (1986)
  - Alpine Convention (1991) and its protocols
  - Convention on the Conservation of the marine fauna and flora of the Antartic (1980)
- Soil: UNCCD Convention to Combat Desertification in Africa (1994)
- Waste: Basel Convention on hazardous wastes (1989)
- Water:
  - Helsinki Convention on Watercourses and International Lakes (1992)
  - River basin conventions (Danube (1987), Elbe (1990), Oder (1996), Rhine (1999))
  - Barcelona Convention (1976) as amended and its protocols
  - OSPAR Convention(1992) as amended Bonn Agreement (1983)
  - Helsinki Convention on the Baltic Sea (1992)

UNIT -2

Water Resources of India

Water is essential for human civilisation, living organisms, and natural habitat. It is used for drinking, cleaning, agriculture, transportation, industry, recreation, and animal husbandry, producing electricity for domestic, industrial and commercial use. Due to its multiple benefits and the problems created by its excesses, shortages and quality deterioration, water as a resource requires special attention.

The hydrologic cycle moves enormous quantity of water around the globe. However, much of the world's water has little potential for human use because 97.5% of all water on earth is saline water. Out of the remaining 2.5% freshwater, most of which lies deep and frozen in Antarctica and Greenland, only about 0.26% fish in rivers, lakes and in the soils and shallow aquifers which are readily usable for mankind.

Water Resources

a. **Surface Water**: India's average annual surface run-off generated by rainfall and snowmelt is estimated to be about 1869 billion cubic meter (BCM). However, it is estimated that only about 690 BCM or 37 per cent of the surface water resources can actually be mobilised. This is because (i) over 90 per cent of the annual flow of the Himalayas rivers occur over a four month period and (ii) potential to capture such resources is complicated by limited suitable storage reservoir sites.
b. **Rainfall**: The average annual rainfall in India is about 1170 mm. This is considerable variation in rain both temporarily and spatially. Most rain falls in the monsoon season (June-September), necessitating the creation of large storages for maximum utilisation of the surface run-off. Within any given year, it is possible to have both situations of drought and of floods in the same region. Regional varieties are also extreme, ranging from a low value of 100 mm in Western Rajasthan to over 11,000 mm in Meghalaya in North-Eastern India. Possible changes in rainfall patterns in the coming decade, global warming and climate change and other predicted or observed long-term trends on water availability could affect India's water resources.
c. **Ground Water**: India's rechargeable annual groundwater potential has been assessed at around 431 BCM in aggregate terms. On an all India basis it is estimated that about 30 per cent of the groundwater potential has been tapped for irrigation and domestic use. The regional situation is very much different and large parts of India have already exploited almost all of their dynamic recharge. Haryana and Punjab have exploited about 94 per cent of their groundwater resources. Areas with depleting groundwater tables are found in Rajasthan, Gujarat, most of western Uttar Pradesh and in all of the Deccan states.

Hydrological cycle

The Hydrological cycle (also known as the water cycle) is the journey water takes as it circulates from the land to the sky and back again.

The sun's heat provides energy to evaporate water from the earth's surface (oceans, lakes, etc.). Plants also lose water to t he air transpiration. The water vapour eventually condenses, forming tiny droplets in clouds.

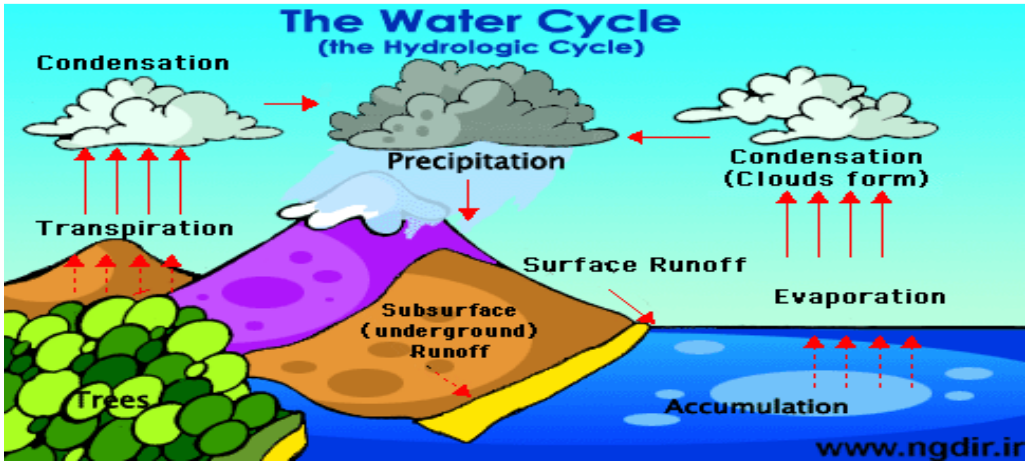
When the clouds meet cool air over land, precipitation (rain, sleet, or snow) is triggered, and water returns to the land (or sea). Some of the precipitation soaks into the ground. Some of the underground water is trapped between rock or clay layers - this is called groundwater. But most of the water flows downhill as runoff (above ground or underground), eventually returning to the seas as slightly salty water.

What is the Hydrological Cycle?

The total amount of water on the earth and in its atmosphere does not change but the earth's water is always in movement. Oceans, rivers, clouds and rain, all of which contain water, are in a frequent state of change and the motion of rain and flowing rivers transfers water in a never-ending cycle. This circulation and conservation of earth's water as it circulates from the land to the sky and back again is called the 'hydrological cycle' or 'water cycle'.

How does the Hydrological Cycle work?

The stages of the cycle are:



- **Evaporation**: Water is transferred from the surface to the atmosphere through evaporation, the process by which water changes from a liquid to a gas. The sun's heat provides energy to evaporate water from the earth's surface. Land, lakes, rivers and oceans send up a steady stream of water vapour and plants also lose water to the air (transpiration). Approximately 80% of all evaporation is from the oceans, with the remaining 20% coming from inland water and vegetation.

- **Transport**: The movement of water through the atmosphere, specifically from over the oceans to over land, is called transport. Some of the earth's moisture transport is visible as clouds, which themselves consist of ice crystals and/or tiny water droplets. Clouds are propelled from one place to another by the jet stream, surface-based circulations like land and sea breezes or other mechanisms. However, a typical cloud 1 km thick contains only enough water for a millimetre of rainfall, whereas the amount of moisture in the atmosphere is usually 10-50 times greater than this. Most water is transported in the form of water vapour, which is actually the third most abundant gas in the atmosphere. Water vapour may be invisible to us, but not to satellites which are capable of collecting data about moisture patterns in the atmosphere.
- **Condensation**: The transported water vapour eventually condenses, forming tiny droplets in clouds.
- **Precipitation**: The primary mechanism for transporting water from the atmosphere to the surface of the earth is precipitation. When the clouds meet cool air over land, precipitation, in the form of rain, sleet or snow, is triggered and water returns to the land (or sea). A proportion of atmospheric precipitation evaporates.
- **Groundwater**: Some of the precipitation soaks into the ground and this is the main source of the formation of the waters found on land - rivers, lakes, groundwater and glaciers. Some of the underground water is trapped between rock or clay layers - this is called groundwater. Water that infiltrates the soil flows downward until it encounters impermeable rock and then travels laterally. The locations where water moves laterally are called 'aquifers'. Groundwater returns to the surface through these aquifers, which empty into lakes, rivers and the oceans. Under special circumstances, groundwater can even flow upward in artesian wells. The flow of groundwater is much slower than run-off with speeds usually measured in centimetres per day, metres per year or even centimetres per year.
- **Run-off**: Most of the water which returns to land flows downhill as run-off. Some of it penetrates and charges groundwater while the rest, as river flow, returns to the oceans where it evaporates. As the amount of groundwater increases or decreases, the water table rises or falls accordingly. When the entire area below the ground is saturated, flooding occurs because all subsequent precipitation is forced to remain on the surface.

Different surfaces hold different amounts of water and absorb water at different rates. As a surface becomes less permeable, an increasing amount of water remains on the surface, creating a greater potential for flooding. Flooding is very common during winter and early spring because frozen ground has no permeability, causing most rainwater and melt water to become run-off.

WATER CONSERVATION AND MANAGEMENT:

Water conservation encompasses the policies, strategies and activities to manage fresh water as a sustainable resource, to protect the water environment, and to meet current and

future human demand. Population, household size and growth and affluence all affect how much water is used. Factors such as climate change will increase pressures on natural water resources especially in manufacturing and agricultural irrigation.

In implementing water conservation principles there are a number of key activities that may be beneficial.

1. Any beneficial reduction in water loss, use and waste of resources.
2. Avoiding any damage to water quality.
3. Improving water management practices that reduce or enhance the beneficial use of water.

Methods Of Water Conservation

(a) Conservation by surface water storage

Storage of water by construction of various water reservoirs have been one of the oldest measures of water conservation. The scope of storage varies from region to region depending on water availability and topographic condition. The environmental impact of such storage also needs to be examined for developing environment friendly strategies.

(b) Conservation of rain water

Rain water has been conserved and used for agriculture in several parts of our country since ancient times. The infrequent rain if harvested over a large area can yield considerable amount of water. Contour farming is an example of such harvesting technique involving water and moisture control at a very simple level. It often consists of rows of rocks placed along the contour of steps. Runoff captured by these barriers also allows for retention of soil, thereby serving as erosion control measure on gentle slopes. This technique is especially suitable for areas having rainfall of considerable intensity, spread over large part i.e. in Himalayan area, north east states and Andaman and Nicobar islands. In areas where rainfall is scanty and for a short duration, it is worth attempting these techniques, which will induce surface runoff, which can then be stored.

(c) Ground water conservation

Attributes of groundwater

• There is more groundwater than surface water.

• Groundwater is less expensive and economic resource and available almost everywhere.

• Groundwater is sustainable and reliable source of water supply.

• Groundwater is relatively less vulnerable to pollution.

• Groundwater is a free of pathogenic organisms.

• Groundwater needs little treatment before use.

• Groundwater is the key to life in arid and semi arid regions.

• Groundwater is source of dry weather flow in some rivers and streams.

As highlighted earlier, out of total 4000 BCM (billion cubic meters) precipitation that occurs in India, about 45 mhan (million hectares meters) percolates as ground water flow. It may not be possible to tap the entire ground water resources. The ground water potential is only 490 BCM. As we have limited ground water available, it is very important that we use it economically and judiciously and conserve it to the maximum. ***Some of the techniques of ground water management and conservation are described below.***

(i) Artificial recharge

In water scarce areas, there is an increased dependence on ground water. The water table declines quickly due to low and erratic rainfall. The only alternative is to replenish the ground water by artificial means. As you have studied in the previous lesson, there are various techniques to develop and manage ground water artificially. In one of the methods, water is spread over ground to increase area and length of time for water to remain in contact with soil, so as to allow maximum possible opportunity for water to enter into the ground. Try to recollect the other methods of recharging ground water.

(ii) Percolation tank method

Percolation tanks are constructed across the water course for artificial recharge. The studies conducted in a Maharastra indicates that on an average, area of influence of percolation of 1.2 km2, the average ground water rise was of the order of 2.5 m and the annual artificial recharge to ground water from each tanks was 1.5 hec m.

(d) Catchment area protection (CAP)

Catchment protection plans are usually called watershed protection or management plans. These form are an important measure to conserve and protect the quality of water in a watershed. It helps in withholding runoff water albeit temporarily by a check bund constructed across the streams in hilly terrains to delay the run off so that greater time is available for water to seep underground. Such methods are in use in north-east states, in hilly areas of tribal belts. This technique also helps in soil conservation. Afforestation in the catchment area is also adopted for water and soil conservation.

(e) Inter-basin transfer of water

A broad analysis of water and land resources and population statistics of various river basins in our country reveals that areas in western and peninsular regions have comparatively low water resources/cultivable land ratio. Northern and eastern region which are drained by Ganga and Brahmaputra have substantial water resources. Hence, the scheme of diverting water from region with surplus water to water defecit region can be adopted GangaCauveri link would enable to transfer of vast quantities of Ganga basin flood water running out to sea,

to west and south west India. The transfer of the surplus Ganga water would make up for the periodical shortage in Sone, Narmada, Godaveri, Krishna and Cauvery. The National Grid Commission envisages diversion of part of the surplus discharge in the Ganga near Patna during the high flood period.

(f)Adoption of drip sprinkler irrigation

Surface irrigation methods, which are traditionally used in our country, are unsuitable for water scarce areas, as large amount of water is lost through evaporation and percolation. Drip irrigation is an efficient method of irrigation in which a limited area near the plant is irrigated by dripping water. It is suitable method for any area and especially for water scarce areas. This method is particularly useful in row crop. Similarly sprinkler method is also suitable for such water scarce areas. About 80% water consumption can be reduced by this method, whereas the drip irrigation can reduce water consumption by 50 to 70 %.

Conservation of water in domestic use

There is a large scope of conserving water at house hold level. A general awareness among the people about the importance of water and its availability, and need for conservation can help in minimizing wastage to a large extent. Losses during water supply also need to be prevented by reducing the leakages.

Some of the ways for improving the efficiency of water use at household level are:

- Reduce wastage-leaking pipes mean that lot of water never reaches to the people. In Delhi estimated losses are 35-40 %.
- Closing of taps while not in use.
- Better irrigation techniques – irrigation systems waste up to 70% water used. In drip irrigation water loss is significantly less.
- Use low flush toilets-reducing the amount of water used each time the lavatory is flushed.
- Use bowls to wash vegetables, dishes instead of running tap.
- Greater use of recycled water ‘grey water’ in the home. Instead of using potable or treated water use bath and shower water for watering the plants.
- Use washing machine or dish washer when it is fully loaded.

RIVER ACTION PLAN

The water quality data generated through National Water Monitoring Programme and River Basin Studies carried out since, 1980 indicated deterioration of water quality in riverine segments and other water bodies. The water bodies not meeting the desired water quality criteria are identified as polluted river stretches/water bodies. The deviation of water quality from the desired water quality criteria in the data generated for the river Ganga formed the basis for launching Ganga Action Plan (GAP). Subsequently, the river stretches not meeting the desired criteria are identified in all the major river basins. The identified polluted river stretches were intensively surveyed by State Pollution Control Boards (SPCBs) and Central

Pollution Control Board (CPCB) to identify the sources of pollution such as Urban Centres and Industrial Units. National River Conservation Directorate (NRCD) is implementing the River Action Plans for restoration of water quality based on the findings of survey reports submitted by CPCB/SPCBs. The thrust of NRCD is towards providing funds to state agencies for interception, diversion and treatment of sewage discharged to the water bodies from identified Urban Centers. At present NRCD is implementing the Action Plans in 157 cities and towns located along 30 rivers. The name of the rivers are Adyar, Cooum, Betwa, Bhadra, Brahmani, Cauvery, Chambal, Damodar, Ganga, Godavari, Gomti, Khan, Krishna, Kshipra, Mahanadi, Mandovi, Narmada, Pennar, Sabarmati, Satluj, Subarnarekha, Tapti, Tunga, Tungbhadra, Tambiraparni, Vennar, Vaigai, Walnganga, Yamuna and Musi. The schemes taken up by NRCD are related to Municipal Wastewater Treatment and are progressing in various stages. The component of Industrial Effluents contribution to polluted stretches is required to be addressed by SPCBs through consent management and surveillance. The SPCBs may compile information on Industrial Effluents being discharged in the polluted stretches in their respective states and come out with a time targeted plan to restore the water quality in the rivers. The SPCBs may also carry out performance study of functional Sewage Treatment Plant (STP) to evaluate the efficacy of treatment systems. This exercise shall be helpful in enforcement of treatment standards imposed by SPCBs and NRCD.

Ganga Action Plan (GAP)

The Ganga action plan was, launched by Shri Rajeev Gandhi, the then Prime Minister of India on 14 Jan. 1986 with the main objective of pollution abatement, to improve the water quality by Interception, Diversion and treatment of domestic sewage and present toxic and industrial chemical wastes from identified grossly polluting units entering in to the river. The other objectives of the Ganga Action Plan are as under.

- Control of non-point pollution from agricultural run-off, human defecation, cattle wallowing and throwing of unburnt and half burnt bodies into the river.
- Research and Development to conserve the biotic, diversity of the river to augment its productivity.
- New technology of sewage treatment like Up-flow Anaerobic Sludge Blanket (UASB) and sewage treatment through afforestation has been successfully developed.
- Rehabilitation of soft-shelled turtles for pollution abatement of river have been demonstrated and found useful.
- Resource recovery options like production of methane for energy generation and use of aquaculture for revenue generation have been demonstrated.
- To act as trend setter for taking up similar action plans in other grossly polluted stretches in other rivers.

The ultimate objective of the GAP is to have an approach of integrated river basin management considering the various dynamic inter-actions between abiotic and biotic eco-system.

Notwithstanding some delay in the completion of the first phase of GAP it has generated considerable interest and set the scene for evolving a national approach towards replicating this program for the other polluted rivers of the country. The Government of India proposed to extend this model with suitable modifications to the national level through a National River Action Plan (NRAP). The NRAP mainly draws upon the lessons learnt and the

experience gained from the GAP besides seeking the views of the State Governments and the other concerned Departments/Agencies.

Under NRCP scheme the CPCB had conducted river basin studies and had identified 19 gross polluted stretches and 14 less polluted stretches along 19 rivers, which include 11 stretches situated along 7 rivers of M.P.

WATER POLLUTION

Water pollution is the contamination of water bodies (e.g. lakes, rivers , oceans , aquifers and groundwater). Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds. Water pollution affects plants and organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and populations, but also to the natural biological communities. Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells). It has been suggested that it is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily. An estimated 700 million Indians have no access to a proper toilet, and 1,000 Indian children die of diarrheal sickness every day. Some 90% of China's cities suffer from some degree of water pollution and nearly 500 million people lack access to safe drinking water. In addition to the acute problems of water pollution in developing countries, developed countries continue to struggle with pollution problems as well. In the most recent national report on water quality in the United States, 45 percent of assessed stream miles, 47 percent of assessed lake acres, and 32 percent of assessed bay and estuarine square miles were classified as polluted.

Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, such as drinking water , and/or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish. Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water Groundwater pollution: Interactions between groundwater and surface water are complex. Consequently, groundwater pollution, sometimes referred to as groundwater contamination, is not as easily classified as surface water pollution. By its very nature, groundwater aquifers are susceptible to contamination from sources that may not directly affect surface water bodies, and the distinction of point vs. non-point source may be irrelevant. A spill or ongoing releases of chemical or radionuclide contaminants into soil (located away from a surface water body) may not create point source or non-point source pollution, but can contaminate the aquifer below, defined as a toxin plume. The movement of the plume, called a plume front, may be analyzed through a hydrological transport model or groundwater model. Analysis of groundwater contamination may focus on the soil characteristics and site geology, hydrogeology, hydrology, and the nature of the contaminants.

Causes of Water Pollution

1. **Industrial waste:** Industries produce huge amount of waste which contains toxic chemicals and pollutants which can cause air pollution and damage to us and our environment. They contain pollutants such as lead, mercury, sulphur, asbestos, nitrates and many other harmful chemicals. Many industries do not have proper waste management system and drain the waste in the fresh water which goes into rivers, canals and later in to sea. The toxic chemicals have the capability to change the colour of water, increase the amount of minerals, also known as Eutrophication, change the temperature of water and pose serious hazard to water organisms.
2. **Sewage and waste water**: The sewage and waste water that is produced by each household is chemically treated and released in to sea with fresh water. The sewage water carries harmful bacteria and chemicals that can cause serious health problems. Pathogens are known as a common water pollutant; The sewers of cities house several pathogens and thereby diseases. Microorganisms in water are known to be causes of some very deadly diseases and become the breeding grounds for other creatures that act like carriers. These carriers inflict these diseases via various forms of contact onto an individual. A very common example of this process would be Malaria.
3. **Mining activities**: Mining is the process of crushing the rock and extracting coal and other minerals from underground. These elements when extracted in the raw form contain harmful chemicals and can increase the amount of toxic elements when mixed up with water which may result in health problems. Mining activities emit several metal waste and sulphides from the rocks and is harmful for the water.
4. **Marine dumping**: The garbage produce by each household in the form of paper, aluminium, rubber, glass, plastic, food if collected and deposited into the sea in some countries. These items take from 2 weeks to 200 years to decompose. When such items enter the sea, they not only cause water pollution but also harm animals in the sea.
5. **Accidental Oil leakage**: Oil spill pose a huge concern as large amount of oil enters into the sea and does not dissolve with water; there by opens problem for local marine wildlife such as fish, birds and sea otters. For e.g.: a ship carrying large quantity of oil may spill oil if met with an accident and can cause varying damage to species in the ocean depending on the quantity of oil spill, size of ocean, toxicity of pollutant.

Ground Water Pollution

Underground water, which was considered fairly safe source of water is also becoming increasingly polluted these days. The groundwater is threatened with contamination due to seepage from industrial and municipal wastes and effluents, sewage channels and agricultural runoff.

The specific contaminants leading to pollution in water include a wide spectrum of chemicals, pathogens, and physical changes such as elevated temperature and

discoloration. While many of the chemicals and substances that are regulated may be naturally occurring (calcium, sodium, iron, manganese, etc.) the concentration is often the key in determining what is a natural component of water and what is a contaminant. High concentrations of naturally occurring substances can have negative impacts on aquatic flora and fauna.

Surface Water Pollution

Surface water is usually rain water that collects in surface water bodies, like oceans, lakes, or streams. Another source of surface water is groundwater that discharges to the surface from springs. Surface water pollution occurs when hazardous substances come into contact and either dissolve or physically mix with the water. Because of the close relationship between sediments and surface water, contaminated sediments are often considered part of surface water contamination. Sediments include the sand and soils on the bottom of an ocean, lake, or stream.

Surface water can become contaminated in many ways. Surface water can be contaminated when hazardous substances are discharged directly from an outfall pipe or channel or when they receive contaminated storm water runoff. Direct discharges can come from industrial sources or from certain older sewer systems that overflow during wet weather. Storm water runoff becomes contaminated when rain water comes into contact with contaminated soil and either dissolves the contamination or carries contaminated soil particles. Surface water can also be contaminated when contaminated groundwater reaches the surface through a spring, or when contaminants in the air are deposited on the surface water. Contaminated soil particles carried by storm water runoff or contaminants from the air can sink to the bottom of a surface water body, mix with the sediment, and remain.

Waste Water Management

Wastewater management encompasses a broad range of efforts that promote effective and responsible water use, treatment, and disposal and encourage the protection and restoration of our nation's watersheds. EPA's Office of Wastewater Management oversees the regulatory and voluntary programs that help manage our nation's wastewater.

Under the Clean Water Act, EPA works in partnership with EPA Regions, states, local governments, tribes, the private sector, and non-governmental organizations to regulate discharges into surface waters. Other EPA initiatives include green infrastructure, energy management, effective municipal capital finance mechanisms, wastewater and storm water infrastructure sustainability, and water efficiency.

Domestic sewage:

Domestic sewage is 99.9 percent pure water, while the other 0.1 percent is pollutants. Although found in low concentrations, these pollutants pose risk on a large scale. In urban areas, domestic sewage is typically treated by centralized sewage treatment plants. In the

U.S., most of these plants are operated by local government agencies, frequently referred to as publicly owned treatment works (POTW). Municipal treatment plants are designed to control conventional pollutants : BOD and suspended solids. Well-designed and operated systems (i.e., secondary treatment or better) can remove 90 percent or more of these pollutants. Some plants have additional sub-systems to treat nutrients and pathogens. Most municipal plants are not designed to treat toxic pollutants found in industrial wastewater.

Cities with sanitary sewer overflows or combined sewer overflows employ one or more engineering approaches to reduce discharges of untreated sewage, including:

- utilizing a green infrastructure approach to improve storm water management capacity throughout the system,
- reduce the hydraulic overloading of the treatment plant
- repair and replacement of leaking and malfunctioning equipment
- Increasing overall hydraulic capacity of the sewage collection system (often a very expensive option).

A household or business not served by a municipal treatment plant may have an individual septic tank, which treats the wastewater on site and discharges into the soil. Alternatively, domestic wastewater may be sent to a nearby privately owned treatment system (e.g. in a rural community).

Industrial wastewater: Some industrial facilities generate ordinary domestic sewage that can be treated by municipal facilities. Industries that generate wastewater with high concentrations of conventional pollutants (e.g. oil and grease), toxic pollutants (e.g. heavy metals, volatile organic compounds) or other nonconventional pollutants such as ammonia, need specialized treatment systems. Some of these facilities can install a pre-treatment system to remove the toxic components, and then send the partially-treated wastewater to the municipal system. Industries generating large volumes of wastewater typically operate their own complete on-site treatment systems.

Some industries have been successful at redesigning their manufacturing processes to reduce or eliminate pollutants, through a process called pollution prevention. Heated water generated by power plants or manufacturing plants may be controlled with: cooling ponds , man-made bodies of water designed for cooling by evaporation , convection , and radiation cooling towers , which transfer waste heat to the atmosphere through evaporation and/or heat transfer cogeneration , a process where waste heat is recycled for domestic and/or industrial heating purposes.

Agricultural wastewater

Nonpoint source controls

Sediment (loose soil) washed off fields is the largest source of agricultural pollution in the United States. Farmers may utilize erosion controls to reduce runoff flows and retain soil on their fields. Common techniques include contour ploughing, crop mulching, crop rotation, planting perennial crops and installing riparian buffers. Nutrients (nitrogen and phosphorus) are typically applied to farmland as commercial fertilizer; animal manure; or spraying of municipal or industrial wastewater (effluent) or sludge. Nutrients may also enter runoff from

crop residues, irrigation water, wildlife, and atmospheric deposition. Farmers can develop and implement nutrient management plans to reduce excess application of nutrients.

To minimize pesticide impacts, farmers may use Integrated Pest Management (IPM) techniques (which can include biological pest control) to maintain control over pests, reduce reliance on chemical pesticides, and protect water quality.

Point source wastewater treatment

Farms with large livestock and poultry operations, such as factory farms, are called concentrated animal feeding operations or feedlots in the US and are being subject to increasing government regulation. Animal slurries are usually treated by containment in anaerobic lagoons before disposal by spray or trickle application to grassland. Constructed wetlands are sometimes used to facilitate treatment of animal wastes. Some animal slurry are treated by mixing with straw and composted at high temperature to produce bacteriologically sterile and friable manure for soil improvement.

AIR POLLUTION

Air pollution is the introduction of particulates, biological molecules, or other harmful materials into the Earth's atmosphere, possibly causing disease, death to humans, damage to other living organisms such as food crops, or the natural or built environment.

Major ***primary pollutants*** produced by human activity include:

- Sulphur oxides (SO_x) - particularly sulphur dioxide, a chemical compound with the formula SO_2. SO_2 is produced by volcanoes and in various industrial processes. Coal and petroleum often contain sulphur compounds, and their combustion generates sulphur dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4, and thus acid rain.[2] This is one of the causes for concern over the environmental impact of the use of these fuels as power sources.
- Nitrogen oxides (NO_x) - Nitrogen oxides, particularly nitrogen dioxide, are expelled from high temperature combustion, and are also produced during thunderstorms by electric discharge. They can be seen as a brown haze dome above or a plume downwind of cities. Nitrogen dioxide is a chemical compound with the formula NO_2. It is one of several nitrogen oxides. One of the most prominent air pollutants, this reddish-brown toxic gas has a characteristic sharp, biting odor.

- Carbon monoxide (CO) - CO is a colourless, odourless, toxic yet non-irritating gas. It is a product by incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.

- Volatile organic compounds - VOCs are a well-known outdoor air pollutant. They are categorized as either methane (CH_4) or non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming. Other hydrocarbon VOCs are also significant greenhouse gases because of their role in creating

ozone and prolonging the life of methane in the atmosphere. This effect varies depending on local air quality. The aromatic NMVOCs benzene, toluene and xylene are suspected carcinogens and may lead to leukemia with prolonged exposure. 1,3-butadiene is another dangerous compound often associated with industrial use.

- Particulates, alternatively referred to as particulate matter (PM), atmospheric particulate matter, or fine particles, are tiny particles of solid or liquid suspended in a gas. In contrast, aerosol refers to combined particles and gas. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols. Averaged worldwide, anthropogenic aerosols—those made by human activities—currently account for approximately 10 percent of our atmosphere. Increased levels of fine particles in the air are linked to health hazards such as heart disease altered lung function and lung cancer.

- Persistent free radicals connected to airborne fine particles are linked to cardiopulmonary disease.

- Toxic metals, such as lead and mercury, especially their compounds.

- Chlorofluorocarbons (CFCs) - harmful to the ozone layer; emitted from products are currently banned from use. These are gases which are released from air conditioners, refrigerators, aerosol sprays, etc. CFC's on being released into the air rises to stratosphere. Here they come in contact with other gases and damage the ozone layer. This allows harmful ultraviolet rays to reach the earth's surface. This can lead to skin cancer, disease to eye and can even cause damage to plants.
- Ammonia (NH_3) - emitted from agricultural processes. Ammonia is a compound with the formula NH_3. It is normally encountered as a gas with a characteristic pungent odor. Ammonia contributes significantly to the nutritional needs of terrestrial organisms by serving as a precursor to foodstuffs and fertilizers. Ammonia, either directly or indirectly, is also a building block for the synthesis of many pharmaceuticals. Although in wide use, ammonia is both caustic and hazardous. In the atmosphere, ammonia reacts with oxides of nitrogen and sulphur to form secondary particles.
- Odors — such as from garbage, sewage, and industrial processes
- Radioactive pollutants - produced by nuclear explosions, nuclear events, war explosives, and natural processes such as the radioactive decay of radon.

Secondary pollutants include:

- Particulates created from gaseous primary pollutants and compounds in photochemical smog. Smog is a kind of air pollution. Classic smog results from large amounts of coal

burning in an area caused by a mixture of smoke and sulphur dioxide. Modern smog does not usually come from coal but from vehicular and industrial emissions that are acted on in the atmosphere by ultraviolet light from the sun to form secondary pollutants that also combine with the primary emissions to form photochemical smog.

- Ground level ozone (O_3) formed from NO_x and VOCs. Ozone (O_3) is a key constituent of the troposphere. It is also an important constituent of certain regions of the stratosphere commonly known as the Ozone layer. Photochemical and chemical reactions involving it drive many of the chemical processes that occur in the atmosphere by day and by night. At abnormally high concentrations brought about by human activities (largely the combustion of fossil fuel), it is a pollutant, and a constituent of smog.
- Peroxyacetyl nitrate (PAN) - similarly formed from NO_x and VOCs.

Minor air pollutants include:

- A large number of minor hazardous air pollutants. Some of these are regulated in USA under the Clean Air Act and in Europe under the Air Framework Directive
- A variety of persistent organic pollutants, which can attach to particulates

Persistent organic pollutants (POPs) 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 potentially significant impacts on human health and the environment.

There are various locations, activities or factors which are responsible for releasing pollutants into the atmosphere. These sources can be classified into two major categories.

Anthropogenic (man-made) sources:

These are mostly related to the burning of multiple types of fuel.

- Stationary sources include smoke stacks of power plants, manufacturing facilities (factories) and waste incinerators, as well as furnaces and other types of fuel-burning heating devices. In developing and poor countries, traditional biomass burning is the major source of air pollutants; traditional biomass includes wood, crop waste and dung.

- Mobile sources include motor vehicles, marine vessels, and aircraft.

- Controlled burn practices in agriculture and forest management. Controlled or prescribed burning is a technique sometimes used in forest management, farming, prairie restoration or greenhouse gas abatement. Fire is a natural part of both forest and grassland ecology and controlled fire can be a tool for foresters. Controlled burning stimulates the germination of some desirable forest trees, thus renewing the forest.

- Fumes from paint, hair spray, varnish, aerosol sprays and other solvents

- Waste deposition in landfills, which generate methane. Methane is highly flammable and may form explosive mixtures with air. Methane is also an asphyxiant and may displace oxygen in an enclosed space. Asphyxia or suffocation may result if the oxygen concentration is reduced to below 19.5% by displacement.

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

Natural sources:

- Dust from natural sources, usually large areas of land with few or no vegetation
- Methane, emitted by the digestion of food by animals, for example cattle
- Radon gas from radioactive decay within the Earth's crust. Radon is a colorless, odorless, naturally occurring, radioactive noble gas that is formed from the decay of radium. It is considered to be a health hazard. Radon gas from natural sources can accumulate in buildings, especially in confined areas such as the basement and it is the second most frequent cause of lung cancer, after cigarette smoking.

- Smoke and carbon monoxide from wildfires
- Vegetation, in some regions, emits environmentally significant amounts of VOCs on warmer days. These VOCs react with primary anthropogenic pollutants—specifically, NO_x, SO_2, and anthropogenic organic carbon compounds — to produce a seasonal haze of secondary pollutants. Black gum, poplar, oak and willow are some examples of vegetation that can produce abundant VOCs. The VOC production from these species results in ozone levels up to eight times higher than the low-impact tree species.
- Volcanic activity, which produces sulphur, chlorine, and ash particulates

Effects of Air pollution

1. Respiratory and heart problems: The effects of Air pollution are alarming. They are known to create several respiratory and heart conditions along with Cancer, among other threats to the body. Several millions are known to have died due to direct or indirect effects of Air pollution. Children in areas exposed to air pollutants are said to commonly suffer from pneumonia and asthma.

2. Global warming: Another direct effect is the immediate alterations that the world is witnessing due to Global warming. With increased temperatures worldwide, increase in sea levels and melting of ice from colder regions and icebergs, displacement and loss of habitat

have already signaled an impending disaster if actions for preservation and normalization aren't undertaken soon.

3. Acid Rain: Harmful gases like nitrogen oxides and sulphur oxides are released into the atmosphere during the burning of fossil fuels. When it rains, the water droplets combines with these air pollutants, becomes acidic and then falls on the ground in the form of acid rain. Acid rain can cause great damage to human, animals and crops.

4. Eutrophication: Eutrophication is a condition where high amount of nitrogen present in some pollutants gets developed on sea's surface and turns itself into algae and adversely affect fish, plants and animal species. The green colored algae that is present on lakes and ponds is due to presence of this chemical only.

5. Effect on Wildlife: Just like humans, animals also face some devastating effects of air pollution. Toxic chemicals present in the air can force wildlife species to move to new place and change their habitat. The toxic pollutants deposit over the surface of the water and can also affect sea animals.

6. Depletion of Ozone layer: Ozone exists in earth's stratosphere and is responsible for protecting humans from harmful ultraviolet (UV) rays. Earth's ozone layer is depleting due to the presence of chlorofluorocarbons, hydro chlorofluorocarbons in the atmosphere. As ozone layer will go thin, it will emit harmful rays back on earth and can cause skin and eye related problems. UV rays also have the capability to affect crops.

Effect of pollutants on vegetation, direct effects, and indirect effect, gas toxicity, wet and dry deposition, and deposition mixtures

Dust pollution is of localized importance near roads, quarries, cement works, and other industrial areas. Apart from screening out sunlight, dust on leaves blocks stomata and lowers their conductance to CO_2, simultaneously interfering with photosystem II. Polluting gases such as SO_2 and NO_x enter leaves through stomata, following the same diffusion pathway as CO_2. NO_x dissolves in cells and gives rise to nitrite ions (NO_2^-, which are toxic at high concentrations) and nitrate ions (NO_3^-) that enter into nitrogen metabolism as if they had been absorbed through the roots. In some cases, exposure to pollutant gases,

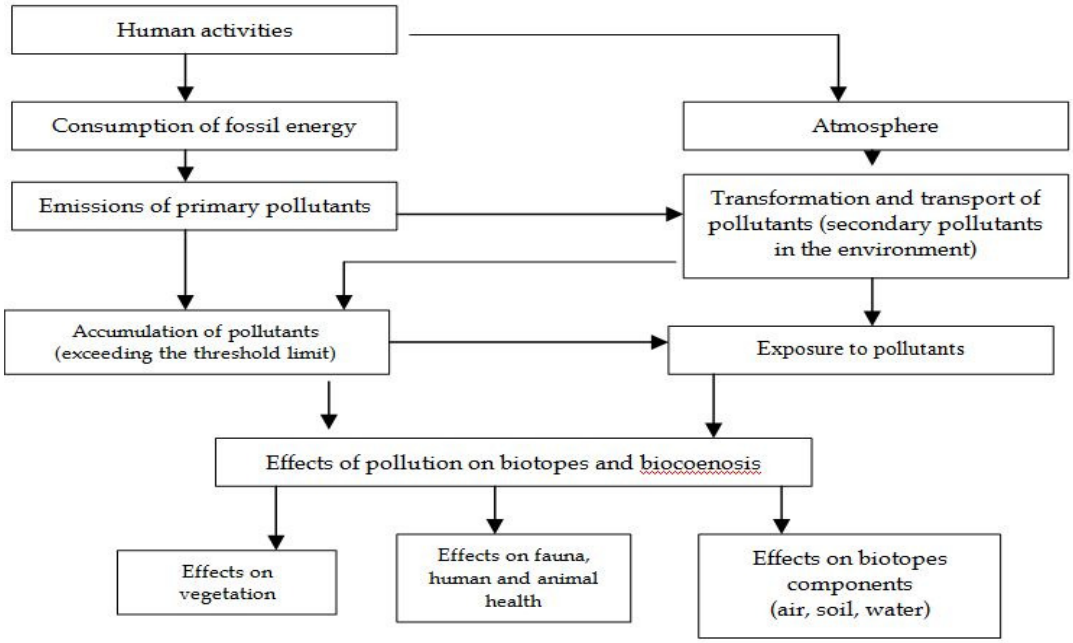


FIGURE 3. The air pollutants flow diagram

particularly SO_2, causes stomatal closure, which protects the leaf against further entry of the pollutant but also curtails photosynthesis. In the cells, SO_2 dissolves to give bisulphite and sulphite ions; sulphite is toxic, but at low concentrations it is metabolized by chloroplasts to sulphate, which is not toxic. At sufficiently low concentrations, bisulphite and sulphite are effectively detoxified by plants, and SO_2 air pollution then provides a sulphur source for the plant. In urban areas these polluting gases may be present in such high concentrations that they cannot be detoxified rapidly enough to avoid injury. Ozone is presently considered to be the most damaging phytotoxic air pollutant in North America. It has been estimated that wherever the mean daily O_3 concentration reaches 40, 50, or 60 ppb (parts per billion or per 10^9), the combined yields of soybean, maize, winter wheat, and cotton would be decreased by 5, 10, and 16%, respectively. Ozone is highly reactive: It binds to plasma membranes and it alters metabolism. As a result, stomatal apertures are poorly regulated, chloroplast thylakoid membranes are damaged, rubisco is degraded, and photosynthesis is inhibited. Ozone reacts with $O_2$and produces reactive oxygen species, including hydrogen peroxide (H_2O_2), superoxide (O_2^-), singlet oxygen ($^1O_2$*), and the hydroxyl radical ($^{\cdot}OH$). These denature proteins and damage nucleic acids (thereby giving rise to mutations), and cause lipid peroxidation, which breaks down lipids in membranes. Reactive oxygen species form also in the absence of O_3, particularly in electron transport in the mitochondria and chloroplasts, when electrons can be donated to O_2. Cells are protected, at least in part, from reactive

oxygen species by enzymatic and non-enzymatic defence mechanisms. Defence against reactive oxygen species is provided by the scavenging properties of molecules, such as ascorbic acid, α-tocopherol, phenolic compounds, and glutathione. Superoxide dismutases (SODs) catalyze the reduction of superoxide to hydrogen peroxide. Hydrogen peroxide is then converted to H_2O by the action of catalases and peroxidases. Of particular importance is the ascorbate-specific peroxidase localized in the chloroplast. Acting in concert, ascorbate peroxidase, dehydroascorbate reductase, and glutathione reductase remove H_2O_2 in a series of reactions called the *Halliwell–Asada pathway*, named after its discoverers. Glutathione is a sulfur-containing tripeptide that, in its reduced form, reacts rapidly with dehydroascorbate and becomes oxidized in the process.

Exposure of plants to reactive oxygen species stimulates the transcription and translation of genes that encode enzymes involved in protection mechanisms. In Arabidopsis, exposure for 6 hours per day to low levels of O_3 induces the expression of several genes that encode enzymes associated with protection from reactive oxygen species, including SOD, glutathione S-transferase (which catalyzes detoxification reactions involving glutathione), and phenylalanine ammonia lyase (an important enzyme at the start of the phenylpropanoid pathway that leads to the synthesis of flavonoids and other phenolics).

In transgenic tobacco transformed with a gene from *Escherichia coli* to give additional glutathione reductase activity in the chloroplast, short-term exposure to high levels of SO_2 is much less damaging than for wild-type tobacco. Environmental extremes may either accelerate the production of reactive oxygen species or impair the normal defence mechanisms that protect cells from reactive oxygen species. In water-deficient leaves, for example, greater oxygen photoreduction by photosystems I and II increases superoxide production, and the pool of glutathione, as well as the activity of glutathione reductase, increase-presumably as part of the cell defence mechanism. In contrast, levels of ascorbate, another antioxidant, generally decline with mild water stress. Transgenic plants over expressing mitochondrion superoxide dismutase (Mn-SOD), the isozyme localized in the mitochondrial matrix, show less water-deficit damage and, significantly, improved survival and yield under field conditions. In other experiments, transgenic alfalfa overexpressing Mn-SOD was found to be more tolerant of freezing. Conversely, winter rye, wheat, and barley acclimated at 2 °C for several weeks, were found to have developed resistance to the herbicides, paraquat and acifluorfen, which generate reactive oxygen species. Such investigations support the hypothesis that tolerance of oxidative stress is an important factor in tolerance to a wide range of environmental extremes. Many deleterious changes in

metabolism caused by air pollution precede external symptoms of injury, which appear only at much higher concentrations. For example, when plants are exposed to air containing NOx, lesions on leaves appear at a NOx concentration of 5 ml/l, but photosynthesis starts to be inhibited at a concentration of only 0.1 ml/l. These low, threshold concentrations refer to the effects of a single pollutant. However, two or more pollutants acting together can have a synergistic effect, producing damage at lower concentrations than if they were acting separately. In addition, vegetation weakened by air pollution can become more susceptible to invasion by pathogens and pests. Unpolluted rain is slightly acidic, with a pH close to 5.6, because the CO_2 dissolved in it produces the weak acid, H_2CO_3. Dissolution of NOx and SO_2 in water droplets in the atmosphere causes the pH of rain to decrease to 3 to 4, and in southern California polluted droplets in fog can be as acidic as pH 1.7. Dilute acidic solution can remove mineral nutrients from leaves, depending on the age of the leaf and the integrity of the cuticle and surface waxes. The total annual contributions to the soil of acid from acid rain (*wet deposition*) and from particulate matter falling on the soil plus direct absorption from the atmosphere (*dry deposition*) may reach 1.0 to 3.0 kg H^+ per hectare in parts of Europe and the north-eastern United States. In soils that lack free calcium carbonate, and therefore are not strongly buffered, such additions of acid can be harmful to plants. Furthermore, the added acid can result in the release of aluminium ions from soil minerals, causing aluminium toxicity. Air pollution is considered to be a major factor in the decline of forests in heavily polluted areas of Europe and North America. There are indications that fast-growing pioneer species are better able to tolerate an acidifying atmosphere than are climax forest trees, possibly because they have a greater potential for assimilation of dissolved NOx, and more effective acid buffering of the leaf tissue cell sap. Air pollution injury to plants can be evident in several ways. Injury to foliage may be visible in a short time and appear as necrotic lesions (dead tissue), or it can develop slowly as a yellowing or chlorosis of the leaf. There may be a reduction in growth of various portions of a plant. Plants may be killed outright, but they usually do not succumb until they have suffered recurrent injury.

Major primary air pollutants gases are sulphur dioxide, oxides of nitrogen particularly NO_2, HF, HCl, chlorine, ammonia, ethylene and other organic substances. Particulate air pollutants are soot, dust, fine particles of cement and various other substances. Various fertilizers, pesticides and insecticides used in aerial spray are also important air pollutants

GREEN HOUSE EFFECT

The greenhouse effect is a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases, and is re-radiated in all directions. Since part of this re-radiation is back towards the surface and the lower atmosphere, it results in an elevation of the average surface temperature above what it would be in the absence of the gases.

By their percentage contribution to the greenhouse effect on Earth the four major gases are:

- water vapour, 36–70%
- carbon dioxide, 9–26%
- methane, 4–9%
- ozone, 3–7%

The major non-gas contributor to the Earth's greenhouse effect, clouds, also absorb and emit infrared radiation and thus have an effect on radiative properties of the atmosphere.

In order to understand how the greenhouse effect operates, we need to first understand "infrared radiation". Greenhouse gases trap some of the infrared radiation that escapes from the Earth, making the Earth warmer that it would otherwise be. You can think of greenhouse gases as sort of a "blanket" for infrared radiation-- it keeps the lower layers of the atmosphere warmer, and the upper layers colder, than if the greenhouse gases were not there.

About 80-90% of the Earth's natural greenhouse effect is due to water vapour, a strong greenhouse gas. The remainder is due to carbon dioxide, methane, and a few other minor gases.

It is the carbon dioxide concentration that is increasing, due to the burning of fossil fuels (as well as from some rainforest burning). This is the man-made portion of the greenhouse effect, and it is believed by many scientists to be responsible for the global warming of the last 150 years.

Also, the concentration of methane, although small, has also increased in recent decades. The reasons for this increase, though, are uncertain.

The exchange of incoming and outgoing radiation that warms the Earth is often referred to as the greenhouse effect because a greenhouse works in much the same way.

Incoming UV radiation easily passes through the glass walls of a greenhouse and is absorbed by the plants and hard surfaces inside. Weaker IR radiation, however, has difficulty passing through the glass walls and is trapped inside, thus warming the greenhouse. This effect lets tropical plants thrive inside a greenhouse, even during a cold winter.

A similar phenomenon takes place in a car parked outside on a cold, sunny day. Incoming solar radiation warms the car's interior, but outgoing thermal radiation is trapped inside the car's closed windows.

Greenhouse gases and global warming

The gases in the atmosphere that absorb radiation are known as greenhouse gases because they're largely responsible for the greenhouse effect.

These greenhouse gases include water vapor, carbon dioxide (CO2), methane, nitrous oxide (N2O) and other gases, according to the Environmental Protection Agency (EPA).

Since the dawn of the Industrial Revolution in the early 1800s, the burning of fossil fuels like coal, oil and gasoline have greatly increased the concentration of greenhouse gases in the atmosphere, especially CO2, according to NASA.

CO2 and other greenhouse gases act like a blanket, absorbing IR radiation and preventing it from escaping into outer space. The net effect is the gradual heating of Earth's atmosphere and surface, a process known as global warming.

Atmospheric CO_2 levels have increased by more than 40 percent since the beginning of the Industrial Revolution, from about 280 parts per million (ppm) in the 1800s to 400 ppm today. The last time Earth's atmospheric levels of CO_2 reached 400 ppm was during the Pliocene Epoch, between 5 million and 3 million years ago, according to the University of California, San Diego's Scripps Institution of Oceanography.

The greenhouse effect, combined with increasing levels of greenhouse gases and the resulting global warming, is expected to have profound implications, according to the near-universal consensus of scientists.

If global warming continues unchecked, it will cause significant climate change, a rise in sea levels, increasing ocean acidification, extreme weather events and other severe natural and societal impacts, according to NASA, the EPA and other scientific and governmental bodies.

GLOBAL WARMING

Global Warming is the increase of Earth's average surface temperature due to effect of greenhouse gases, such as carbon dioxide emissions from burning fossil fuels or from deforestation, which trap heat that would otherwise escape from Earth.

Global warming is primarily a problem of too much carbon dioxide (CO2) in the atmosphere—which acts as a blanket, trapping heat and warming the planet. As we burn fossil fuels like coal, oil and natural gas for energy or cut down and burn forests to create pastures and plantations, carbon accumulates and overloads our atmosphere. Certain waste management and agricultural practices aggravate the problem by releasing other potent global warming gases, such as methane and nitrous oxide.

CO2 survives in the atmosphere for a long time—up to many centuries—so its heat-trapping effects are compounded over time. Of the many heat-trapping gases, CO2 puts us at the greatest risk of irreversible changes if it continues to accumulate unabated in the atmosphere—as it is likely to do if the global economy remains dependent on fossil fuels for its energy needs. To put this in perspective, the carbon we put in the atmosphere today will literally determine not only our climate future but that of future generations as well.

Substantial scientific evidence indicates that an increase in the global average temperature of more than 3.6 degrees Fahrenheit (°F) (or 2 degrees Celsius [°C]) above pre-industrial levels poses severe risks to natural systems and to human health and well-being. The good news is that, because we as humans caused global warming, we can also do something about it. To avoid this level of warming, large emitters such as the United States need to greatly reduce heat-trapping gas emissions by mid century. Delay in taking such action means the prospect of much steeper cuts later if there is any hope of staying below the 3.6°F (2°C) temperature goal. Delayed action is also likely to make it more difficult and costly to not only make these reductions, but also address the climate consequences that occur in the meantime.

Effects of Global Warming

The effects of global warming are the environmental and social changes caused (directly or indirectly) by human emissions of greenhouse gases. There is a scientific consensus that climate change is occurring, and that human activities are the primary driver. Many impacts of climate change have already been observed, including glacier retreat, changes in the timing of seasonal events (e.g., earlier flowering of plants), and changes in agricultural productivity.

Future effects of climate change will vary depending on climate change policies and social development. The two main policies to address climate change are reducing human greenhouse gas emissions (climate change mitigation) and adapting to the impacts of climate change. Geo-engineering is another policy option.

Global warming is expected to have far-reaching, long-lasting and, in many cases, devastating consequences for planet Earth.

For some years, global warming, the gradual heating of Earth's surface, oceans and atmosphere, was a topic of heated debate in the scientific community. Today, the overwhelming consensus of researchers is that global warming is real and is caused by human activity, primarily the burning of fossil fuels that pump carbon dioxide (CO_2), methane and other greenhouse gases into the atmosphere.

A major report released Sept. 27, 2013, by the Intergovernmental Panel on Climate Change (IPCC) stated that scientists are more certain than ever of the link between human activities and global warming. More than 197 international scientific organizations agree that global warming is real and has been caused by human action.

Additionally, global warming is having a measurable effect on the planet right now, in a variety of ways. "We can observe this happening in real time in many places. Ice is melting in both polar ice caps and mountain glaciers. Lakes around the world, including Lake Superior, are warming rapidly – in some cases faster than the surrounding environment. Animals are changing migration patterns and plants are changing the dates of activity (e.g., leaf-flush in spring to fall in autumn is longer)," Josef Werne, an associate professor in the department of geology and planetary science at the University of Pittsburgh, told Live Science.

Here is an in-depth look at these changes and more:.

Increase in average temperatures and temperature extremes

One of the most immediate and obvious effects of global warming is the increase in temperatures around the world. The average global temperature has increased by about 1.4 degrees Fahrenheit (0.8 degrees Celsius) over the past 100 years, according to the National Oceanic and Atmospheric Administration (NOAA).

Since recordkeeping began in 1895, the hottest year on record for the 48 contiguous U.S. states was 2012. Worldwide, 2012 was also the 10th-warmest year on record, according to NOAA. And nine of the warmest years on record have occurred since 2000. According to NOAA, 2013 tied with 2003 as the fourth warmest year globally since 1880.

In 2014, some cities in the United States had the warmest summers on record, according to Scientific American. A report by the World Meteorological Organization released July 3, 2014, said that deaths from heat increased by more than 2,000 percent over the previous decade.

Extreme weather events

Extreme weather is an effect of global warming. While experiencing some of the hottest summers on record, much of the United States also has been experiencing colder than normal winters.

Changes in climate can cause the jet stream to migrate south, bringing with it cold, Arctic air. This is why some states can have a sudden cold snap or colder than normal winter, even during the long-term trend of global warming, Werne explained.

"Climate is by definition the long-term average of weather, over many years. One cold (or warm) year or season has little to do with overall climate. It is when those cold (or warm) years become more and more regular that we start to recognize it as a change in climate rather than simply an anomalous year of weather," he said.

Global warming may also lead to extreme weather other than cold or heat extremes. For example, hurricane formations will change. Though this is still a subject of active scientific research, current computer models of the atmosphere indicate that hurricanes are more likely to become less frequent on a global basis, though the hurricanes that do form may be more intense.

"And even if they become less frequent globally, hurricanes could still become more frequent in some particular areas," said atmospheric scientist Adam Sobel, author of "Storm Surge: Hurricane Sandy, Our Changing Climate, and Extreme Weather of the Past and Future" (Harper Wave, 2014). "Additionally, scientists are confident that hurricanes will become more intense due to climate change." This is because hurricanes get their energy from the temperature difference between the warm tropical ocean and the cold upper atmosphere. Global warming increases that temperature difference.

"Since the most damage by far comes from the most intense hurricanes — such as typhoon Haiyan in the Philippines in 2013 — this means that hurricanes could become overall more destructive," said Sobel, a Columbia University professor in the departments of Earth and Environmental Sciences, and Applied Physics and Applied Mathematics.

Lightening is another weather feature that is being affected by global warming. According to a 2014 study, a 50 percent increase in the number of lightning strikes within the United States is expected by 2100 if global temperatures continue to rise. The researchers of the study found a 12 percent increase in lightning activity for every 1.8 degree F (1 degree C) of warming in the atmosphere.

The U.S. Climate Extremes Index (CEI) was established in 1996 to track extreme weather events. The number of extreme weather events that are among the most unusual in the historical record, according to the CEI, has been rising over the last four decades.

Scientists project that extreme weather events, such as heat waves, droughts, blizzards and rainstorms will continue to occur more often and with greater intensity due to global warming, according to Climate Central. Climate models forecast that global warming will cause climate patterns worldwide to experience significant changes. These changes will likely include major shifts in wind patterns, annual precipitation and seasonal temperatures variations.

In addition, because high levels of greenhouse gases in the atmosphere are likely to remain high for many years, these changes are expected to last for several decades or longer,

according to the Environmental Protection Agency (EPA). In the north-eastern United States, for example, climate change is likely to bring increased annual rainfall, while in the Pacific Northwest, summer rainfall is expected to decrease.

IceBridge project scientist Michael Studinger calls this photo a textbook example of a receding glacier, one that's shrinking in size. The dark, arc-shaped piles are terminal and lateral moraines, jumbled rock piles left behind as the glacier recedes. A small, frozen lake sits at the left-hand terminus of the glacier. Taken in Thomsen Land, northeast Greenland. Credit: NASA/Michael Studinger.

Ice melt

Since 1970, the area of snow cover in the United States has steadily decreased, according to the EPA, and the average temperature of permafrost (soil that's at or below freezing temperature) has grown warmer.

One of the most dramatic effects of global warming is the reduction in Arctic sea ice: In 2012, scientists saw the smallest amount of Arctic ice cover ever recorded. Most analyses project that, within a matter of years, the Arctic Sea will be completely ice-free during the summer months.

Glacial retreat, too, is an obvious effect of global warming. Only 25 glaciers bigger than 25 acres are now found in Montana's Glacier National Park, where about 150 glaciers were once found, according to the U.S. Geological Survey. A similar trend is seen in glacial areas worldwide.

Sea levels and ocean acidification

As ice melts, the ocean levels rise. In 2014, the World Meteorological Organization reported that sea level rise accelerated .12 inches (3 millimeters) per year on average worldwide. This is around double the average annual rise of .07 in (1.6 mm) in the 20th century.

Melting polar ice in the Arctic and Antarctic region, coupled with melting ice sheets and glaciers across Greenland, North America, South America, Europe and Asia, are expected to raise sea levels significantly. And humans are mostly to blame: In the IPCC report released on Sept. 27, 2013, climate scientists said they are at least 95 percent certain that humans are to blame for warming oceans, rapidly melting ice and rising sea levels, changes that have been observed since the 1950s.

Global sea levels have risen about 8 inches since 1870, according to the EPA, and the rate of increase is expected to accelerate in the coming years. If current trends continue, many coastal areas, where roughly half of the Earth's human population lives, will be inundated.

Researchers project that by 2100, average sea levels will be 2.3 feet (.7 meters) higher in New York City, 2.9 feet (.88 m) higher at Hampton Roads, Va., and 3.5 feet (1.06 m) higher at Galveston, Texas, the EPA reports. According to an IPCC report, if greenhouse gas emissions remain unchecked, sea levels could rise by as much as 3 feet (0.9 meters) by 2100. That estimate is an increase from the estimated 0.9 to 2.7 feet (0.3 to 0.8 meters) that was predicted in the 2007 IPCC report for future sea level rise.

Sea level isn't the only thing changing for the oceans due to global warming. As levels of CO_2 increase, the oceans absorb some of that gas, which increases the acidity of seawater. Werne explains it this way: "When you dissolved CO_2 in water, you get carbonic acid. This is the same exact thing that happens in cans of soda. When you pop the top on a can of Dr Pepper, the pH is 2 — quite acidic."

Since the Industrial Revolution began in the early 1700s, the acidity of the oceans has increased about 25 percent, according to the EPA. "This is a problem in the oceans in large part because many marine organisms make shells out of calcium carbonate (think corals, oysters), and their shells dissolve in acid solution," said Werne. "So as we add more and more CO_2 to the ocean, it gets more and more acidic, dissolving more and more shells of sea creatures. It goes without saying that this is not good for their health."

If current ocean acidification trends continue, coral reefs are expected to become increasingly rare in areas where they are now common, including most U.S. waters, the EPA reports.

Plants and animals

The effects of global warming on the Earth's ecosystems are expected to be profound and widespread. Many species of plants and animals are already moving their range northward or

to higher altitudes as a result of warming temperatures, according to a report from the National Academy of Sciences.

"They are not just moving north, they are moving from the equator toward the poles. They are quite simply following the range of comfortable temperatures, which is migrating to the poles as the global average temperature warms," Werne said. Ultimately, he said, this becomes a problem when the rate of climate change velocity (how fast a region changes put into a spatial term) is faster than the rate that many organisms can migrate. Because of this, many animals may not be able to compete in the new climate regime and may go extinct.

Additionally, migratory birds and insects are now arriving in their summer feeding and nesting grounds several days or weeks earlier than they did in the 20th century, according to the EPA.

Warmer temperatures will also expand the range of many disease-causing pathogens that were once confined to tropical and subtropical areas, killing off plant and animal species that formerly were protected from disease.

These and other effects of global warming, if left unchecked, will likely contribute to the disappearance of up to one-half of Earth's plants and one-third of animals from their current range by 2080, according to a 2013 report in the journal Nature Climate Change.

Social effects

As dramatic as the effects of climate change are expected to be on the natural world, the projected changes to human society may be even more devastating.

Agricultural systems will likely be dealt a crippling blow. Though growing seasons in some areas will expand, the combined impacts of drought, severe weather, lack of snowmelt, greater number and diversity of pests, lower groundwater tables and a loss of arable land could cause severe crop failures and livestock shortages worldwide.

North Carolina State University also notes that carbon dioxide is affecting plant growth. Though CO_2 can increase the growth of plants, the plants may become less nutritious.

In addition to less nutritious food, the effect of global warming on human health is also expected to be serious. The American Medical Association has reported an increase in mosquito-borne diseases like malaria and dengue fever, as well as a rise in cases of chronic conditions like asthma, are already occurring, most likely as a direct result of global warming.

This loss of food security may, in turn, create havoc in international food markets and could spark famines, food riots, political instability and civil unrest worldwide, according to a

number of analyses from sources as diverse as the U.S Department of Defence, the Center for American Progress and the Woodrow Wilson International Center for Scholars.

Many of these expected effects are the result of exhaustive scientific research and climate models, and the fact that most of them are already being observed gives additional credibility to the projected effects of global warming and climate change.

SOLID WASTE MANAGEMENT

Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorised according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic paper etc); or according to hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc).

Management of solid waste reduces or eliminates adverse impacts on the environment and human health and supports economic development and improved quality of life. A number of processes are involved in effectively managing waste for a municipality. These include monitoring, collection, transport, processing, recycling and disposal.

Basically solid waste can be classified into different types depending on their source:

Source	*Typical waste generators*	*Types of solid wastes*
Residential	Single and multifamily dwellings.	Food wastes, paper, cardboard, plastics, textiles, leather, yard wastes, wood, glass, metals, ashes, special wastes (*e.g.*, bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous wastes.).
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants.	Housekeeping wastes, packaging, food wastes, construction and demolition materials, hazardous wastes, ashes, special wastes.
Commercial	Stores, hotels, restaurants, markets, office buildings, etc.	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes.
Institutional	Schools, hospitals, prisons, government centers.	Same as commercial.
Construction and demolition	New construction sites, road repair, renovation sites, demolition of buildings.	Wood, steel, concrete, dirt, etc.
Municipal services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants.	Street sweepings; landscape and tree trimmings; general wastes from parks, beaches, and other recreational areas; sludge.
Process (manufacturing, etc.)	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing.	Industrial process wastes, scrap materials, off-specification products, slay, tailings.
Agriculture	Crops, orchards, vineyards, dairies, feedlots, farms.	Spoiled food wastes, agricultural wastes, hazardous wastes (*e.g.*, pesticides).

Treatment & Disposal

Waste treatment techniques seek to transform the waste into a form that is more manageable, reduce the volume or reduce the toxicity of the waste thus making the waste easier to dispose of. Treatment methods are selected based on the composition, quantity, and form of the waste material. Some waste treatment methods being used today include subjecting the waste to extremely high temperatures, dumping on land or land filling and use of biological processes to treat the waste.

Thermal treatment

This refers to processes that involve the use of heat to treat waste. Listed below are descriptions of some commonly utilized thermal treatment processes.

1. **Incineration**

Incineration is the most common thermal treatment process. This is the combustion of waste in the presence of oxygen. After incineration, the wastes are converted to carbon dioxide, water vapour and ash. This method may be used as a means of recovering energy to be used

in heating or the supply of electricity. In addition to supplying energy incineration technologies have the advantage of reducing the volume of the waste, rendering it harmless, reducing transportation costs and reducing the production of the green house gas methane

2. Pyrolysis and Gasification

Pyrolysis and gasification are similar processes. They both decompose organic waste by exposing it to high temperatures and low amounts of oxygen. Gasification uses a low oxygen environment while pyrolysis allows no oxygen. These techniques use heat and an oxygen starved environment to convert biomass into other forms. A mixture of combustible and non-combustible gases as well as pyroligenous liquid is produced by these processes. All of these products have a high heat value and can be utilised. Gasification is advantageous since it allows for the incineration of waste with energy recovery and without the air pollution that is characteristic of other incineration methods.

3. Open burning

Open burning is the burning of unwanted materials in a manner that causes smoke and other emissions to be released directly into the air without passing through a chimney or stack. This includes the burning of outdoor piles, burning in a burn barrel and the use of incinerators which have no pollution control devices and as such release the gaseous by products directly into the atmosphere (Department of environmental quality 2006). Open- burning has been practiced by a number of urban centres because it reduces the volume of refuse received at the dump and therefore extends the life of their dumpsite. Garbage may be burnt because of the ease and convenience of the method or because of the cheapness of the method. In countries where house holders are required to pay for garbage disposal, burning of waste in the backyard allows the householder to avoid paying the costs associated with collecting, hauling and dumping the waste.

Open burning has many negative effects on both human health and the environment. This uncontrolled burning of garbage releases many pollutants into the atmosphere. These include dioxins, particulate matter, polycyclic aromatic compounds, volatile organic compounds, carbon monoxide, hexa chlorobenzene and ash. All of these chemicals pose serious risks to human health. The Dioxins are capable of producing a multitude of health problems; they can have adverse effects on reproduction, development, disrupt the hormonal systems or even cause cancer. The polycyclic aromatic compounds and the hexa chlorobenzene are considered to be carcinogenic. The particulate matter can be harmful to persons with respiratory problems such as asthma or bronchitis and carbon monoxide can cause neurological symptoms.

The harmful effects of open burning are also felt by the environment. This process releases acidic gases such as the halo-hydrides; it also may release the oxides of nitrogen and carbon. Nitrogen oxides contribute to acid rain, ozone depletion, smog and global warming. In

addition to being a green house gas carbon monoxide reacts with sunlight to produce ozone which can be harmful. The particulate matter creates smoke and haze which contribute to air pollution.

4. **Dumps and Landfills**

(a) Sanitary landfills

Sanitary Landfills are designed to greatly reduce or eliminate the risks that waste disposal may pose to the public health and environmental quality. They are usually placed in areas where land features act as natural buffers between the landfill and the environment. For example the area may be comprised of clay soil which is fairly impermeable due to its tightly packed particles, or the area may be characterised by a low water table and an absence of surface water bodies thus preventing the threat of water contamination.

In addition to the strategic placement of the landfill other protective measures are incorporated into its design. The bottom and sides of landfills are lined with layers of clay or plastic to keep the liquid waste, known as leachate, from escaping into the soil. The leachate is collected and pumped to the surface for treatment. Boreholes or monitoring wells are dug in the vicinity of the landfill to monitor groundwater quality.

A landfill is divided into a series of individual cells and only a few cells of the site are filled with trash at any one time. This minimizes exposure to wind and rain. The daily waste is spread and compacted to reduce the volume, a cover is then applied to reduce odours and keep out pests. When the landfill has reached its capacity it is capped with an impermeable seal which is typically composed of clay soil.

Some sanitary landfills are used to recover energy. The natural anaerobic decomposition of the waste in the landfill produces landfill gases which include Carbon Dioxide, methane and traces of other gases. Methane can be used as an energy source to produce heat or electricity. Thus some landfills are fitted with landfill gas collection (LFG) systems to capitalise on the methane being produced. The process of generating gas is very slow, for the energy recovery system to be successful there needs to be large volumes of wastes.

These landfills present the least environmental and health risk and the records kept can be a good source of information for future use in waste management, however, the cost of establishing these sanitary landfills are high when compared to the other land disposal methods.

(b) Controlled dumps

Controlled dumps are disposal sites which comply with most of the requirements for a sanitary landfill but usually have one deficiency. They may have a planned capacity but no

cell planning, there may be partial leachate management, partial or no gas management, regular cover, compaction in some cases, basic record keeping and they are fenced or enclosed. These dumps have a reduced risk of environmental contamination, the initial costs are low and the operational costs are moderate. While there is controlled access and use, they are still accessible by scavengers and so there is some recovery of materials through this practice.

(c) Bioreactor Landfills

Recent technological advances have lead to the introduction of the Bioreactor Landfill. The Bioreactor landfills use enhanced microbiological processes to accelerate the decomposition of waste. The main controlling factor is the constant addition of liquid to maintain optimum moisture for microbial digestion. This liquid is usually added by re-circulating the landfill leachate. In cases where leachate in not enough, water or other liquid waste such as sewage sludge can be used. The landfill may use either anaerobic or aerobic microbial digestion or it may be designed to combine the two. These enhanced microbial processes have the advantage of rapidly reducing the volume of the waste creating more space for additional waste, they also maximise the production and capture of methane for energy recovery systems and they reduce the costs associated with leachate management. For Bioreactor landfills to be successful the waste should be comprised predominantly of organic matter and should be produced in large volumes.

5. Biological waste treatment

(a) Composting:

Composting is the controlled aerobic decomposition of organic matter by the action of micro organisms and small invertebrates. There are a number of composting techniques being used today. *These include*: in vessel composting, windrow composting, vermin-composting and static pile composting. The process is controlled by making the environmental conditions optimum for the waste decomposers to thrive. The rate of compost formation is controlled by the composition and constituents of the materials i.e. their Carbon/Nitrogen (C/N) ratio, the temperature, the moisture content and the amount of air.

The C/N ratio is very important for the process to be efficient. The micro organisms require carbon as an energy source and nitrogen for the synthesis of some proteins. If the correct C/N ration is not achieved, then application of the compost with either a high or low C/N ratio can have adverse effects on both the soil and the plants. A high C/N ratio can be corrected by dehydrated mud and a low ratio corrected by adding cellulose.

Moisture content greatly influences the composting process. The microbes need the moisture to perform their metabolic functions. If the waste becomes too dry the composting is not

favoured. If however there is too much moisture then it is possible that it may displace the air in the compost heap depriving the organisms of oxygen and drowning them.

A high temperature is desirable for the elimination of pathogenic organisms. However, if temperatures are too high, above 75°C then the organisms necessary to complete the composting process are destroyed. Optimum temperatures for the process are in the range of 50-60 °C with the ideal being 60 °C.

Aeration is a very important and the quantity of air needs to be properly controlled when composting. If there is insufficient oxygen the aerobes will begin to die and will be replaced by anaerobes. The anaerobes are undesirable since they will slow the process, produce odours and also produce the highly flammable methane gas. Air can be incorporated by churning the compost.

(b) Anaerobic Digestion

Anaerobic digestion like composting uses biological processes to decompose organic waste. However, where composting can use a variety of microbes and must have air, anaerobic digestion uses bacteria and an oxygen free environment to decompose the waste. Aerobic respiration, typical of composting, results in the formation of Carbon dioxide and water. While the anaerobic respiration results in the formation of Carbon Dioxide and methane. In addition to generating the humus which is used as a soil enhancer, Anaerobic Digestion is also used as a method of producing biogas which can be used to generate electricity.

Optimal conditions for the process require nutrients such as nitrogen, phosphorous and potassium, it requires that the pH be maintained around 7 and the alkalinity be appropriate to buffer pH changes, temperature should also be controlled.

Integrated Solid Waste Management

Integrated Solid Waste Management (ISWM) takes an overall approach to creating sustainable systems that are economically affordable, socially acceptable and environmentally effective. An integrated solid waste management system involves the use of a range of different treatment methods, and key to the functioning of such a system is the collection and sorting of the waste. It is important to note that no one single treatment method can manage all the waste materials in an environmentally effective way. Thus all of the available treatment and disposal options must be evaluated equally and the best combination of the available options suited to the particular community chosen. Effective management schemes therefore need to operate in ways which best meet current social, economic, and environmental conditions of the municipality.

Integrated Solid Waste Management (ISWM) is a comprehensive waste prevention, recycling, composting, and disposal program. An effective ISWM system considers how to

prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. ISWM involves evaluating local needs and conditions, and then selecting and combining the most appropriate waste management activities for those conditions. ***The major ISWM activities are*** waste prevention, recycling and composting, and combustion and disposal in properly designed, constructed, and managed landfills. Each of these activities requires careful planning, financing, collection, and transport, all of which are discussed in this and the other fact sheets.

(i) **Waste prevention**—also called "source reduction"—seeks to prevent waste from being generated. Waste prevention strategies include using less packaging, designing products to last longer, and reusing products and materials. Waste prevention helps reduce handling, treatment, and disposal costs and ultimately reduces the generation of methane.

(ii) **Recycling and Composting**. Recycling is a process that involves collecting, reprocessing, and/or recovering certain waste materials (e.g., glass, metal, plastics, paper) to make new materials or products. Some recycled organic materials are rich in nutrients and can be used to improve soils. The conversion of waste materials into soil additives is called composting. Recycling and composting generate many environmental and economic benefits. For example, they create jobs and income, supply valuable raw materials to industry, produce soil-enhancing compost, and reduce greenhouse gas emissions and the number of landfills and combustion facilities.

(iii) **Disposal (land filling and combustion)**. These activities are used to manage waste that cannot be prevented or recycled. One way to dispose of waste is to place it in properly designed, constructed, and managed landfills, where it is safely contained. Another way to handle this waste is through combustion. Combustion is the controlled burning of waste, which helps reduce its volume. If the technology is available properly designed, constructed, and managed landfills can be used to generate energy by recovering methane. Similarly, combustion facilities produce steam and water as a by-product that can be used to generate energy.

Hazardous Waste Management

Hazardous waste is any unwanted material the disposal of which poses a threat to the environment, i.e. it is explosive, flammable, oxidising, poisonous/infectious, radioactive, corrosive and/or toxic/ecotoxic.

- Characteristic hazardous wastes are materials that are known or tested to exhibit one or more of the following four hazardous traits:
  - ignitability (i.e., flammable)
  - reactivity
  - corrosivity
  - toxicity

- Listed hazardous wastes are materials specifically listed by regulatory authorities as a hazardous waste which are from non-specific sources, specific sources, or discarded chemical products.

Hazardous-waste management, the collection, treatment, and disposal of waste material that, when improperly handled, can cause substantial harm to human health and safety or to the environment. Hazardous wastes can take the form of solids, liquids, sludges, or contained gases, and they are generated primarily by chemical production, manufacturing, and other industrial activities. They may cause damage during inadequate storage, transportation, treatment, or disposal operations. Improper hazardous-waste storage or disposal frequently contaminates surface and groundwater supplies. People living in homes built near old and abandoned waste disposal sites may be in a particularly vulnerable position. In an effort to remedy existing problems and to prevent future harm from hazardous wastes, governments closely regulate the practice of hazardous-waste management.

Final disposal of hazardous waste

Historically, some hazardous wastes were disposed of in regular landfills. This resulted in unfavourable amounts of hazardous materials seeping into the ground. These chemicals eventually entered natural hydrologic systems. Many landfills now require countermeasures against groundwater contamination, an example being installing a barrier along the foundation of the landfill to contain the hazardous substances that may remain in the disposed waste. Currently, hazardous wastes must often be stabilized and solidified in order to enter a landfill and many hazardous wastes undergo different treatments in order to stabilize and dispose of them.

Recycling

Many hazardous wastes can be recycled into new products. Examples might include lead-acid batteries or electronic circuit boards where the heavy metals these types of ashes go though the proper treatment, they could bind to other pollutants and convert them into easier-to- dispose solids, or they could be used as pavement filling. Such treatments reduce the level of threat of harmful chemicals, like fly and bottom ash, while also recycling the safe product.

Portland cement

Another commonly used treatment is cement based solidification and stabilization. Cement is used because it can treat a range of hazardous wastes by improving physical characteristics and decreasing the toxicity and transmission of contaminants. The cement produced is categorized into 5 different divisions, depending on its strength and components. This process of converting sludge into cement might include the addition of pH adjustment agents,

phosphates, or sulfur reagents to reduce the settling or curing time, increase the compressive strength, or reduce the leach ability of contaminants.

Neutralization

Some HW can be processed so that the hazardous component of the waste is eliminated: making it a non-hazardous waste. An example of this might include a corrosive acid that is neutralized with a basic substance so that it is no-longer corrosive. (see acid-base reactions.)Another mean to neutralize some of the waste is pH adjustment. pH is an important factor on the leaching activity of the hazardous waste. By adjusting the pH of some toxic materials, we are reducing the leaching ability of the waste.

Incineration, destruction and waste-to-energy

A HW may be "destroyed" for example by incinerating it at a high temperature. Flammable wastes can sometimes be burned as energy sources. For example many cement kilns burn HWs like used oils or solvents. Today incineration treatments not only reduce the amount of hazardous waste, but also they also generate energy throughout the gases released in the process. It is known that this particular waste treatment releases toxic gases produced by the combustion of by-product or other materials and this can affect the environment. However, current technology has developed more efficient incinerator units that control these emissions to a point that this treatment is considered a more beneficial option. There are different types of incinerators and they vary depending on the characteristics of the waste. Starved air incineration is another method used to treat hazardous wastes. Just like in common incineration, burning occurs, however controlling the amount of oxygen allowed proves to be significant to reduce the amount of harmful by-products produced. Starved Air Incineration is an improvement of the traditional incinerators in terms of air pollution. Using this technology it is possible to control the combustion rate of the waste and therefore reduce the air pollutants produce in the process.

Hazardous waste landfill (sequestering, isolation, etc.)

A HW may be sequestered in a HW landfill or permanent disposal facility. "In terms of hazardous waste, a landfill is defined as a disposal facility or part of a facility where hazardous waste is placed or on land and which is not a pile, a land treatment facility, a surface impoundment, an underground injection well, a salt dome formation, a salt bed formation, an underground mine, a cave, or a corrective action management unit.

Bio-Medical Waste Management

Introduction

Bio-Medical Waste is any waste generated during the diagnosis, treatment or immunization of human beings or in research activity. The waste produced in the course of health care activities carries a higher potential for infection and injury than any other type of waste. Bio-Medical waste generated in the hospital falls under two major Categories - Non Hazardous and Bio Hazardous. Constituents of Non Hazardous waste are Non-infected plastic, cardboard, packaging material, paper etc.

Bio hazardous waste again falls into **two types** (a) ***Infectious waste***- sharps, non sharps, plastics disposables, liquid waste, etc. (b) ***Non infectious waste***-radioactive waste, discarded glass, chemical waste, cytotoxic waste, incinerated waste etc. Approximately 75-90% of the Bio-Medical waste is non-hazardous and as harmless as any other municipal waste. The remaining 10-25% is hazardous and can be injurious to humans or animals and deleterious to environment. It is important to realise that if both these types are mixed together then the whole waste becomes harmful.

Major hospitals contribute substantially to the quantum of Bio-Medical waste generated. Smaller hospitals, nursing homes, clinics, pathological laboratories, blood banks, etc also contribute a major chunk.

Biomedical waste, (BMW), consists of solids, liquids, sharps, and laboratory waste that are potentially infectious or dangerous and are considered biowaste . It must be properly managed to protect the general public, specifically healthcare and sanitation workers who are regularly exposed to biomedical waste as an occupational hazard.

Biomedical waste differs from other types of hazardous waste, such as industrial waste, in that it comes from biological sources or is used in the diagnosis, prevention, or treatment of diseases. Common producers of biomedical waste include hospitals, health clinics , nursing homes , medical research laboratories , offices of physicians , dentists , and veterinarians , home health care , and funeral homes .

Biomedical Waste Management

Sorting of medical wastes in hospital. At the site where it is generated, biomedical waste is placed in specially-labelled bags and containers for removal by biomedical waste transporters. Other forms of waste should not be mixed with biomedical waste as different rules apply to the treatment of different types of waste.

Household biomedical waste usually consists of needles and syringes from drugs administered at home (such as insulin), soiled wound dressings, disposable gloves, and bed sheets or other cloths that have come into contact with bodily fluids. Disposing of these materials with regular household garbage puts waste collectors at risk for injury and infection especially from sharps as they can easily puncture a standard household garbage bag. Many communities have programs in place for the disposal of household biomedical waste. Some waste treatment facilities also have mail-in disposal programs.

Biomedical waste treatment facilities are licensed by the local governing body which maintains laws regarding the operation of these facilities. The laws ensure that the general public is protected from contamination of air, soil, groundwater, or municipal water supply.

A company that helps out by putting all of the laws and information in one location is B&D Biomedical Waste Services , they have all websites and links to all laws in Florida for the safe and proper disposal of biomedical waste. Another company, Bio-Medical Technology Solutions, Inc. , offers a green alternative to haul-away services for disposal of biomedical waste. The Company's desktop unit, the Demolizer® II , is the only patented, portable, and self-contained system able to process both sharps and typical red bag biomedical waste onsite. Upon processing the biomedical waste in the unit, all regulatory paperwork is printed from the system and the waste is able to be disposed of as common trash.

Protection from Biomedical Waste

Wash your hands with soap and warm water after handling biomedical waste. Also, wash all areas of your body with soap and water that you think may have come into contact with biomedical waste, even if you are not sure your body actually touched the biomedical waste.

- Keep all sores and cuts covered.
- Immediately replace wet bandages with clean, dry bandages.
- Wear disposable latex gloves when handling biomedical waste. Discard the gloves immediately after use.
- Wear an apron or another type of cover to protect your clothes from contact with the waste. If your clothes become soiled, put on fresh clothes, and take a shower, if possible.
- Launder or throw away clothes soiled with biomedical waste.
- Promptly clean and disinfect soiled, hard-surfaced floors by using a germicidal or bleach solution and mopping up with paper towels.
- Clean soiled carpets. First blot up as much of the spill as possible with paper towels and put the soiled paper towels in a plastic lined, leak-proof container. Then try one of the following:
    - Steam clean the carpet with an extraction method.
    - Scrub the carpet with germicidal rug shampoo and a brush. Soak the brush used for scrubbing in a disinfectant solution and rinse the brush. Let the carpet dry, and then vacuum it.

- Never handle syringes, needles, or lancets with your hands. Use a towel, shovel, and/or broom and a dustpan to pick up these sharp objects. Dispose of them in a plastic soda pop bottle with a cap. Tape down the bottle cap. Then throw the bottle in the trash.

As per ***Bio-Medical Waste (Management and Handling) Rules, 1998*** and amendments, any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining there to or in the production of testing of biological and including categories mentioned in schedule 1 of the Rule, is the bio-medical waste.

As per WHO norms the health-care waste includes all the waste generated by healthcare establishments, research facilities, and laboratories. In addition, it includes the waste originating from minor or scattered sources such as that produced in the course of health care undertaken in the home (dialysis, insulin injections, etc.).

Risks to Personnel Due to Bio-Medical Waste

Poor bio-medical waste management exposes hospital and other health care facility workers, waste handlers and community to infection, toxic effects and injuries. Doctors, nurses, paramedical staff, sanitary staff, hospital maintenance personnel, patients receiving treatment, visitors to the hospital, support service personnel, workers in waste disposal facilities, scavengers, general public and more specifically the children playing with the items they can find in the waste outside the hospital when it is directly accessible to them are potentially at risk of being injured or infected when they are exposed to bio- medical waste.

Risk to all those who generate, collect, segregate, handle, package, store, transport, treat and dispose waste (an occupational hazard). Occupational exposure to blood can result from percutaneous injury (needle stick or other sharps injury), mucocutaneous injury (splash of blood or other body fluids into the eyes, nose or mouth) or blood contact with non-intact skin. Over 20 blood born diseases can be transmitted but particular concern is the threat of spread of infectious and communicable diseases like AIDS, Hepatitis B & C, Cholera, Tuberculosis, Diphtheria etc. Waste chemicals radioactive waste and heavy metals also finds its way in waste stream which are also hazardous to health.

Dangers of improper Management of Bio-Medical Waste:

There is public health hazard due to poor management of bio-medical waste which can cause a number of diseases. Serious situations are very likely to happen when biomedical waste is dumped on uncontrolled sites where it can be easily accessed by public. Children and rag pickers are particularly at risk to come in contact with infectious waste. Inappropriate treatment and disposal contributes to environmental pollution (uncontrolled incineration causes air pollution, dumping in drains, tanks and along the river bed causes water pollution and unscientific land filling causes soil pollution).

In many parts of the country bio-medical waste is neither segregated nor disinfected. It is being indiscriminately dumped into municipal bins, along the roadsides, into water bodies or is being burnt in the open air. All this is leading to rapid proliferation and spreading of infectious, dangerous and fatal communicable diseases. The improper handling and mismanagement of bio-medical waste is posing serious problems, few of the problems due to improper disposal are as follows:

- The infectious waste which is only 20% – 25% of the entire waste from hospitals is not segregated and is mixed with general waste by doing so the whole of waste may turn up to infectious waste. If the same is dumped into the municipal bin then there are fair chances of the waste in municipal bin to become infectious.
- The disposal of sharps will lead to needle stick injuries, cuts, and infections among hospital staff, municipal workers, rag pickers and the general public. This will lead to transmission of diseases like Hepatitis B, C, E and HIV etc.
- The needles and syringes which are not mutilated or destroyed are being circulated back through traders who employ the poor and the destitute to collect such waste for repackaging and selling in the market.
- One of the reasons for spreading of infection is reuse of disposable items like syringes, needles, catheters, IV and dialysis sets etc

UNIT -3

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

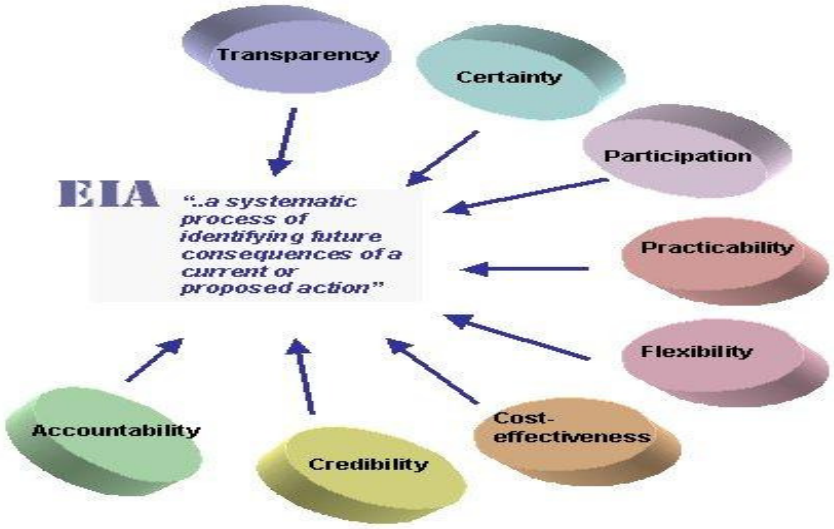
It is a process of evaluating the likely **environmental impacts** of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health **impacts**, both beneficial and adverse.

Formal impact assessments may be governed by rules of administrative procedure regarding public participation and documentation of decision making, and may be subject to judicial review. An impact assessment may propose measures to adjust impacts to acceptable levels or to investigate new technological solutions.

The **purpose** of the assessment is to ensure that decision makers consider the environmental impacts when deciding whether or not to proceed with a project. The International Association for Impact Assessment (IAIA) defines an environmental impact assessment as "the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made." EIAs are unique in that they do not require adherence to a predetermined environmental outcome, but rather they require decision makers to account for environmental values in their decisions and to justify those decisions in light of detailed environmental studies and public comments on the potential environmental impacts.

The Environmental Impact Assessment (EIA) should be prepared on the basis of the existing background pollution levels vis-a-vis contributions of pollutants from the proposed plant. The EIA should address some of the basic factors listed below:

- Meteorology and air quality
  Ambient levels of pollutants such as Sulphur Dioxide, oxides of nitrogen, carbon monoxide, suspended particulate matters, should be determined at the center and at 3 other locations on a radius of 10 km with 120 degrees angle between stations. Additional contribution of pollutants at the locations are required to be predicted after taking into account the emission rates of the pollutants from the stacks of the proposed plant, under different meteorological conditions prevailing in the area.
- Hydrology and water quality
- Site and its surroundings
- Occupational safety and health
- Details of the treatment and disposal of effluents(liquid, air and solid) and the methods of alternative uses
- Transportation of raw material and details of material handling
- Control equipment and measures proposed to be adopted



Objectives of EIA

- ensuring environmental factors are considered in the decision-making process
- ensuring that possible adverse environmental impacts are identified and avoided or minimised
- informing the public about the proposal

EIA- its impact

EIA aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to decision-makers. By using EIA both environmental and economic benefits can be achieved, such as reduced cost and time of project implementation and design, avoided treatment/clean-up costs and impacts of laws and regulations.

Advantages of EIA:

- facilitates the design of a monitoring programme
- allows people to examine the underlying need for a project
- gives people the opportunity to identify problems
- helps a developer to design a more publicly acceptable project
- exploration of alternatives can help identify cost-saving and other beneficial changes

According to a United Nations Environment Program Training Resource Manual the main advantages and benefits of EIA are:

- improved project design;
- more informed decision-making;
- more environmentally sensitive decisions;

- increased accountability and transparency during the development process;
- improved integration of projects into their environmental and social setting;
- reduced environmental damage;
- more effective projects in terms of meeting their financial and/or socio-economic objectives; and
- a positive contribution toward achieving sustainability.

THE EIA PROCESS

- The EIA process comprises:
- screening - to decide if and at what level EIA should be applied
- scoping - to identify the important issues and prepare terms of reference
- impact analysis - to predict the effects of a proposal and evaluate their significance
- mitigation - to establish measures to prevent, reduce or compensate for impacts
- reporting – to prepare the information necessary for decision making
- review – to check the quality of the EIA report
- decision-making – to approve or reject) the proposal and set conditions
- follow up – to monitor, manage and audit impacts of project implementation
- public involvement – to inform and consult with stakeholders

THE EIA PROCESS IN INDIA:

The role for EIA was formally recognized at the earth summit held at Rio conference in 1992. Principle 17 of the Rio declaration states that – "EIA as a national instrument shall be undertaken for the proposed activities that are likely to have significant adverse impact on the environment and are subject to a decision of a competent national authority".

In India many of the developmental projects till as recently as the 1980s were implemented with very little or no environmental concerns. The environmental issues began receiving attention when a national committee on environmental planning and coordination was set up under the 4th five year plan (1969- 1978). Till 1980, the subjects of environment and forests were the concern of the Dept of Science and Technology and Ministry of Agriculture respectively. Later, the issues were formally attended by the Dept of Environment which was established in 1980. This was then upgraded to the Ministry of Environment & Forest in 1985. In 1980, clearance of large projects from the environmental angle became an administrative requirement to the extent that the planning commission and the central investment board sought proof of such clearance before according financial sanction.

Five year later, the Dept of Environment and Forests, Government of India, issued guidelines for Environmental Assessment of river valley projects. These guidelines require various studies such as impacts on forests and wild life in the submergence zone, water logging potential, upstream and downstream aquatic ecosystems and fisheries, water related diseases, climatic changes and sesmicity. A major legislative measures for the purpose of environmental clearance was in 1994 when specific notification was issued under section 3 and rule 5 of the environment protection Act , 1986 called the "Environment impact Assessment Notification 1994". The first step in seeking environmental clearance for a development project is to determine what statutory legislations apply to the particular project.

The MOEF has brought out several notifications restricting the development of industries in specified ecologically sensitive areas. In addition there are also draft rules framed for the siting of industries. Environmental clearance for development projects can be obtained either at the state level or at the central level depending on certain criteria concerning the characteristics of the project. However (regardless of where the final environmental clearance is obtained from), for most projects the consent must first be taken from the state pollution control board or pollution control committees in the case of union territories.

NOTIFICATION BY MoEF

ENVIRONMENT IMPACT ASSESSMENT NOTIFICATION S.O.60(E), dated 27/01/1994

1) S.O. 60 (E)- Whereas a notification under clause (a) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986 inviting objections from the public within sixty days from the date of publication of the said notification, against the intention of the Central Government to impose restrictions and prohibitions on the expansion and modernization of any activity or new projects being undertaken in any part of India unless environmental clearance has been accorded by the Central Government or the State Government in accordance with the procedure specified in that notification was published as SO No. 80(E) dated 28th January, 1993;

And whereas all objections received have been duly considered; Now, therefore, in exercise of the powers conferred by sub-section (1) and clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986) read with clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby directs that on and from the date of publication of this notification in the Official Gazette, expansion or modernization of any activity (if pollution load is to exceed the existing one, or new project listed in Schedule I to this notification, shall not be undertaken in any part of India unless it has been accorded environmental clearance by the Central Government in accordance with the procedure hereinafter specified in this notification;

2) Requirements and procedure for seeking environmental clearance of projects: I.(a) Any person who desires to undertake any new project in any part of India or the expansion or modernization of any existing industry or project listed in the Schedule-I shall submit an application to the Secretary, Ministry of Environment and Forests, New Delhi. The application shall be made in the proforma specified in Schedule-II of this notification and shall be accompanied by a project report which shall, inter alia, include an Environmental Impact Assessment Report, Environment Management Plan and details of public hearing as specified in Schedule-IV prepared in accordance with the guidelines issued by the Central Government in the Ministry of Environment and Forests from time to time. However, Public Hearing is not required in respect of (i) small scale industrial undertakings located in (a) notified/designated industrial areas/industrial estates or (b) areas earmarked for industries under the jurisdiction of industrial development authorities; (ii) widening and strengthening of highways; (iii) mining projects (major minerals) with lease area up to twenty five hectares, (iv) units located in Export Processing Zones, Special Economic Zones and (v) modernisation of existing irrigation projects.

Provided that for pipeline projects, Environmental Impact Assessment report will not be required: Provided further, that for pipeline and high way projects, public hearing shall be conducted in each district through which the pipeline or highway passes through.

(b) Cases rejected due to submission of insufficient or inadequate data and Plan may be reviewed as and when submitted with complete data and Plan. Submission of incomplete data or plans for the second time would itself be a sufficient reason for the Impact assessment Agency to reject the case summarily.

II. In case of the following site specific projects: a. mining; b. pit-head thermal power stations; c. hydro-power, major irrigation projects and/or their combination including flood control; d. ports and harbours (excluding minor ports); e. prospecting and exploration of major minerals in areas above 500 hectares;

The project authorities will intimate the location of the project site to the Central Government in the Ministry of Environment and Forests while initiating any investigation and surveys. The Central Government in the Ministry of Environment and Forests will convey a decision regarding suitability or otherwise of the proposed site within a maximum period of thirty days. The said site clearance shall be granted for a sanctioned capacity and shall be valid for a period of five years for commencing the construction, operation or mining.

III. (a) The reports submitted with the application shall be evaluated and assessed by the Impact Assessment Agency, and if deemed necessary it may consult a committee of Experts, having a composition as specified in Schedule-III of this Notification. The Impact Assessment Agency (IAA) would be the Union Ministry of Environment and Forests. The Committee of Experts mentioned above shall be constituted by the Impact Assessment Agency or such other body under the Central Government authorised by the Impact Assessment Agency in this regard.

(b) The said Committee of Experts shall have full right of entry and inspection of the site or, as the case may be, factory premises at any time prior to, during or after the commencement of the operations relating to the project.

(c) The Impact Assessment Agency shall prepare a set of recommendations based on technical assessment of documents and data, furnished by the project authorities supplemented by data collected during visits to sites or factories, if undertaken and details of the public hearing.

The assessment shall be completed within a period of ninety days from receipt of the requisite documents and data from the project authorities and completion of public hearing and decision conveyed within thirty days thereafter.

The clearance granted shall be valid for a period of five years for commencement of the construction or operation of the project.

IV. In order to enable the Impact Assessment Agency to monitor effectively the implementation of the recommendations and conditions subject to which the environmental clearance has been given, the project authorities concerned shall submit a half yearly report to the Impact Assessment Agency. Subject to the public interest, the Impact Assessment Agency shall make compliance reports publicly available.

V. If no comments from the Impact Assessment Agency are received within the time limit, the project would be deemed to have been approved as proposed by project authorities.

3) Nothing contained in this Notification shall apply to: a. any item falling under entry Nos. 3, 18 and 20 of the Schedule-I to be located or proposed to be located in the areas covered by the Notifications S.O. No.102 (E) dated 1st February, 1989, S.O. 114 (E) dated 20th February, 1991; S.O. No. 416 (E) dated 20th June, 1991 and S.O. No.319 (E) dated 7th May, 1992. b. any item falling under entry no.1,2,3,4,5,7,9,10,13,14,16,17,19,21,25,27 of Schedule-I if the investment is less than Rs.100 crores for new projects and less than Rs. 50 crores for expansion / modernization projects. c. any item reserved for Small Scale Industrial Sector with investment less than Rs. 1 crore. d. defence related road construction projects in border areas. e. any item falling under entry no. 8 of Schedule-I, if that product is covered by the notification G.S.R. 1037(E) dated 5th December 1989. f. Modernization projects in irrigation sector if additional command area is less than 10,000 hectares or project cost is less than Rs. 100 crores.

4) Concealing factual data or submission of false, misleading data/reports, decisions or recommendations would lead to the project being rejected. Approval, if granted earlier on the basis of false data, would also be revoked. Misleading and wrong information will cover the following:

- False information
- False data
- Engineered reports
- Concealing of factual data
- False recommendations or decisions

ISO 9000:

The ***purpose*** of the ISO 9000 standard initially (1987 & 1994 revisions) was to provide a company with the minimum requirements for a quality system to be effective in providing customers with products of a consistent quality that met their requirements. Certification or Registration (the terms are used interchangeably) to ISO 9001, 9002 or 9003 provided customer organizations with confidence that a supplier had implemented an appropriate quality system, therefore providing a more reliable quality of product. If problems with the quality of products should arise, the customer complaint and corrective action system would ensure correction of the problem and prevention of recurrence.

The standards were updated in 1994 (ISO9000:1994) and again in December 2000 (ISO 9000:2000). All companies certified to one of the earlier ISO9000:1994 standards are required to re-certify under the latest ISO9000:2000 standard by December 2003 in order to maintain certification. This section is provided for reference only.

The old ISO 9000:1994 Series was a set of five individual, but related, international standards on quality management and quality assurance. They are generic in nature and not specific to any particular product or service. These standards were developed with the goal of effectively documenting the quality system elements to be implemented in order to maintain an efficient quality system in a company. However, the standards themselves do not specify the means to be used for implementing the quality system elements

ISO 9000 and ISO 14000:

ISO 9000 has become synonymous with quality. ISO 9000 translates "quality management" into a continuously improving process designed to meet or exceed customer and regulatory requirements.

ISO 14000 has become synonymous with quality environmental matters. ISO 14000 translates "environmental management" into a continuously improving process designed to minimize harmful environment effects while improving environmental performance. The original set of ISO 14000 standards were published in 1997.

The ***ISO 14000 series of environmental management*** standards are intended to assist organizations manage the environmental effect of their business practices. The ISO 14000 series is similar to the ISO 9000 series published in 1987. The purpose of the ISO 9000 series is to encourage organizations to institute quality assurance management programs. Although ISO 9000 deals with the overall management of an organization and ISO 14000 deals with the management of the environmental effects of an organization, both standards are concerned with processes, and there is talk of combining the two series into one.

Both series of standards were published by ISO, the International Organization for Standardization. The purpose of ISO is to facilitate international trade and cooperation in commercial, intellectual, scientific and economic endeavors by developing international standards. ISO originally focused on industrial and mechanical engineering standards. Now, it has ventured into setting standards for an organization's processes, policies, and practices.

Both series of standards stemmed from concerns about international trade. One of the issues of the 1986 GATT negotiations in Uruguay was the removal of non-tariff trade barriers. Standards fall into this category. The ISO 9000 standard was published about a year after the Uruguay GATT negotiations. The ISO 14000 standards are a response to both the GATT negotiations and to the growing global concern for the environment as evidenced by the 1992 Rio Conference on the environment.

Both the ISO 9000 and the ISO 14000 series have critics and proponents. The critics of the standards point out that quality management policies proposed by ISO 9000 do not necessarily result in quality products. Critics also project that the environmental management policies of ISO 14000 will not guarantee that an organization is not damaging the environment. Both series require third-party certification, and the certification business is booming, thanks in part to these two standards. Questions have risen regarding the fairness of the certification process. Both series are heavy in their documentation requirements and demand a significant amount of time and personnel.

The proponents of the series point to the economic benefits that can be gained by putting the standards into practice. These benefits include the opening of new markets and the development of streamlined procedures, which can lead to increased profits. There are also non-tangible benefits of ISO 14000 certification, such as improved employee morale, improved corporate image, and the feeling of "doing the right thing".

Because of the strong similarities between the two standards, it is almost impossible to discuss ISO 14000 without including a discussion of ISO 9000 and the ISO standards-setting process. In addition, the experiences that organizations have had with the ISO 9000 series

have raised questions that many people want resolved before they wholeheartedly embrace the ISO 14000 series.

A Review of ISO 9000

The ISO 9000 standards for quality assurance and quality management were published in 1987 by ISO Technical Committee 176. This series of standards had a dramatic impact due to their scope and rate of acceptance. This series of standards applies to all sizes and types of manufacturing and service companies and cover almost everything in a company's business functions with the main focus on processes, procedures and practices. As Hall states "The focus was to do things right in the first place rather than the retrospective, and more expensive, doctrine of inspection for faults after the event." (Hall, T. J. The Quality Systems Manual: the definitive guide to the ISO 9000 family and TickIt. John Wiley and Sons: Chicester, England.1995).

The history behind this series of standards can be traced to the USA during World War II. From the USA, the concept of quality assurance spread to Europe via NATO where it evolved into the Allied Quality Assurance Publication (AQAP). This series of documents discussed everything from production efficiency to selection of suppliers. The AQAP series were adopted by the UK Ministry of Defence for the British Armed Forces. This series had a trickle down effect as organizations began to require quality assurance programs from their suppliers. The problem was that there was much diversity in the requirements for different organizations.

The diversity issue was addressed by the British Standard BS 5750 which was based on the AQAP series and was introduced in 1979. The BS 5750 standard was considered so effective that it was adopted almost without change by ISO in 1987 as ISO 9000. The formation of the European Union and the perception that it was required in order to do business with Europe lead to the widespread acceptance of the ISO 9000 series.

The main documents in this series are:

- ISO 9000 - Guidelines for selection and use.
- ISO 9002 - Quality Systems Model for quality assurance in design, development, production and servicing.
- ISO 9003 - Quality Systems Model for quality assurance in final inspection and test.
- ISO 10011 - Guidelines for auditing quality systems.
- ISO 10012 - Quality assurance requirements for measuring equipment.
- ISO 10013 - Guidelines for developing quality manuals.

The main value of the 9000 series is that the analyses of processes required by the standard leads to improving or re-engineering of processes. The benefits to a company who follows the standard's practices are said to be new markets for their goods and services, increased cost-efficiency, improved employee morale and increased customer satisfaction.

ISO 14000 Overview

Many believe that environmental protection movements originated in the 1960s. However, the sentiments of environmentalism can be seen in the conservation efforts that began in the

late 1800s. The first environmental protection law in the United States was the Refuse Act of 1899. However, it was not until the 1960s that the environment became a political and consumer issue.

Increased environmental activism in the 1980s created a greater consumer awareness of the environmental issues. More and more environmental regulations were enacted and companies began to use their adherence to these regulations as marketing tools. The Rio Conference on the Environment in 1992 reflected increased global concerns about the environment and called for a world commitment to the protection of the environment. These concerns, coupled with the GATT negotiations in Uruguay in 1986 which called for the removal of non-tariff trade barriers, were the impetus behind ISO 14000.

ISO Technical Committee 207 is responsible for the ISO 14000 series of standards. Just as the ISO 9000 standards are based on the British BS 5750 standard of 1979, the ISO 14000 series are based on the British standard BS 7750 which was instituted in 1992. This standard also served as the basis for the European Union's Eco-Management and Audit Scheme (EMAS), a more stringent set of standards strongly influenced by the high environmental standards of German companies. EMAS differs from ISO 14000 in that it emphasizes public environmental reporting.

Many organizations had taken little interest in ISO 9000 when it was in development and were surprised by the overwhelming acceptance of ISO 9000. These organizations were wary of a new international standard in ISO 14000 and they took a more active interest in it's development. Subsequently the standards of BS 7750 were softened in order to be acceptable by countries outside of Europe. In particular, US companies who can be subjected to expensive civil suits, were very hesitant to endorse a stringent set of environmental management standards. The fear is that violation of these standards could result in litigation. Some organizations, for example, fear that the extensive documentation required by the ISO 14000 series could be used against them in an y legal action regarding violation of environmental regulations.

The actual environmental standards of ISO 14000 deal with how a company manages the environment inside it's facilities and the immediate outside environment. However, the standards also call for analysis of the entire life cycle of a product, from raw material to eventual disposal. These standards do not mandate a particular level of pollution or performance, but focus on awareness of the processes and procedures that can effect the environment. It should be noted that adherence to the ISO 14000 standards does not in anyway release a company from any national or local regulations regarding specific performance issues regarding the environment.

Some of the standards in the ISO 14000 series are:

- ISO 14001 - Specification of Environmental Management Systems
- ISO 14004 - Guideline Standard
- ISO 14010 through ISO 14015 - Environmental Auditing and Related Activities
- ISO 14020 through ISO 14024 - Environmental Labelling
- ISO 14031 through ISO 14032 - Environmental Performance Evaluation
- ISO 14040 through ISO 14043 - Life Cycle Assessment
- ISO 14050 - Terms and Definitions

Although the ISO 14000 standards are similar to the ISO 9000 standards, the nature of the environmental standards creates a need for people who are technical environment professionals in addition to those required to maintain the documentation necessary f or certification.

ENVIRONMENTAL LAWS OF INDIA

Conservation and protection of the environment have been an inseparable part of Indian heritage and culture. Realizing its importance, the Indian State has also enshrined it in the Constitution which requires both the state and the citizen to **"protect and improve the environment".**

a) The State's responsibility with regard to environmental protection has been laid down under Article 48-A of our Constitution, which reads as follows: "The State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country".

b) Environmental protection is a fundamental duty of every citizen of this country under Article 51-A(g) of our Constitution which reads as follows: "It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures."

c) Article 21 of the Constitution is a fundamental right which reads as follows: "No person shall be deprived of his life or personal liberty except according to procedure established by law."

d) Article 48-A of the Constitution comes under Directive Principles of State Policy and Article 51 A(g) of the Constitution comes under Fundamental Duties.

e) The State's responsibility with regard to raising the level of nutrition and the standard of living and to improve public health has been laid down under Article 47 of the Constitution which reads as follows: "The State shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties and, in particular, the State shall endeavour to bring about prohibition of the consumption except for medicinal purposes of intoxicating drinks and of drugs which are injurious to health."

h) The 42nd amendment to the Constitution was brought about in the year 1974 makes it the responsibility of the State Government to protect and improve the environment and to safeguard the forests and wildlife of the country. The latter, under Fundamental Duties, makes 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.

Indian Penal Code

The Indian Penal Code has a chapter on offences affecting Public Health, Safety, Convenience (Chapter XIV). Sec. 268 provides that "a person is guilty of a public nuisance who does any act or is guilty of an illegal omission which causes any common injury, danger or annoyance to the public or to the people in general who dwell or occupy property in the vicinity, or which must necessarily cause injury, obstruction, danger, or annoyance to persons who may have occasion to use any public right." The section further explains that a common nuisance is not excusable on the ground that it causes some convenience or advantage. Other concerned provisions are: a "negligent act likely to spread infection or disease dangerous to life" (Sec. 269 IPC.), a "malignant act likely to spread infection or disease dangerous to life" (Sec. 270 IPC.), "making atmosphere noxious to health" (Sec. 278 IPC.).

But the essential requirement of the provision to punish a man is the guilty intention of the accused, i.e. either the act of the accused should be negligent, malignant or voluntary, which vitiates the atmosphere. In case of public nuisance, the Penal Code provides for fines up to Rs. 200/- by way of punishment (Sec. 290 IPC.) and for making the atmosphere noxious to health Rs. 500/- only (Sec.78 IPC.).

The punishments are too meagre to meet the objectives. With these penal provisions, it is not possible to check environmental pollution.

ROLE OF JUDICIARY IN ENVIRONMENT PROTECTION

The Role Played by Indian Judiciary in Environmental Protection

It is noteworthy that India is one of the few countries of the world whose Constitution contains specific provision for environmental protection. Though at the time of its proclamation in 1950, the Indian Constitution included some provisions for improvement in the quality of life, environmental protection and improvement were explicitly incorporated into our Constitution by Forty-Second Amendment in 1976.

Article 48A was added to the article on directive principles of state policy. It declared:

"The State shall endeavor to protect and improve the environment and to safeguard the forests and wild life of the country". In a similar vein, Article 51A (g) "Fundamental Duties" makes it incumbent upon every citizen "to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for the living creatures".

It is interesting to note that in the recent past the judicial interpretation of Article 21 of our Constitution has expanded the scope of the 'right to life and personal liberty' to include the protection of the environment as a duty of the Indian State.

The Forty-Second Amendment has also expanded the list of concurrent subjects by incorporating 'Population Control and Family Planning' and bringing 'Forests' and 'Protection of Wild Animals and Birds' from the 'State List' to the 'Concurrent List'.

Though an organ of the Indian State, the Indian judiciary has shown far greater sensitivity and concern for environmental issues than, the other two organs, viz., the 'Executive' and the 'Legislature'. In this context, the recent spurt of 'judicial activism' assumes significance, particularly when the processes of globalization, liberalization and privatization have accentuated environmental degradation.

In a landmark decision in 1994, the Supreme Court observed:

"Article 21 protects (the) right to life as a fundamental right. Enjoyment of life and its attainment including (the) right to (live) with human dignity encompasses within its ambit, the protection and preservation of environment, ecological balance free from pollution of air and water, sanitation without which life cannot be enjoyed. Any contra acts or actions would cause environmental pollution. Environmental, ecological, air, water pollution, etc. should be regarded as amounting to violations of Article 21″.

Thus, the Supreme Court and the High Courts have been entertaining environmental petitions under Articles 32 and 226 of the Indian Constitution as constituting violation of Article 21. While entertaining environmental litigations by environmental NGOs and enlightened public figures like M.C. Mehta, these courts have passed landmark judgments, thereby forcing public bodies to take action on burning environmental issues.

Judicial activism in the field of environmental protection has been applauded by people like M.C. Mehta, Satyaranjan Sathe, Justice Kuldeep Singh and Justice Ashok Desai. However, it is important to note that judicial activism has serious limitations, and executive laxity and unconcern towards environment cannot be made good just by judicial activism. Judicial

activism cannot make good laxity in the enforcement of environmental laws. There can be no substitute for a check on the executive by a vigilant public and a people's movement to save the environment.

MANDATORY REQUIREMENTS – ENVIRONMENTAL LAWS

1. Wildlife Protection Act, 1972:

The **Wildlife Protection Act, 1972** is an Act of the Parliament of India enacted for protection of plants and animal species. 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 III and Schedule IV are also protected, but the penalties are much lower. Schedule V includes the animals which may be hunted. The plants in Schedule VI are prohibited from cultivation and planting. The hunting to the Enforcement authorities have the power to compound offences under this Schedule (i.e. they impose fines on the offenders).

The Government enacted Wildlife (Protection) Act 1972 with the objective of effectively protecting the wildlife of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The Act was amended in January 2003 and punishment and penalty for offences under the Act have been made more stringent. The Ministry has proposed further amendments in the law by introducing more rigid measures to strengthen the Act. The objective is to provide protection to the listed endangered flora and fauna and ecologically important protected areas.

2. Water (Prevention and Control of Pollution) Act, 1974

The Water (Prevention and Control of Pollution) Act was enacted in 1974 to provide for the prevention and control of water pollution, and for the maintaining or restoring of wholesomeness of water in the country. The Act was amended in 1988. The Water (Prevention and Control of Pollution) Cess Act was enacted in 1977, to provide for the levy and collection of a cess on water consumed by persons operating and carrying on certain types of industrial activities. This cess is collected with a view to augment the resources of the Central Board and the State Boards for the prevention and control of water pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974. The Act was last amended in 2003.

Salient features of the Water (Prevention and Control of Pollution) Act, 1974.

- Water (Prevention and Control of Pollution) Act, 1974 is an appropriate step for the management of water pollution; the maintenance or restoration of wholesomeness of water; the establishment, with a view to carrying out the purposes aforementioned, of Boards for the prevention and control of water pollution; conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.
- The Act deals with a particular type of pollution and presents an integrated approach to tackle the problem. It is an important legislative measure which has been enacted to implement the decision taken in the United Nation's Conference on Human Environment held in June 1972 at Stockholm.
- The Water (Prevention and Control of Pollution) Act, 1974 has 64 Sections and has been divided into eight chapters relating to i) Preliminary, ii) Central and State Boards for the Prevention and Control of Water Pollution, iii) Joint Boards, iv) Powers and Functions of Boards, v) Prevention and Control of Water Pollution, vi) Funds, Accounts and Audit, vii) Penalties and Procedures, and viii) Miscellaneous.
- The Act provides for the creation of the Central Pollution Control Board and State Pollution Control Boards. It authorises the establishment of the Joint Boards. The main function of the Central Board, under Section 16(1) of the Act, is to promote cleanliness of streams and wells in the States. Section 16(2) provides certain functions in the nature of advice, planning, co-ordination, publications, education and programmes for preventing, controlling and abating water pollution.
- The State Boards (under Section 17) of the Act are expected not only to plan comprehensive programmes for the prevention and control of water pollution in the State but also to inspect sewage or trade effluents, works and plants for their treatment, to lay down standards for such effluents, their treatment and for the quality of receiving waters, and to make orders for waste disposal and the like.
- Under the Water (Prevention and Control of Pollution) Act, 1974, power to give "directions" is conferred on-

  - The Central Government (which can give directions to the Central Boards),
  - The Central Board (which can give directions to the State Boards),
  - The State Government (which can give directions to State Boards).
  - In case of conflict between directions given by the Central Government, that matter shall be referred to the Central Government for decision. If the Central Board's directions are not complied with by the - State Board, the Central Board can order the former to perform the functions of the latter for a specified period.
- The Act provides that the State Government in consultation with the State Board is empowered to declare any area or areas within the jurisdiction of the concerned State as "Water Pollution Prevention and Control Area".

3. Environment (Protection) Act, 1986

Objectives of the Act:-

- To co-ordinate the activities of the various regulatory agencies already in existence.
- Creation of an authority or authorities with adequate powers for environmental protection.

- Regulation of discharge of environmental pollutants and handling of hazardous substance.
- Speedy response in the event of accidents threatening environmental and deterrents punishment to those who endanger human environment, safety and health

The purpose of the Act is to implement the decisions of the United Nations Conference on the Human Environments they relate to the protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants and property. The Act is an "umbrella" legislation designed to provide a framework for central government coordination of the activities of various central and state authorities established under previous laws, such as the Water Act and the Air Act.

As per this Act, the Central Government shall have the power to take all such measures for the purpose of protecting and improving the quality of the environment and to prevent environmental pollution. Further, the Central Government shall have the power to give directions in writing to any person or officer or any authority for any of the purposes of the Act, including the power to direct the closure, prohibition or regulation of any industry, operation or process.

No person carrying on an industry, operation or process shall discharge or emit any environmental pollutant in excess of standards prescribed by the Government. Further persons handling with hazardous substances shall comply with the procedural safeguards as may be prescribed by the authorities.

As per the Act where the discharge of any environmental pollutant in excess of prescribed standard occurs, or is apprehended to occur due to any accidental or other unforeseen act or event, the person responsible for such discharge shall be bound to prevent or mitigate the pollutant so caused as well as intimate the fact of such occurrence to the concerned authorities.

The Central Government or any other officer empowered by the Central Government shall have the powers to take the samples of air, water, soil or any other substances from any factory, premises, etc for the purpose of analysis. The said officer shall without delay send the container with the sample to the laboratory established or recognized by Central Government. The Central Government has established several environmental laboratories for the purposes of the Environment (Protection) Act.

For the purposes of protecting and improving the quality of the environment and preventing and abetting environmental pollution, the standards of emission or discharge of environmental pollutants from the industries, operations or processes are specified in Schedules 1 to 1V of the Environment (Protection) Rules.

The Central Government takes into consideration various factors while prohibiting or restricting the location of industries and carrying on of processes and operations in different areas. Every person carrying on an industry, operation or process requiring consent under the water (prevention and control of pollution) Act, 1974 or under The Air (Prevention and Control of Pollution) Act, 1981 or both or authorization under the Hazardous Waters (Management and Handling) Rules, 1989 shall submit an environmental statement for the

financial year ending on the 31st March in Form V to the concerned State Pollution Control Board on or before the Thirteenth day of September every year, beginning 1993.

4. **Air (Prevention & Control of Pollution) Act, 1981**

An act to provide for the prevention, control and abatement of air pollution, for the establishment, with a view to carry out the aforesaid purposes, of Boards, for conferring on and assigning to such Boards powers and functions relating thereto and for matters connected therewith.

The objective of this Act is 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. Decisions were taken at the United Nations Conference on the Human 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, includes the preservation of the quality of air and control of air pollution. Therefore it is considered necessary to implement the decisions foresaid in so far as they relate to the preservation of the quality of air and control of air pollution.

Delhi environmental laws:

India Program

In 1998, ELI (environmental laws India) launched its India Program to promote environmental law, policy, and management in India. The Institute works in conjunction with the government, NGOs, industry, and academic institutions to strengthen the legal, policy, and institutional infrastructure for sustainable development, environmental protection, and natural resource conservation in India. ELI has worked with its partners to build the capacity of the judiciary and enforcement agencies, to build the capacity of civil society to participate in environmental decision making, to build the capacity of industry to comply with environmental law, and to strengthen implementation of environmental law.

ELI's India Program team consists of Senior Attorney John Pendergrass and Visiting Scholar Usha Wright.

Factory Manager Compliance Training

Since 2003, ELI has worked with industry, state pollution control boards, NGOs, and academia to build the capacity of India's private sector to comply with environmental law. Supported by the GE Foundation and by USAID, and working with Environmental Management and Policy Research Institute (EMPRI) of Bangalore and the Federation of Indian Chambers of Commerce and Industry (FICCI), ELI developed two courses for managers of small and medium sized enterprises on how to comply with environmental law. FICCI and ELI delivered a pilot workshop to managers of electroplating facilities clustered in Mathura in northern India.

Contemporaneously, EMPRI and ELI delivered a pilot workshop in Bangalore for a diverse audience of managers of small and medium sized enterprises. In addition to segments on India's water, air, hazardous waste, and other substantive laws, the course covered why it is

beneficial to industry to comply with environmental law. Faculty included senior officials of the Karnataka State Pollution Control Board, Professor MK Ramesh, experts from NGOs and industry, and ELI Senior Attorney John Pendergrass. ELI and EMPRI prepared a Pocket Guide to Environmental Compliance, which provided information on the environmental rules applicable to industry. The Bangalore workshop included a site visit to a model facility to observe good environmental management in practice. A follow up session three months later demonstrated the value of the training as the majority of participants described specific improvements to environmental performance at their facilities.

In 2008, with additional support from several multinational corporations in India, ELI worked with academic institutions and state pollution control boards in Gujarat and Karnataka to expand the coverage of the course to include segments on occupational health and safety and product stewardship and to involve managers from staff of suppliers. The courses were hosted by Indus Institute of Technology and Engineering in Ahmedabad and the National Law School of India University (NLS) in Bangalore, with the respective state pollution control boards as additional sponsors and speakers. In Ahmedabad, the course was keynoted by India's retired Chief Justice PN Bhagwati, author of several seminal decisions by the Indian Supreme Court on environmental rights. ELI and its academic, industry, and state pollution control board partners repeated the course in Bangalore in November 2009 and in Ahmedabad and Bangalore in January 2011.

REFERENCES:

1. Sayre, Don., Inside ISO 14000- The Competitive Advantage of Environmental Management, St Lucie Press Delray Beach, Florida
2. Gupta N.C., (2006), Social Auditing of Environmental Law in India, edited book, New Century Publications.
3. Divan, Shyam and Rosen Ceranz, Armin, (2007), Environmental Law and Policy in India, Cases, materials and statutes, Oxford University Press.
4. Bowles, Ian A. and Glenn T. Prickett, (2001), Footprints in the Jungle: Natural Resource Industries, Infrastructure and Biodiversity Conservation, Oxford University Press.
5. www.oas.org/dsd/publications/Unit/oea37e/ch05.htm
6. www.slideshare.net/highchordz/ppt-on-environmental-management
7. www.epa.gov/ems
8. en.wikipedia.org/wiki/Ecosystem
9. simple.wikipedia.org/wiki/Pollution
10. www.ecokids.ca/PUB/eco_info/topics/biodiversity/index.cfm
11. indiabiodiversity.org
12. http://www.moef.nic.in/legis/air/air1.html
13. http://www.epa.gov/superfund/students/wastsite/srfcspil.htm