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## *Unit-I*

## *Water Pollution*

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# Marine Pollution- causes, effects and control measures

# Marine Pollution

- Marine pollution is the introduction of harmful substances, chemicals, or waste materials into oceans, seas, and coastal waters, leading to adverse effects on marine ecosystems, human health, and economic activities. Marine pollution poses a significant threat to the environment, economy, and human health. Addressing it requires a combination of stringent regulations, community involvement, and innovative solutions to ensure the long-term sustainability of marine ecosystems.
- Causes of Marine Pollution :
- 1. Land-Based Sources:
- Agricultural Runoff:Fertilizers (nitrates and phosphates) lead to eutrophication, causing algal blooms and oxygen depletion.Pesticides harm marine organisms, disrupting food chains.
- Industrial Discharges:Heavy metals like mercury, lead, and cadmium accumulate in marine organisms, leading to bioaccumulation and biomagnification.
- Toxic chemicals such as PCBs (polychlorinated biphenyls) damage marine ecosystems.
- Urban Wastewater:Untreated or partially treated sewage introduces pathogens, causing waterborne diseases

- 2. Marine Activities:
- Oil Spills:Accidental releases from oil rigs, tankers, or pipelines coat marine life and beaches, destroying habitats.
- Dumping of Wastes:Illegal disposal of hazardous materials and solid waste, including plastics, into the sea.
- Ballast Water Discharges:Ships release ballast water containing invasive species, which disrupt native ecosystems.
- 3. Plastic Pollution:Single-use plastics such as bottles, bags, and microplastics persist in marine environments for hundreds of years.Fishing gear like nets and lines entangles marine animals, leading to injury or death.
- 4. Atmospheric Deposition:Airborne pollutants from industries and vehicles, such as nitrogen oxides and sulfur compounds, settle in oceans, contributing to acidification.
- 5. Climate Change:Rising ocean temperatures and acidification stress coral reefs and marine species.Melting polar ice caps release trapped pollutants.
- 6. Natural Disasters:Floods, tsunamis, and hurricanes wash pollutants from land into the sea, increasing debris and sedimentation.

# Effects of Marine Pollution

- 1.Ecological Effects:
- Loss of Biodiversity:Destruction of habitats like coral reefs, mangroves, and seagrasses.
- Disruption of Food Chains:Bioaccumulation of toxins affects top predators like dolphins, whales, and seabirds.
- Eutrophication:Algal blooms lead to oxygen-depleted zones (dead zones) where marine life cannot survive.
- 2. Effects on Marine Life:
- Ingestion of Plastics:Marine animals mistake plastics for food, leading to starvation or internal injuries.
- Toxicity:Exposure to chemicals like heavy metals and pesticides affects reproduction and growth.
- Habitat Destruction:Oil spills and coastal development degrade essential habitats.

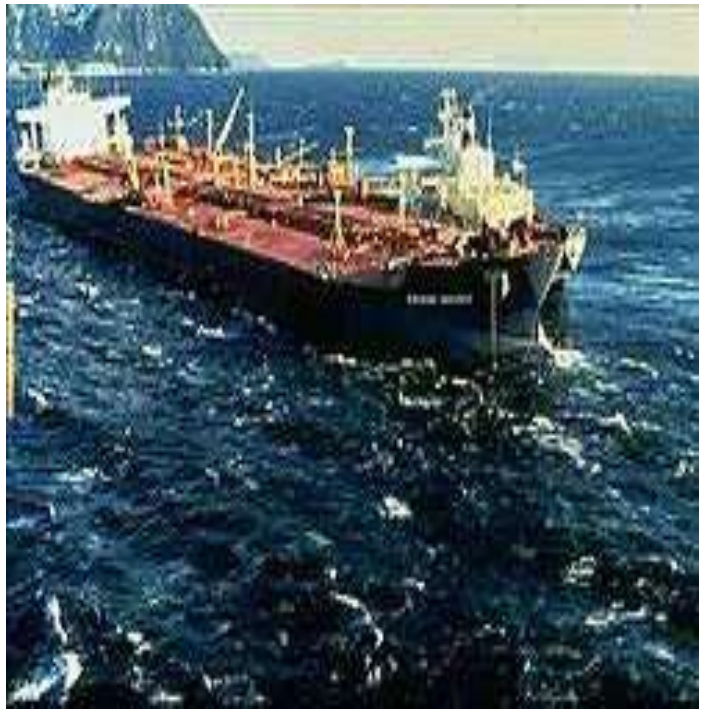
- 3. Human Health Risks:
- Contaminated Seafood:Consumption of fish with toxins like mercury causes neurological and developmental issues.
- Waterborne Diseases:Pathogens from untreated sewage lead to cholera, dysentery, and hepatitis.
- 4. Economic Impacts:
- Fisheries Decline:Pollution reduces fish populations, affecting livelihoods.
- Tourism Loss:Polluted beaches and damaged coral reefs deter tourists.
- Cleanup Costs:High expenses for oil spill and waste cleanup operations.

# Control of Marine Pollution

- 1. Regulatory Measures:
- International Conventions:MARPOL (International Convention for the Prevention of Pollution from Ships) regulates ship-generated pollution.The London Convention prohibits the dumping of hazardous wastes into oceans.
- National Policies:Implementation of strict environmental laws and monitoring systems to regulate industrial discharges and waste management.
- 2. Waste Management Practices:
- Reduce, Reuse, Recycle:Promote alternatives to single-use plastics and recycling initiatives.
- Proper Disposal:Develop infrastructure for solid waste collection and treatment to prevent dumping into water bodies.
- 3. Sustainable Agricultural Practices:
- Controlled Use of Fertilizers and Pesticides:Use slow-release fertilizers and organic pesticides to reduce runoff.
- Buffer Zones:Establish vegetative barriers near waterways to trap pollutants.

- 4. Oil Spill Prevention and Response:
- Regulations on Oil Transport:Enforce double-hull designs for tankers to reduce spill risks.
- Spill Response Plans:Develop emergency response systems for quick containment and cleanup.
- 5. Public Awareness and Education:
- Campaigns to educate individuals about the impacts of marine pollution and how they can contribute to prevention
- Organizing beach cleanups and community-led monitoring programs.
- 6. Technological Innovations:
- Wastewater Treatment:Implement advanced treatment technologies to remove pathogens and chemicals before discharging into the sea.
- Bioremediation:Use of microorganisms to break down oil and chemical spills.
- Plastic Alternatives: Develop biodegradable and ocean-friendly materials.

# Exxon Valdez oil spill-1989



# Case Study: The Exxon Valdez Oil Spill

- On March 24, 1989, the tanker *Exxon Valdez* grounded on Bligh Reef in Alaska's Prince William Sound, rupturing its hull and spilling nearly 11 million gallons of crude oil into a remote, scenic, and biologically productive body of water.
- It was the largest single oil spill in U.S. coastal waters. In the weeks and months that followed, the oil spread over a wide area in Prince William Sound and beyond, resulting in a previously unprecedented response and cleanup.
  - The crude oil affected 5200 km of coastline, Killed 250,000 seabirds,$15 billion in damages to economy, Exxon paid $3.8 billion in damages and clean-up costs.This incident Led to improvements in oil tanker safety and clean-up strategies

# Prince William Sound of Alaska

# Deepwater Horizon Blowout in the Gulf of Mexico, April 20, 2010

Fig. 20-18, p. 547

- The Deepwater Horizon rig, owned and operated by offshore-oil-drilling company Transocean and leased by oil company BP, was situated in the Macondo oil prospect in the Mississippi Canyon, a valley in the continental shelf. The oil well over which it was positioned was located on the seabed 4,993 feet (1,522 metres) below the surface and extended approximately 18,000 feet (5,486 metres) into the rock. On the night of April 20 a surge of natural gas blasted through a concrete core recently installed in order to seal the well for later use.
- Once released by the fracture of the core, the natural gas traveled up the Deepwater rig's riser to the platform, where it ignited, killing 11 workers and injuring 17.
- The rig capsized and sank on the morning of April 22, rupturing the riser, through which drilling mud had been injected in order to counteract the upward pressure of oil and natural gas.
- Without any opposing force, oil began to discharge into the gulf. The volume of oil escaping the damaged well—originally estimated by BP to be about 1,000 barrels per day—was thought by U.S. government officials to have peaked at more than 60,000 barrels per day.

# Control of Oil Pollution

- Control of Oil Pollution:
- Physical Methods:
- i) Skimming: The oil could be removed from the surface.
- ii) Oil can be removed by suitable absorbent Eg: saw dust, polyurethane foam.
- Chemical Methods:
- i) Evaporation, emulsification, absorbents, burning of oil are effective methods.
- Biological method:
- ii) Super bug (*Pseudomonas putida*) has been proved to be effective to clean up the oil pollution.

- iii)Oleophilic fertilizers enrich the oil eating microbes like *Pseudomonas* sp, and hence they could be used.
- iv)The more promising applications of the results of toxicological research for the protection of the marine environment include standardization of the components of various toxicants in the sea based on their biological criteria along with eco toxicological characterisation of sewage effluent and its compounds.
- General awareness must be created among the common people regarding the disposal of various wastes for eg., coloured idols, polythene bags etc., The legislations must also be very strictly enforced. However, control of marine pollution also needs further research.

# Thermal Pollution

# Thermal Pollution

- Various industrial processes may utilize water for cooling and resultant warm water is often discharged into streams or lakes. Coal-oil-fired generators and thermal atomic energy plants results in thermal pollution. Thermal pollution thus can exert a disruptive effect on aquatic ecosystems.
- The hot effluents are discharged at a temperature of 8° C to 10°C higher than the temperature of intake water. This unutilized heat, discharged into the river water system, produces pollution known as “Thermal Pollution.”
- Sources of Thermal Pollution

i. Coal - fired power plants effluent

ii. Domestic sewage

iii. Hydroelectric power effluent

iv. Industrial effluents and

v. Nuclear power plants effluent

vi. Electric utilities constitute the major source of thermal pollution of rivers and lakes.

- Natural Causes: Natural causes like volcanoes and geothermal activity under the oceans and seas can trigger warm lava to raise the temperature of water bodies. Lightening can also introduce massive amount of heat into the oceans. This means that the overall temperature of the water source will rise, having significant impacts on the environment.
- Water as Cooling Agent in Power, Manufacturing and Industrial plants: Production and Manufacturing plants are biggest source of thermal pollution. These plants draw water from nearby source to keep machines cool and then release back to the source with higher temperature.
- When heated water returns to the river or ocean, the water temperature rises sharply. When oxygen levels are altered in the water, this can also degrade the quality and longevity of life in wildlife that lives underwater.
- This process can also wipe away streamside vegetation, which constantly depends on constant levels of oxygen and temperature. By altering these natural environments, industries are essentially helping decrease the quality of life for these marines based life forms and can ultimately destroy habitats if they are not controlled and careful about their practices.

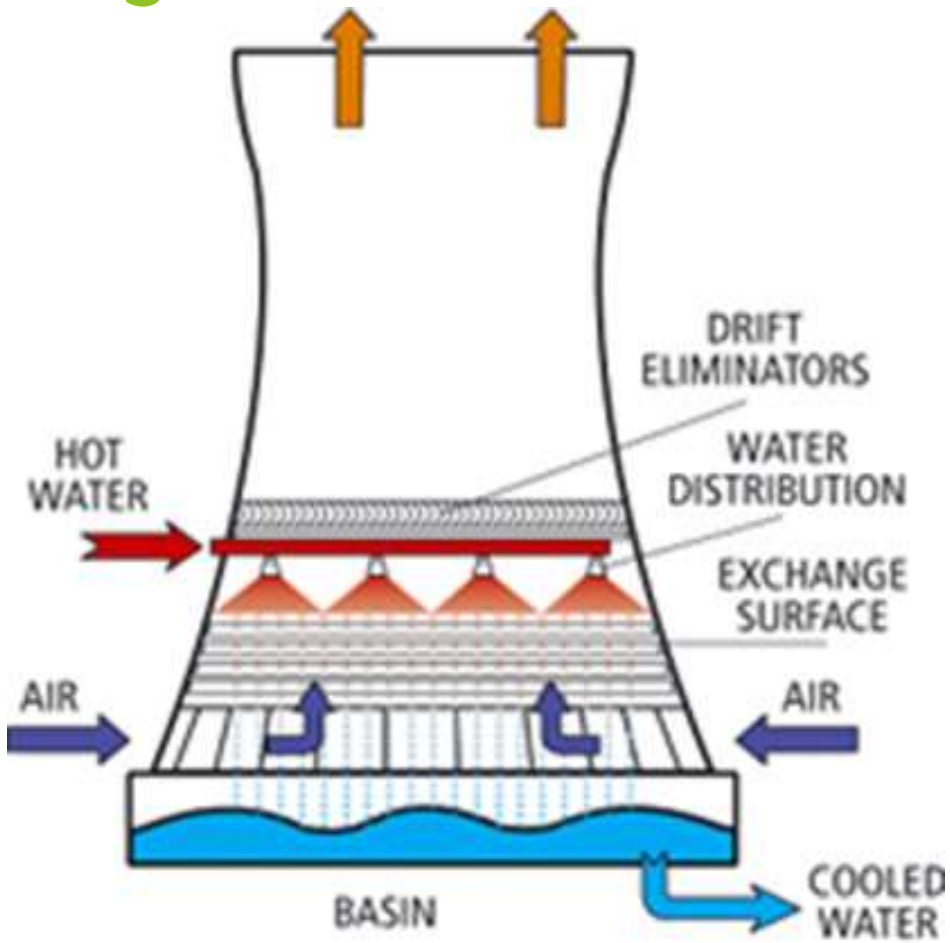
- **Effects of Thermal Pollution:**
- Reduction of Dissolved Oxygen: Concentration of dissolved oxygen decreases with the rise in temperature of the water. Thus cold-water fish swimming at 10°C which require more oxygen cannot tolerate the hot water of 30°C and may die.
- Changing Water Properties: A rise in temperate changes the physical and chemical properties. The vapour pressure increases sharply, while viscosity of water, density and solubility of gases decreases. .
- Interference with Biological Activities: The temperature is considered to be of vital significance to physiology, metabolism and biochemical process in controlling respiratory rates, digestion, excretion and overall development of aquatic organisms. The temperature changes totally disrupt the entire ecosystem.
- Variation in Reproductive Rate: The increase in temperature triggers the deposition of eggs by the female, for eg., shell fish oysters arid clams spawn within four hours when the water temperature reaches the critical level.

- Change in Metabolic Rate: The rate of metabolic activities shows a marked rise with an increase in the temperature.
- Invasion of Destructive Organisms: Thermal pollutants may permit the invasion of the organisms that are tolerant to warm water and are highly destructive, e g., Invasion of ship worms.
- Undesirable Changes in the Algal Population: Excess nutrients from the washout water from farm lands combined with thermal pollution cause an excessive algal growth with consequent changes. All the major group of algae, like diatoms, green, blue- green algae, have a distinct tolerance range for water temperature. High temperature promotes blue green algal blooms which disrupts the aquatic food chain.
- Possible long range impact of Thermal Pollution: The combustion of fossil fuels will contribute to a reduction in the rate at which heat gets radiated from the earth through the operation of the “Green house Effect”. Both effects act to increase the Earth’s average temperature and cause Global warming.

- Increase in Toxins: With the constant flow of high temperature discharge from industries, there is a huge increase in toxins that are being regurgitated into the natural body of water. These toxins may contain chemicals or radiation that may have harsh impact on the local ecology and make them susceptible to various diseases.
- Loss of Biodiversity: A dent in the biological activity in the water may cause significant loss of biodiversity. Changes in the environment may cause certain species of organisms to shift their base to some other place while their could be significant number of species that may shift in because of warmer waters.  Organisms that can adapt easily may have an advantage over organisms that are not used to the warmer temperatures.
- Ecological Impact: A sudden thermal shock can result in mass killings of fish, insects, plants or amphibians. Hot water may prove favorable for some species while it could be lethal for other species. Small water temperature increases the level of activity while higher temperature decreases the level of activity. Many aquatic species are sensitive to small temperature changes such as one degree Celsius that can cause significant changes in organism metabolism and other adverse cellular biology effects.

- Methods to Control Thermal Pollution:
- Artificial Lakes or Cooling Ponds: Hot effluent is allowed to discharge into the lake's shallow end 1 or 2 meters deep and the water for cooling purposes is drawn from the other end of the lake at about 15m deep.
- Cooling Towers: Cooling towers are able to transfer heat from cooling water to the atmosphere, generally through evaporation of water.
- Thermal pollution problems will continue to grow at a sharp rate if electric power production continues to increase as dramatically as it has in the first 9 decades of the 20th century.
- More efficient methods of generating power and using it are required and more emphasis is needed for avoiding unnecessary energy consumption.

# Schematic Drawing of a Natural Draft Evaporating Cooling Tower

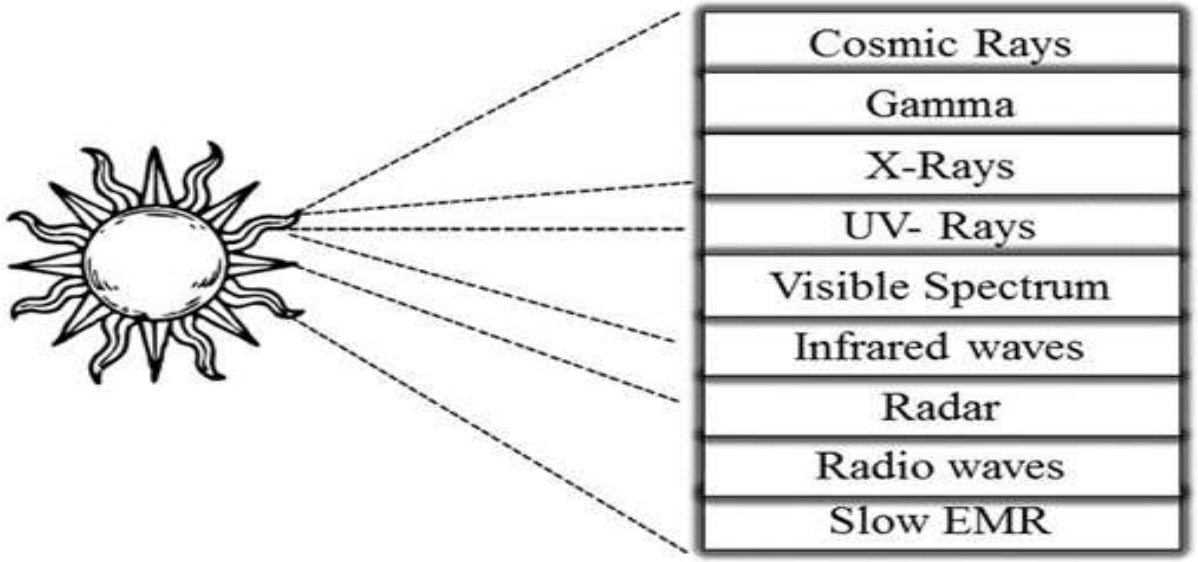


# Radioactive Pollution

- **Radioactive Pollution:** Contamination of the environment with radioactive elements is called radioactive pollution. Atomic bomb explosion is a main reason for radioactive pollution.
- **Sources of Radioactive Pollution**
- 1.Natural Sources -Solar radiation, Radio nuclides in the earth crust, Human internal radiations, environmental radiations.
- 2.Anthropogenic Sources (manmade): Medical -X-rays, Radioactive fallout, nuclear reactors, research laboratories, atomic power plants, electric fields.
- 3.Miscellaneous Sources- TV sets, luminous wrist watches, wall clocks
- etc., are radioactive. But radiation from these sources are very small.
- **Types of Radiation:-**
- There are 2 types of radiation:
- 1.Electromagnetic Radiation or Non-ionizing Radiation.

EMR is otherwise called as non-ionising radiation as they could excite atoms but not produce ions except cosmic rays. They originate mainly from the sun.

# Electro magnetic radiation

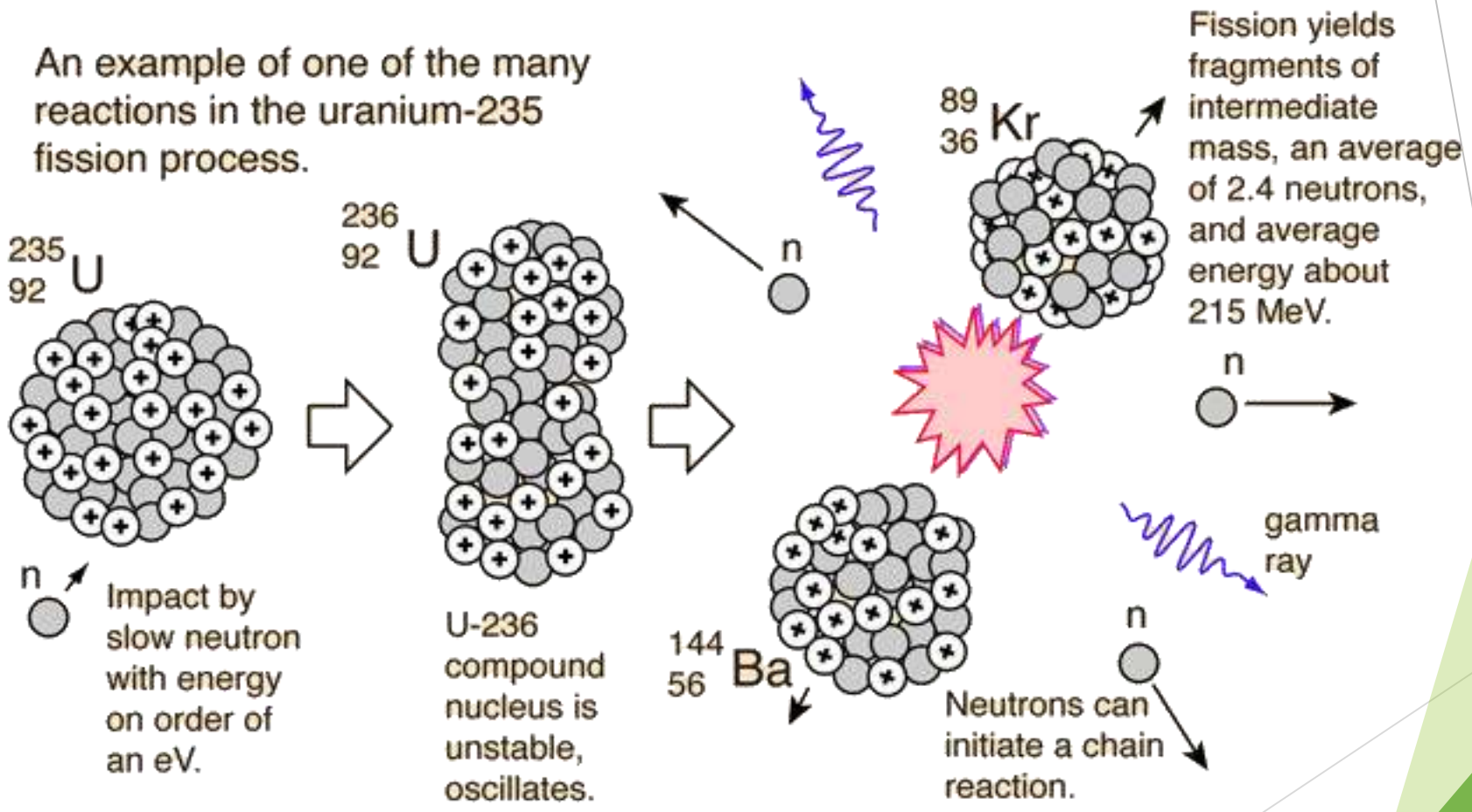


2. Particulate or Atomic Radiation: consists of a stream of minute particles such as electrons, protons, neutrons which move in a straight line in the form of radiation and produce ion pairs (Ionisation). The particle which possesses ‘Pocket of energy’ is called photon. It includes the following radiations,

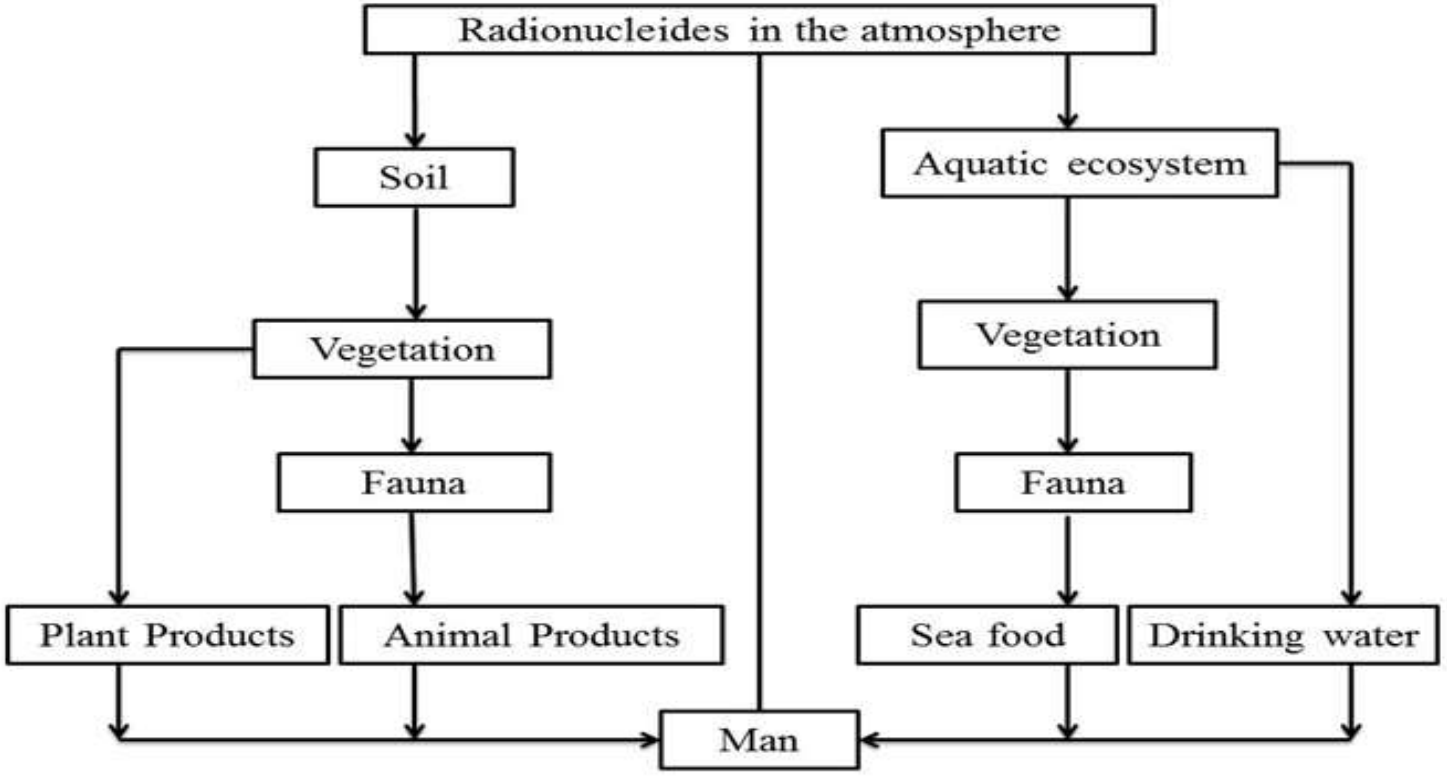
a)Cosmic rays b)Alpha particles c)Beta particles d)Proton particles e)Energetic neutron

- Units of Radiation:The radiation can be measured by the following units: Curie, Roentgen, Becquerel, Gray, Rutherford.
- **Sources of radioactive Pollution:**
- Atomic Explosion: In the atomic explosion, there occurs nuclear reaction. During which, the nuclei, of radioactive elements split up and liberate neutrons. When a neutron strikes the nucleus of an atom of isotopes U235 or Plutonium - 239 it causes the nucleus to split into two fragments, each of which is a nucleus with about half the protons and neutrons of the original nucleus.

# Nuclear fission reaction



- In the process of splitting, enormous heat is liberated within a fraction of microseconds. The temperature increases to millions of degrees which is enough to vaporize the surrounding materials. Explosion produces a fire ball which expands rapidly towards the sky creating numerous hazards and produces mushroom cloud of nuclear blast.
- Radioactive fallout causing radiation pollution is mainly of two types:
- a) Early Fallout: If the nuclear explosion is at a very low altitude, it sucks up large quantities of soil and water affecting severely all the living organism.
- b) Delayed Fallout: If the nuclear explosion occurs at a higher altitude, it sucks little dirt and water. The fission products may be injected into the air and spread everywhere to several kilometers. Hence, nuclear explosion is very hazardous to our ecosystem.


Radionucleides in the atmosphere
Soil
Aquatic ecosystem
Vegetation
Vegetation
Fauna
Fauna
Plant Products
Animal Products
Sea food
Drinking water
Man

- Effects of Radioactive Pollution
- The radioactive pollution includes: 1.Somatic effect 2.Genetic effect and 3.Bio magnification
- 1. Somatic Effect: The effects produced by radiation to somatic cells constitute somatic effects or non genetic effects. They appear within an individual life and disappear with the death of the individual. Mainly this effect is caused by Electromagnetic radiation, and it includes Skin cancer, dermatitis, Sun burn - red colouration of skin, Eye cataracts, Reduction of fertility, Lymphoma - cancer in the lymph nodes, Leukemia, It blocks the mitosis, Biomolecules are denatured by radiations, Still birth, Central nervous system damage, Cancer, Skin ageing-premature of skin, Mouth ulcers.
- 2. Genetic Effects: The radiation affect the genes of the gamete cells. The changes are not apparent in the individual. The effects are exhibited by the off spring and in the subsequent generations. They acutely affect the cell functions particularly DNA, RNA replication and the chromosome. They result inBlock meiosis, Chromosomal aberrations, Inhibit the DNA, RNA replication, Chromosomal fragmentation, Gene mutation
- 3. Bio magnification: Radioactive elements get concentrated through the food chain. This is known as biological magnification or bi concentration. It will affect the whole ecosystem eventually and cause cancer in human being.

- Effect of Radioactive Pollution on the Ecosystem:-
- Increases the mortality rate of planktons, and subsequently effect the food chain, Chlorosis, Necrosis, Increases the evapo transpiration through (stomata ,Mutation
- **Control of Radioactive Pollution**
- Nuclear devices should never be exploded in air. If these activities are extremely necessary, they should be exploded underground.
- In nuclear reactors, closed - cycle coolant system with gaseous coolants of very high purity may be used to prevent extraneous activation products.
- In nuclear and chemical industries, the use of radio-isotopes may be carried under a jet of soil or water instead of powder or gaseous forms.
- In nuclear mines, wet drilling may be employed along with underground drainage.
- Nuclear reactors must be enclosed in broad concrete walls to prevent the radiations that emerges out.
- Workers should wear protective garments and glass spectacles should be worn to screen the eyes from radiation.
- Extreme care should be exercised in the disposal of industrial waste contaminated with radio nuclides.

# Water borne infections

- Worldwide, 1.1 billion people lack access to improved water supplies, and 2.4 billion do not have access to sanitation services. Hundreds of millions more rely on improved water supplies that are not safe because of microbial or chemical contamination. Diarrheal diseases, which are frequently transmitted by contaminated water, continue to be a leading cause of morbidity and mortality, especially among children.
- There are four primary routes of transmission of water-related diseases, and each route has a set of proven disease prevention measures.
- The first route is **water-borne transmission**, in which water contaminated with pathogens is ingested and causes disease. Transmission of water-borne diseases can be prevented by assuring access to a sufficient quantity of disinfected water, proper disposal of human waste, and improved hygiene.
- A second route is **water-washed transmission** in which poor personal or domestic hygiene results in exposure to pathogens through a person-to-person. Water-washed diseases can be prevented by increasing the quantity of water available to populations and effectively promoting improved hygiene.
- A third route is **water-based transmission** through skin contact with water infested with pathogens that spend part of their life cycle in an animal that lives in water. Water-based disease transmission can be prevented by eliminating contact with infested water, controlling the populations of the intermediate hosts in water, and reducing fecal contamination of surface waters by human waste.
- The fourth route is **water-related transmission** through insect vectors that breed in water or bite near water. Prevention strategies include elimination of insect breeding sites, use of insecticide treated bednets, and reduction of insect populations.

- Water-borne pathogens, which are largely transmitted through a fecal-oral route, are important causative agents of disease outbreaks in the developing as well as developed world.
- In addition, water-borne pathogens contribute to background rates of disease not detected as outbreaks and therefore not reported to public health authorities.
- Table 1 contains examples of water-borne diseases. The focus of the table is microbiologic agents of disease.
- Inorganic compounds such as arsenic and lead are also important causes of water-borne disease.

| Disease | Pathogen | Transmission | Symptoms |
|---|---|---|---|
| Cholera | *Vibrio cholerae* | Fecal-oral | Acute, profuse watery diarrhea, dehydration |
| Gastroenteritis | *Escherichia coli*, *Campylobacter spp.*, *Salmonella spp.* | Fecal-oral, | person→ person, or animal→ person Watery or loose stools, stomach cramps |
| Typhoid | *Salmonella typhi* | Fecal-oral | Fever, headache, nausea, loss of appetite, constipation |
| Amoebic dysentery | *Entamoeba histolytica* | Fecal-oral, person→ person | Stomach pain, bloody diarrhea, fever |
| Cryptosporidiosis | *Cryptosporidium parvum* | Fecal-oral, person→ person, or animal→ person | Watery diarrhea, stomach cramps |

| Dracunculiasis (Guinea worm) | Dracunculus medinensis | Person→ copepod→ person | Emergence of worm through skin causes an ulcer, severe local pain, and swelling |
|---|---|---|---|
| Giardiasis | *Giardia intestinalis* | Infection occurs after ingestion of oocyst-contaminated materials by a susceptible host. | Abdominal cramps, arthralgias, diarrhea, hives, nausea, pruritus, and vomiting |
| Viral Gastroentritis | Norovirus and adenovirus commonly cause waterborne illness; rotavirus and hepatitis A are less common etiologies. | Viruses can survive in treated and untreated surface water and are somewhat chlorine resistant. | Abdominal pain, diarrhea, nausea, and vomiting |
| | | | |

- The potential waterborne pathogens include:
- —bacteria, viruses, protozoa and helminths ,with the exception of *Schistosoma*, which is primarily spread by contact with contaminated surface water during bathing and washing;
- The human health effects caused by waterborne transmission vary in severity from mild gastroenteritis to severe and sometimes fatal diarrhoea, dysentery, hepatitis and typhoid fever.
- Contaminated water can be the source of large outbreaks of disease,including cholera, dysentery etc., for the majority of waterborne pathogens, however, there are other important sources of infection, such as food and water.

# Dimension of the problem

- In developing countries four-fifths of all the illnesses are caused by water-borne diseases, with diarrhoea being the leading cause of childhood death.
- The global picture of water and health has a strong local dimension with some 1.1 billion people still lacking access to improved drinking water sources and some 2.4 billion to adequate sanitation. Today we have strong evidence that water-, sanitation and hygiene-related diseases account for some 2,213,000 deaths annually and an annual loss of 82,196,000 Disability Adjusted Life Years (DALYs) (R. Bos, Dec. 2004).
- WHO estimates indicate that worldwide over 2 billion people are infected with **schistosomes** and soil transmitted helminthes and 300 million of these suffer serious illness as a result.
- **Malaria** kills over a million people every year, and a large percentage of them are under five as well, mainly in Africa South of the Sahara. In 2001 the estimated global burden of malaria amounted to 42.3 million, constituting 10 % of Africa's overall disease burden. Malaria causes at least 396.8 million cases of acute illness each year. Pregnant women are the main adult risk group. As one of the major public health problems in tropical countries, it has been claimed that malaria has reduced economic growth in African countries by 1.3 % each year over the past 30 years.

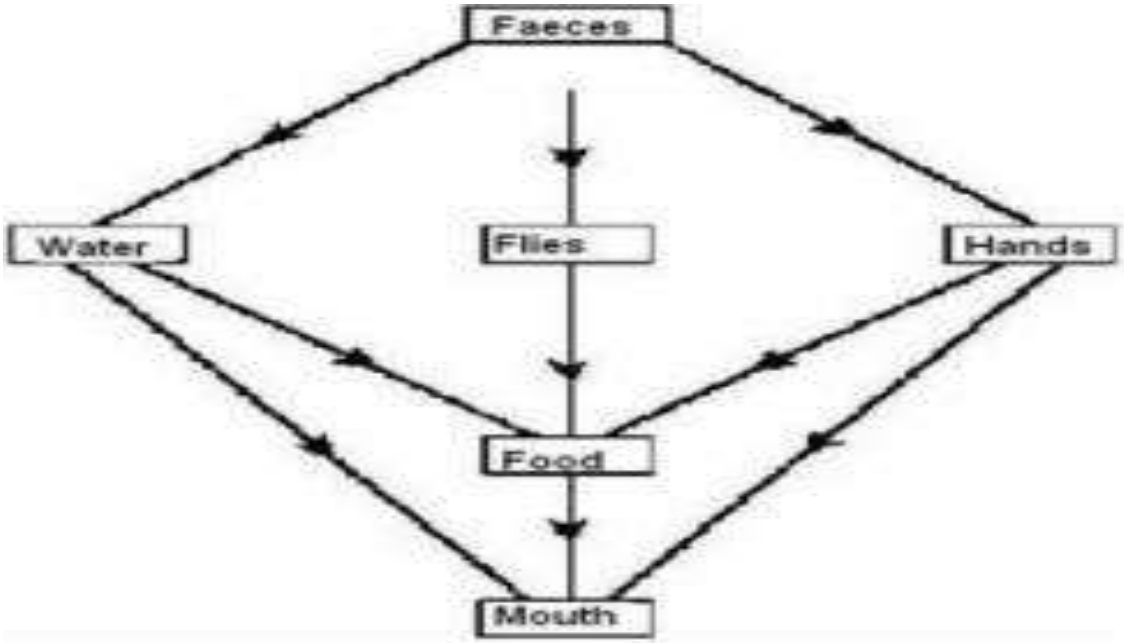
- An estimated 246.7 million people worldwide are infected by **schistomiasis**, and of these 20 million suffer severe consequences of the infection, while 120 million suffer milder symptoms. An estimated 80% of transmission takes place in Africa south of the Sahara .
- **Diarrhoea** occurs worldwide and causes 4% of all deaths and 5% of the health loss to disability.
- In Bangladesh alone, some 35 million people are exposed, on a daily basis, to elevated levels of **arsenic** in their drinking water, which will ultimately threaten their health and shorten their life expectancy.
- After the Tsunami attack in Asia on Sunday the 26th of December 2004 people faced the threat of water borne diseases linked to flooding, like Shigellosis, Cholera, Hepatitis A, Leptospirosis, Typhoid Fever, Malaria and Dengue fever.

# Transmission

- Water borne diseases spread by contamination of drinking water systems with the urine and faeces of infected animal or people.
- This is likely to occur where public and private drinking water systems get their water from surface waters (rain, creeks, rivers, lakes etc.), which can be contaminated by infected animals or people. Runoff from landfills, septic fields, sewer pipes, residential or industrial developments can also sometimes contaminate surface water.
- This has been the cause of many dramatic outbreaks of faecal-oral diseases such as cholera and typhoid. However, there are many other ways in which faecal material can reach the mouth, for instance on the hands or on contaminated food. In general, contaminated food is the single most common way in which people become infected.

- The germs in the faeces can cause the diseases by even slight contact and transfer. This contamination may occur due to floodwaters, water runoff from landfills, septic fields, and sewer pipes.
- The following picture shows the faecal-oral routes of diseases transmission.
- The only way to break the continued transmission is to improve the people's hygienic behaviour and to provide them with certain basic needs: drinking water, washing and bathing facilities and sanitation. Malaria transmission is facilitated when large numbers of people sleep outdoors during hot weather, or sleep in houses that have no protection against invading mosquitoes. Malaria mosquitoes, tropical black flies, and bilharzias snails can all be controlled with efficient drainage because they all depend on water to complete their life cycles.

# Transmission



# Salmonellosis

- Salmonellosis is an infection caused by bacteria of the genus *Salmonella*. It typically affects the intestinal tract and occasionally other parts of the body. This illness is commonly associated with the consumption of contaminated food or water.
- Causes of Salmonellosis
- Contaminated Food and Water:- Raw or undercooked poultry, eggs, and meat, - Unpasteurized milk and dairy products - Raw fruits and vegetables.Animal and Environmental Exposure: - Contact with infected animals, especially reptiles, amphibians, birds, and pets. Handling contaminated surfaces or objects.Person-to-Person Transmission- Through fecal-oral contact, particularly in settings with poor hygiene or sanitation.
- Symptoms of Salmonellosis-- Symptoms usually appear 6–72 hours after infection and may include:
- Diarrhea (sometimes bloody). - Abdominal cramps. - Fever. - Nausea and vomiting. - Headache. - Chills.
- Severe cases may lead to: Dehydration. - Septicemia (infection spreading to the bloodstream). - Long-term complications like reactive arthritis.

# *Thypoid fever*

- Typhoid fever is a systemic bacterial infection caused by Salmonella enterica serotype Typhi. It spreads through contaminated food or water and primarily affects regions with poor sanitation.
- Causative Agent:Bacterium: *Salmonella enterica serotype Typhi* (*S. typhi*).
- Mode of Transmission: Fecal-oral route via contaminated water, food, or close contact with an infected person.
- Symptoms of Typhoid Fever: Symptoms typically appear 6–30 days after exposure and progress through stages if untreated:Early Symptoms (First Week):Prolonged fever (gradually increasing in severity, often reaching 103–104°F or 39–40°C).Fatigue and malaise.Headache.Abdominal pain or discomfort.Dry cough.
- Later Symptoms (Second Week Onward):Gastrointestinal:Diarrhea or constipation (constipation is more common in adults; diarrhea in children).Enlarged spleen or liver (splenomegaly or hepatomegaly).Systemic:Rash (rose-colored spots on the chest and abdomen, seen in some patients).Severe abdominal distension.
- Severe Complications (If Untreated):Intestinal perforation and peritonitis.Severe gastrointestinal bleeding.Septicemia (bacteria entering the bloodstream).Neurological symptoms (confusion or delirium).

# *Shigellosis*

- Shigellosis is an infectious disease caused by a group of bacteria called Shigella. It primarily affects the intestines, leading to diarrhea and other gastrointestinal symptoms.
- The disease is caused by Shigella bacteria, which are classified into four major species:*Shigella dysenteriae* (most severe infections, rare in developed countries).*Shigella flexneri* (common in developing countries).Shigella boydii (less common globally).*Shigella sonnei* (most common in developed countries).
- Symptoms of Shigellosis: Symptoms typically develop 1–2 days after infection and may include:Gastrointestinal Symptoms: Watery diarrhea, progressing to bloody or mucus-laden stools.Abdominal pain or cramps. Tenesmus (a feeling of incomplete bowel evacuation).
- Systemic Symptoms: Fever, Fatigue and general malaise,Nausea and vomiting.
- Severe Cases: Dehydration due to excessive fluid loss.Seizures (especially in young children due to fever).Hemolytic-uremic syndrome (rare, associated with Shigella dysenteriae).

# *Cholera*

- Cholera is an acute diarrheal disease caused by the bacterium *Vibrio cholerae*. It spreads through contaminated water or food and can lead to sev
- Causative Agent:Bacterium: *Vibrio cholerae* (specifically the toxigenic strains, such as O1 and O139 serogroups).
- Toxin: Produces cholera toxin (CTX), which disrupts the normal absorption of water and electrolytes in the intestines, leading to profuse watery diarrhea.
- Symptoms of Cholera:
- Mild to Moderate Cases: Most infections are asymptomatic or result in mild diarrhea.
- Severe Cases (Cholera Grav):Watery Diarrhea:Often described as "rice-water stools" (pale, milky appearance).Rapid loss of fluids and electrolytes. Vomiting:Non-bilious and not associated with nausea.Dehydration Symptoms:Thirst, dry mouth, and decreased urine output.Sunken eyes and skin turgor loss.Hypotension and rapid heart rate.Complications (if untreated):Severe dehydration.Hypovolemic shock.Acute renal failure.Death, within hours in extreme cases were dehydration and death if untreated.

# Prevention

- Clean water is a pre-requisite for reducing the spread of water-borne diseases. It is well recognised that the prevalence of water-borne diseases can be greatly reduced by provision of clean drinking water and safe disposal of faeces.
- Water is disinfected to kill any pathogens that may be present in the water supply and to prevent them from growing again in the distribution systems.
- Disinfection is then used to prevent the growth of pathogenic organisms and to protect public health and the choice of the disinfect depends upon the individual water quality and water supply system.
- Without disinfection, the risk from waterborne disease is increased.
  The two most common methods to kill microorganisms in the water supply are: oxidation with chemicals such as chlorine, chlorine dioxide or ozone, and irradiation with Ultra-Violet (UV) radiation.

# Eutrophication

- Eutrophication is characterized by excessive plant and algal growth due to the increased availability of one or more limiting growth factors needed for photosynthesis (Schindler 2006), such as sunlight, carbon dioxide, and nutrient fertilizers.
- Eutrophication occurs naturally over centuries as lakes age and are filled in with sediments (Carpenter 1981).
- However, human activities have accelerated the rate and extent of eutrophication through both point-source discharges and non-point loadings of limiting nutrients, such as nitrogen and phosphorus, into aquatic ecosystems (i.e., cultural eutrophication), with dramatic consequences for drinking water sources, fisheries, and recreational water bodies (Carpenter et al. 1998).
- For example, aquaculture scientists and pond managers often intentionally eutrophicate the water bodies by adding fertilizers to enhance primary productivity.
- However, during the 1960s and 1970s, scientists linked algal blooms to nutrient enrichment resulting from anthropogenic activities such as agriculture, industry, and sewage disposal (Schindler 1974).
- The known consequences of cultural eutrophication include blooms of blue-green algae (i.e., cyanobacteria), tainted drinking water supplies, degradation of recreational opportunities, and hypoxia.

# Effects

- The most conspicuous effect of cultural eutrophication is the creation of dense blooms of noxious, foul-smelling phytoplankton that reduce water clarity and harm water quality Algal blooms limit light penetration, reducing growth and causing die-offs of plants in littoral zones while also lowering the success of predators that need light to pursue and catch prey (Lehtiniemi et al. 2005).
- Furthermore, high rates of photosynthesis associated with eutrophication can deplete dissolved inorganic carbon and raise pH to extreme levels during the day.
- When these dense algal blooms eventually die, microbial decomposition severely depletes dissolved oxygen, creating a hypoxic or anoxic ‘dead zone' lacking sufficient oxygen to support most organisms.

- Dead zones are found in many freshwater lakes including the Laurentian Great Lakes (e.g., central basin of Lake Erie; Arend et al. 2011) during the summer. Furthermore, such hypoxic events are particularly common in marine coastal environments surrounding large, nutrient-rich rivers.
- (e.g., Mississippi River and the Gulf of Mexico; Susquehanna River and the Chesapeake Bay) and have been shown to affect more than 245,000 square kilometers in over 400 near-shore systems (Diaz & Rosenberg 2008).
- Hypoxia and anoxia as a result of eutrophication continue to threaten lucrative commercial and recreational fisheries worldwide.
- Some algal blooms pose an additional threat because they produce noxious toxins (e.g., microcystin and anatoxin-*a*;).

- Over the past century, harmful algal blooms (HABs) have been linked with (1) degradation of water quality,
- (2) destruction of economically important fisheries (Burkholder et al. 1992), and (3) public health risks (Morris 1999).
- Within freshwater ecosystems, cyanobacteria are the most important phytoplankton associated with HABs (Paerl 1988). Toxigenic cyanobacteria, including Anabaena, Cylindrospermopsis, Microcystis, and Oscillatoria (Planktothrix), tend to dominate nutrient-rich, freshwater systems due to their superior competitive abilities under high nutrient concentrations, low nitrogen-to-phosphorus ratios, low light levels, reduced mixing, and high temperatures.
- Poisonings of domestic animals, wildlife , and even humans by blooms of toxic cyanobacteria have been documented throughout the world and by 1878 first observation of dead livestock associated with a bloom of cyanobacteria.
- Furthermore, cyanobacteria are responsible for several off-flavor compounds (e.g., methylisoborneal and geosmin) found in municipal drinking water systems as well as in aquaculture-raised fishes, resulting in large financial losses for state and regional economies .
- In addition to posing significant public health risks, cyanobacteria have been shown to be poor quality food for most zooplankton grazers in laboratory studies (Wilson et al.2006; Tillmanns et al. 2008), thus reducing the efficiency of energy transfer in aquatic food webs and potentially preventing zooplankton from controlling algal blooms.

- Red tides, also called harmful algal blooms (HABs), occur when microscopic algae multiply to higher-than-normal concentrations, often discoloring the water.
- Although more than 50 HAB species occur in the Gulf of Mexico, one of the most well-known species is *Karenia brevis*, the Florida red tide organism.
- Organic pollution also causes the excessive multiplication of harmful organisms, such as dinoflagellates-*Gymnodinium brevis* and *Gymnodinium splendens* which result in red tides and thereby results in large scale mortality of fish and when such fishes are consumed by man it result in severe poisoning.

# Red tides

A dead African buffalo (Syncerus caffer) found in a reservoir with a dense bloom of the toxic cyanobacterium *Microcystis* at the Loskop Dam Nature Reserve in South Africa.


# References

*The United Nations World Water Development Report 'Water for people Water for life'* p.102

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