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ENVIRONMENTAL SCIENCE PART ONE

[NOISE , THERMAL ,AIR , WATER POLLUTION AND TYPES OF POLLUTANTS]

SYLLABUS

UNIT 1 -Multidisciplinary nature of environmental studies

Defination Scope and importance ;Need for public awareness

UNIT 2- Natural Resourses

UNIT 3 Ecosystems

UNIT 4 Biodiversity and its conservation

UNIT 5 Environmental Pollution Causes ,effects and control of -Air pollution,Water pollution , Soil Pollution, Marine Pollution,Noise Pollution,Thermal Pollution , Nuclear Hazards ,Solid waste management Disaster management ,Pollution control ,Pollution case studies

UNIT 6 Social Issues and Environmental Protection Act ;Environmental Ethics

UNIT 7 Human population and the Environment

UNIT 8 Field work

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ENVIRONMENTAL POLLUTION is normally taken to mean harm done to the natural environment by human activity. In fact, some environmental pollution can have natural sources, for example volcanic activity, which can cause major air pollution or water pollution and destroy flora and fauna. In terms of environmental issues, however, environmental pollution relates to human actions,especially in connection with energy resources. The demands of the industrialized nations for energy to power machines, provide light, heat, and so on are constantly increasing.The most versatile form of energy is electricity, which can be produced from a wide variety of other energy sources, such as the fossil fuels - coal, oil, and gas - and nuclear power produced from uranium.These are all non-renewable resources in addition,their extraction, transportation, utilization, and, and waste products, all give rise to pollutants of one form or another.The effects of these pollutants can have consequences not only for the local environment, but also at a global level.

Environmental issues

Matters relating to the detrimental effects of human activity on the biosphere, their causes, and the search for possible solutions Since the Industrial Revolution, the demands made by both the industrialized and developing nations on the Earth's natural resources are increasingly affecting the balance of the Earth's resources. Over a period of time, some of these resources are renewable - trees can be replanted,soil nutrients can be

replenished – but many resources, such as fossil fuels and minerals, are non-renewable and in danger of eventual exhaustion. In addition, humans are creating many other problems which may endanger not only their own survival, but also that of other species. For instance,deforestation and air pollution are not only damaging and radically altering many natural environments, they are also affecting the Earth's climate by adding to the

greenhouse effect and global warming, while water pollution is seriously affecting aquatic life,including fish populations, as well as human health.

WIDESPREAD EFFECTS OF POLLUTION

Many people think of air, water, and soil pollution as distinctly separate forms of pollution. However, each part of the global ecosystem - air,water, and soil - depends upon the others, and upon the plants and animals living within the environment.Thus, pollution that might appear to affect only one part of the environment is also likely to affect other parts.

For example, the emission of vehicle exhausts or acid gases from a power plant might appear to harm only the surrounding atmosphere. But once released into the air they are carried by the prevailing winds, often for several hundred kilometres, before being deposited as acid rain. This can produce an enormous range of adverse effects across a very large area, for example: increased acidity levels in lakes and rivers are harmful to fish stocks and other aquatic life;physical damage to trees and other vegetation results in widespread destruction of forest areas; increased acidity of soils reduces the range of crops that can be grown, as well as decreasing production levels; rocks such as limestone, both in the natural landscape and in buildings, are eroded - the effect of acid rain on some of the world's most important architectural structures is having disastrous consequences. In addition,acid rain in the form of aerosols or attached to smoke particles can cause respiratory problems in humans. Pollution of the Arctic atmosphere is creating Arctic haze- the result of aerosol emissions, such as dust, soot, and sulphate particles, originating in Europe.

ECOLOGY

Greek oikos `house´ Study of the relationship among organisms and the environments in which they live, including all living and nonliving components. The chief environmental factors governing the distribution of plants and animals are temperature, humidity, soil, light intensity, daylength, food supply, and interaction with other organisms. The term was coined by the biologist Ernst Haeckel in 1866. Ecology may be concerned with individual organisms (for example,behavioural ecology, feeding strategies), with populations (for example, population dynamics), or with entire communities (for example, competition between species for access to resources in an ecosystem, or predator-prey relationships).Applied ecology is concerned with the management and conservation of habitats and the consequences and control of

pollution.

HABITAT

Localized environment in which an organism lives, and which provides for all (oral most all) of its needs. The diversity of habitats found within the Earth's ecosystem is enormous, and they are changing all the time. Many can be considered inorganic or physical; for example, the Arctic ice cap, a cave, or a cliff face. Others are more

complex; for instance, a woodland or a forest floor. Some habitats are so precise that they are called microhabitats, such as the area under a stone where a particular type of insect lives. Most habitats provide a home for many species.Science of naming and identifying species, and determining their degree of relatedness. It

plays an important role in preserving biodiversity; only a small fraction of existing species have been named and described.

BALANCE OF NATURE

In ecology, the idea that there is an inherent equilibrium in most ecosystems, with plants and animals interacting so as to produce a stable,continuing system of life on Earth.The activities of human beings can,and frequently do, disrupt the balance of nature.Organisms in the ecosystem are adapted to each other - for example,waste products produced by one species are used by another and resources used by some are replenished by others; the oxygen needed by animals is produced by plants while the waste product of animal respiration, carbon dioxide, is used by plants as a raw material in photosynthesis. The nitrogen cycle,the water cycle, and the control of animal populations by natural predators are other examples.

The idea of a balance of nature is also expressed in the Gaia hypothesis, which likens the Earth to a living organism, constantly adjusting itself to circumstances so as to increase its chances of survival.

FOOD CHAIN

In ecology, a sequence showing the feeding relationships between organisms in a particular ecosystem.Each organism depends on the next lowest member of the chain for its food. A pyramid of numbers can be used to show the reduction in food energy at each step up the foodchain.Energy in the form of food is shown to

be transferred from autotrophs, or producers, which are principally plants and photosynthetic microorganisms, to a series of heterotrophs, or consumers. The heterotrophs comprise the herbivores, which feed on the producers;carnivores, which feed on the herbivores; and decomposers, which break down the dead bodies and waste products of all four groups (including their own), ready for recycling.In reality, however, organisms have varied diets, relying on different kinds of foods, so that the food chain is an oversimplification.

The more complex food web shows a greater variety of relationships, but again emphasizes that energy passes from plants to herbivores to carnivores. Environmentalists have used the concept of the food chain to show how poisons and other forms of pollution can pass from one animal to another, threatening rare species.For example, the pesticide DDT has been found in lethal concentrations in the bodies of animals at the top of the food chain, such as the golden eagle Aquila chrysaetos.

CONSERVATION

In the life sciences, action taken to protect and preserve the natural world, usually from pollution,overexploitation, and other harmful features of human activity. The late1980s saw a great increase in public concern for the environment, with membership of conservation groups,such as Friends of the Earth, Greenpeace, and the US Sierra Club,rising sharply. Globally the most important issues include the depletion of atmospheric ozone by the action of chlorofluorocarbons (CFCs), the build-up of carbon dioxide in the atmosphere (thought to contribute to an intensification of the greenhouse effect), and deforestation.Conservation groups in Britain originated in the 1860s; they include the Commons Preservation Society 1865, which fought successfully against the enclosure of Hampstead Heath (1865) and Epping Forest(1866) in London; the National Footpaths Preservation Society 1844 ; and the National Trust 1895. In the UK the conservation debate has centred on water quality, road-building schemes, the safety of nuclear power, and the ethical treatment of animals.

Twelve coastal sites in Great Britain,including five Special Areas of Conservation, have been designated by the European Commission to be part of a network of Natura 2000 sites. The EC will provide funds to help preserve these sites from development,overfishing, and pollution, and to monitor rare

plants.They include the North Northumber land Coast, with its sea caves, its breeding population of grey seals in the Farne Islands,and Arctic species such as the wolf fish; the Wash and North Norfolk Coast, with its population of common seals,waders, and wildfowl, and its extensive salt marshes; and Plymouth Sound and estuaries, with their submerged sandbanks.

A £10 million project, `Turning the Tide´ was launched 1997 by the Millennium Commission. It would fund coastal restoration of Britain's only magnesium limestone cliffs between Hartlepool and Sunderland.The area is rich in wild flowers, with grassland and denes (steep, wooded valleys). Intensive farming and the use of fertilisers damaged the flora and fauna of the area. The beaches are polluted as a result of over two centuries of coal mining along the Durham coast. Waste from the mines was dumped into the sea and onto the beaches, leaving heaps of spoil 12 to 15 ft high. The restoration project is aimed at removing spoil from the beaches and returning the cliffs to their natural grassland.

NATURE RESERVE

Area set aside to protect a habitat and the wildlife that lives within it,with only restricted admission for the public. A nature reserve often provides a sanctuary for rare species. The world's largest is Etosha Reserve, Namibia; area 99,520sq km/38,415 sq mi.

ENDANGERED SPECIES

Plant or animal species whose numbers are so few that it is at risk of becoming extinct. Officially designated endangered species are listed by the International Union for the Conservation of Nature (IUCN). Endangered species are not a new phenomenon; extinction is an integral part of evolution. The replacement of one species by another usually involves the eradication of the less successful form, and ensures the continuance and diversification of life in all forms. However, extinctions induced by humans are thought to be destructive, causing evolutionary dead-ends that do not allow for succession by a more fit species. The great majority of recent extinctions have been directly or indirectly induced by humans; most often by the loss, modification, or pollution of the organism's habitat, but also by hunting for `sport´ or for commercial purposes.

According to a 1995 report to Congress by the US Fish and Wildlife Service, althoughseven of the 893 species listed as endangered under the US Endangered

SpeciesAct 1968-93 have become extinct,40% are no longer declining in number. In February 1996, aprivate conservation group, Nature Conservancy, reported around 20,000 native US plantand animal species to be rare or imperilled.

According to the Red Data List of endangered species, published in 1996 by the IUCN,25% of all mammal species (including 46% of primates, 36% of insectivores, and 33% of pigs and antelopes), and 11% of all bird species are threatened with extinction.

An example of an endangered species is the Javan rhinoceros.There are only about 50 alive today and, unless active steps are taken to promote this species' survival, it will probably be extinct within a few decades.

Action by governments has been prompted and supplemented by private agencies, such as the World Wide Fund for Nature (formerly theWorld Wildlife Fund). In attempts to save particular species or habitats, a distinction is often made between preservation – that is, maintaining the pristine state of nature exactly as it was or might have been – and conservation, the management of natural resources in such a way as to integrate the requirements of the local human population with those of the animals, plants, or the habitat being conserved.

ECOTOURISM

Effects of tourism -The threat to conservationTourism is now the world's largest industry, generating over $2 billion every year. It isalso, potentially, one of the most damaging to the environment. Tourist developments often cause pollution, deplete scarce water resources, destroy natural habitats, and disturb wildlife.For example, marine turtles are currently threatened in some of their last European strongholds by beach developments; many national parks are now so heavily visited that people are threatening the very wildlife that the park is supposed to protect; sales of wildlife products to tourists is threatening some species with extinction; and producing host water in trekkers' accommodation in the Nepal Himalayas is causing serious timber shortages in places.

The cost to wildlife-The dusky seaside sparrow Ammodramus maritimus nigrescens,which lived in the Spartina bakerii-dominated salt marsh habitat on the east coast of Florida, became functionally extinct in the 1980s due mainly to habitat loss caused by tourist developments.Conservationists fear that African game parks are already suffering from overuse, and an industry representative is

quoted as complaining that, at one time, 23 vehicles were surrounding one cheetah.

A possible solution Now, a new form of ecotourism is being developed, which aims to avoid the worst excesses of uncontrolled tourist development, and to play a positive role in conservation.Ecotourism is usually smaller-scale,relatively higher priced, and tailored specifically forpeople who want their holiday to be more than simply a laze on the beach. Ecotourism trips are designed to minimize the impact on the environment and, conversely, to provide local communities with a positive economic incentive for protecting wild habitats. A study in Cameroon, for example, showed that a standing natural forest would generate far more in terms of tourist earnings than it would if it were cut down for timber. Studies on `land value´ and tourism in the Monteverde Cloud Forest in Costa Rica have indicated a value of $1,250 perhectare. Ecotourism is already amajor industry in countries such as Costa Rica and Kenya.

SOCIAL CONCERNS

Most ecotourism initiatives also try to address social concerns. A sudden influx of tourists into a previouslyremote community can be culturally devastating, and ecotourists are usually encouraged to minimize these impacts by learning and respecting local cultural and religious norms, and by approaching communities in as sensitive a way as possible. Some national tourism authorities now publish posters or leaflets advising visitors of what to do or not to do,such as one advising on religious and cultural practices in Thailand. Well-designed ecotourism should also not conflict with sustainable land use, such as the collection of non-timber forest products in tropical rainforests,or local fishing activities.Real help for conservation efforts. Some holidays go even further, when tourists pay to go and work on conservation projects around the world. The visitor gets a great holiday, with the added excitement of taking part in activities aimed at protecting the natural environment .Local people have the chance to meet tourists in ways that are educative.

Chapter 2

WATER POLLUTION is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). Water pollution occurs when pollutants are directly or indirectly discharged 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 of 580 people in India 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 bays 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.

Surface water and groundwater have often been studied and managed as separate resources, although they are interrelated. Surface water seeps through the soil and becomes groundwater. Conversely, groundwater can also feed surface water sources. Sources of surface water pollution are generally grouped into two categories based on their origin.

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Point source water pollution refers to contaminants that enter a waterway from a single, identifiable source, such as a pipe or ditch. Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain. The U.S. Clean Water Act (CWA) defines point source for regulatory enforcement purposes. The CWA definition of point source was amended in 1987 to include municipal storm sewer systems, as well as industrial stormwater, such as from construction sites.

NONPOINT SOURCES

Nonpoint source pollution refers to diffuse contamination that does not originate from a single discrete source. NPS pollution is often the cumulative effect of small amounts of contaminants gathered from a large area. A common example is the leaching out of nitrogen compounds from fertilized agricultural lands. Nutrient runoff in stormwater from "sheet flow" over an agricultural field or a forest are also cited as examples of NPS pollution.

Contaminated storm water washed off of parking lots, roads and highways, called urban runoff, is sometimes included under the category of NPS pollution. However, this runoff is typically channeled into storm drain systems and discharged through pipes to local surface waters, and is a point source.

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.[7] 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

The specific contaminants leading to pollution in water include a wide spectrum of chemicals, pathogens, and physical or sensory 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.

Oxygen-depleting substances may be natural materials, such as plant matter (e.g.

leaves and grass) as well as man-made chemicals. Other natural and anthropogenic substances may cause turbidity (cloudiness) which blocks light and disrupts plant growth, and clogs the gills of some fish species.

Many of the chemical substances are toxic. Pathogens can produce waterborne diseases in either human or animal hosts. Alteration of water's physical chemistry includes acidity (change in pH), electrical conductivity, temperature, and eutrophication. Eutrophication is an increase in the concentration of chemical nutrients in an ecosystem to an extent that increases in the primary productivity of the ecosystem. Depending on the degree of eutrophication, subsequent negative environmental effects such as anoxia (oxygen depletion) and severe reductions in water quality may occur, affecting fish and other animal populations.

PATHOGENS

Coliform bacteria are a commonly used bacterial indicator of water pollution, although not an actual cause of disease. Other microorganisms sometimes found in surface waters which have caused human health problems include:

· Burkholderia pseudomallei ,Cryptosporidium parvum ,Giardia lamblia ,Salmonella ,Novovirus and other viruses Parasitic worms (helminths).

High levels of pathogens may result from inadequately treated sewage discharges. This can be caused by a sewage plant designed with less than secondary treatment (more typical in less-developed countries). In developed countries, older cities with aging infrastructure may have leaky sewage collection systems (pipes, pumps, valves), which can cause sanitary sewer overflows. Some cities also have combined sewers, which may discharge untreated sewage during rain storms.

Muddy river polluted by sediment. Pathogen discharges may also be caused by poorly managed livestock operations.

CHEMICAL AND OTHER CONTAMINANTS

Contaminants may include organic and inorganic substances.

Organic water pollutants include:

· Detergents ,Disinfection by-products found in chemically disinfected drinking water, such as chloroform

· Food processing waste, which can include oxygen-demanding substances, fats and grease. Insecticides and herbicides, a huge range of organohalides and other chemical compounds

· Petroleum hydrocarbons, including fuels (gasoline, diesel fuel, jet fuels, and fuel oil) and lubricants (motor oil), and fuel combustion byproducts, from stormwater runoff.· Tree and bush debris from logging operations

· Volatile organic compounds (VOCs), such as industrial solvents, from improper storage.·Chlorinated solvents, which are dense non-aqueous phase liquids (DNAPLs), may fall to the bottom of reservoirs, since they don't mix well with water and are denser. ·Example Polychlorinated biphenyl (PCBs) ,Trichloroethylene

· Perchlorate ·Various chemical compounds found in personal hygiene and cosmetic products.

INORGANIC WATER POLLUTANTS INCLUDE:

- Acidity caused by industrial discharges (especially sulfur dioxide from power plants) ·Ammonia from food processing waste
- Chemical waste as industrial by-products
- Fertilizers containing nutrients--nitrates and phosphates—which are found in stormwater runoff from agriculture, as well as commercial and residential use[16]
- Heavy metals from motor vehicles (via urban stormwater runoff) and acid mine drainage · Silt (sediment) in runoff from construction sites, logging, slash and burn practices or land clearing sites.
- Toxic metals- Hg.Cr,Pb,Cu,Zn,Fe,Al,Cd,Ni,Co, As, Sn Fluoride

MACROSCOPIC pollution—large visible items polluting the water—may be termed "floatables" in an urban stormwater context, or marine debris when found on the open seas, and can include such items as:

- Trash or garbage (e.g. paper, plastic, or food waste) discarded by people on the ground, along with accidental or intentional dumping of rubbish, that are washed by rainfall into storm drains and eventually discharged into surface waters
- Nurdles, small ubiquitous waterborne plastic pellets
- Shipwrecks, large derelict ships.

THERMAL POLLUTION

Thermal pollution is the rise or fall in the temperature of a natural body of water caused by human influence. Thermal pollution, unlike chemical pollution, results in a change in the physical properties of water. A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. Elevated water temperatures decreases oxygen levels, which can kill fish, and can alter food chain composition, reduce species biodiversity, and foster invasion by new thermophilic species. Urban runoff may also elevate temperature in surface waters.

Thermal pollution can also be caused by the release of very cold water from the base of reservoirs into warmer rivers.

Example The Vermont Yankee Nuclear Power Plant discharges heated water to the Connecticut River.

TRANSPORT AND CHEMICAL REACTIONS OF WATER POLLUTANTS

Most water pollutants are eventually carried by rivers into the oceans. In some areas of the world the influence can be traced hundred miles from the mouth by studies using hydrology transport models. Advanced computer models such as SWMM or the DSSAM Model have been used in many locations worldwide to examine the fate of pollutants in aquatic systems. Indicator filter feeding species such as copepods have also been used to study pollutant fates in the New York Bight, for example. The highest toxin loads are not directly at the mouth of the Hudson River, but 100 kilometers south, since several days are required for incorporation into planktonic tissue. The Hudson discharge flows south along the coast due to coriolis force. Further south then are areas of oxygen depletion, caused by chemicals using up oxygen and by algae blooms, caused by excess nutrients from algal cell death and decomposition. Fish and shellfish kills have been reported, because toxins climb the food chain after small fish consume

copepods, then large fish eat smaller fish, etc. Each successive step up the food chain causes a stepwise concentration of pollutants such as heavy metals (e.g. mercury) and persistent organic pollutants such as DDT. This is known as biomagnification, which is occasionally used interchangeably with bioaccumulation.

Example A polluted river draining an abandoned copper mine on Anglesey

Large gyres (vortexes) in the oceans trap floating plastic debris. The North Pacific Gyre for example has collected the so-called "Great Pacific Garbage Patch" that is now estimated at 100 times the size of Texas. Many of these long-lasting pieces wind up in the stomachs of marine birds and animals. This results in obstruction of digestive pathways which leads to reduced appetite or even starvation. Many chemicals undergo reactive decay or chemically change especially over long periods of time in groundwater reservoirs. A noteworthy class of such chemicals is the chlorinated hydrocarbons such as trichloroethylene (used in industrial metal degreasing and electronics manufacturing) and tetrachloroethylene used in the dry cleaning industry (note latest advances in liquid carbon dioxide in dry cleaning that avoids all use of chemicals). Both of these chemicals, which are carcinogens themselves, undergo partial decomposition reactions, leading to new hazardous chemicals (including dichloroethylene and vinyl chloride). Groundwater pollution is much more difficult to abate than surface pollution because groundwater can move great distances through unseen aquifers. Non-porous aquifers such as clays partially purify water of bacteria by simple filtration (adsorption and absorption), dilution, and, in some cases, chemical reactions and biological activity: however, in some cases, the pollutants merely transform to soil contaminants. Groundwater that moves through cracks and caverns is not filtered and can be transported as easily as surface water. In fact, this can be aggravated by the human tendency to use natural sinkholes as dumps in areas of Karst topography. There are a variety of secondary effects stemming not from the original pollutant, but a derivative condition. An example is silt-bearing surface runoff, which can inhibit the penetration of sunlight through the water column, hampering photosynthesis in aquatic plants.

CONTROL OF POLLUTION

Domestic sewage

Domestic sewage is typically 99.9 percent water with 0.1 percent 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. Well-designed and operated systems (i.e., secondary treatment or better) can remove 90 percent or more of these pollutants. Some plants have additional systems to remove nutrients and pathogens. Most municipal plants are not specifically 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 stormwater management capacity throughout the system, and 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).

Example:Deer Island Waste Water Treatment Plant serving Boston, Massachusetts and vicinity.

MARINE POLLUTION

Marine pollution occurs when harmful, or potentially harmful, effects result from the entry into the ocean of chemicals, particles, industrial, agricultural and residential waste, noise, or the spread of invasive organisms. Most sources of marine pollution are land based. The pollution often comes from nonpoint sources such as agricultural runoff and wind blown debris and dust. Nutrient pollution, a form of water pollution, refers to contamination by excessive inputs of nutrients. It is a primary cause of eutrophication of surface waters, in which excess nutrients, usually nitrogen or phosphorus, stimulate algal growth.

Many potentially toxic chemicals adhere to tiny particles which are then taken up by plankton and benthos animals, most of which are either deposit or filter feeders. In this way, the toxins are concentrated upward within ocean food chains. Many particles combine chemically in a manner highly depletive of oxygen, causing estuaries to become anoxic.

When pesticides are incorporated into the marine ecosystem, they quickly become absorbed into marine food webs. Once in the food webs, these pesticides can cause mutations, as well as diseases, which can be harmful to humans as well as the entire food web.

Toxic metals can also be introduced into marine food webs. These can cause a change to tissue matter, biochemistry, behaviour, reproduction, and suppress growth in marine life. Also, many animal feeds have a high fish meal or fish hydrolysate content. In this way, marine toxins can be transferred to land animals, and appear later in meat and dairy products.

Although marine pollution has a long history, significant international laws to counter it were only enacted in the twentieth century. Marine pollution was a concern during several United Nations Conferences on the Law of the Sea beginning in the 1950s. Most scientists believed that the oceans were so vast that they had unlimited ability to dilute, and thus render pollution, harmless.

In the late 1950s and early 1960s, there were several controversies about dumping radioactive waste off the coasts of the United States by companies licensed by the Atomic Energy Commission, into the Irish Sea from the British reprocessing facility at Windscale, and into the Mediterranean Sea by the French Commissariat à l'Energie Atomique. After the Mediterranean Sea controversy, for example, Jacques Cousteau became a worldwide figure in the campaign to stop marine pollution. Marine pollution made further international headlines after the 1967 crash of the oil tanker Torrey Canyon, and after the 1969 Santa Barbara oil spill off the coast of California.

Marine pollution was a major area of discussion during the 1972 United Nations Conference on the Human Environment, held in Stockholm. That year also saw the signing of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, sometimes called the London Convention. The London Convention did not ban marine pollution, but it established black and gray lists for substances to be banned (black) or regulated by national authorities (gray). Cyanide and high-level radioactive waste, for example, were put on the black list. The London Convention applied only to waste dumped from ships, and thus did nothing to regulate waste discharged as liquids from pipelines.

There are many different ways to categorize, and examine the inputs of pollution into our marine ecosystems. Patin notes that generally there are three main types of inputs of pollution into the ocean: direct discharge of waste into the oceans, runoff into the waters due to rain, and pollutants that are released from the atmosphere.

One common path of entry by contaminants to the sea are rivers. The evaporation of water from oceans exceeds precipitation. The balance is restored by rain over the continents entering rivers and then being returned to the sea. The Hudson in New York State and the Raritan in New Jersey, which empty at the northern and southern ends of Staten Island, are a source of mercury contamination of zooplankton (copepods) in the open ocean. The highest concentration in the filter-feeding copepods is not at the mouths of these rivers but 70 miles south, nearer Atlantic City, because water flows close to the coast. It takes a few days before toxins are taken up by the plankton[.

Pollution is often classed as point source or nonpoint source pollution. Point source pollution occurs when there is a single, identifiable, and localized source of the pollution. An example is directly discharging sewage and industrial waste into the ocean. Pollution such as this occurs particularly in developing nations. Nonpoint source pollution occurs when the pollution comes from ill-defined and diffuse sources. These can be difficult to regulate. Agricultural runoff and wind blown debris are prime examples.

Pollutants enter rivers and the sea directly from urban sewerage and industrial waste discharges, sometimes in the form of hazardous and toxic wastes.

INLAND MINING for copper, gold. etc., is another source of marine pollution. Most of the pollution is simply soil, which ends up in rivers flowing to the sea. However, some minerals discharged in the course of the mining can cause problems, such as copper, a common industrial pollutant, which can interfere with the life history and development of coral polyps. Mining has a poor environmental track record. For example, according to the United States Environmental Protection Agency, mining has contaminated portions of the headwaters of over 40% of watersheds in the western continental US. Much of this pollution finishes up in the sea.

SURFACE RUNOFF from farming, as well as urban runoff and runoff from the construction of roads, buildings, ports, channels, and harbours, can carry soil and particles laden with carbon, nitrogen, phosphorus, and minerals. This nutrient-rich water can cause fleshy algae and phytoplankton to thrive in coastal areas; known as algal blooms, which have the potential to create hypoxic conditions by using all available oxygen.