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DEPARTMENT OF AGRICULTURAL ENGINEERING

CAI 334 IRRIGATION WATER QUALITY AND WASTE WATER MANAGEMENT

UNIT 3 WATER POLLUTION

3.1 SOURCES AND TYPES OF POLLUTION

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WATER POLLUTION

Pollution may be defined as ‘an undesirable change in the physical, chemical or biological characteristics of our air, water and land that may or will harmfully, affect human life, the lives of the desirable species, our industrial processes, living conditions and cultural assets, or that may or will waste or deteriorate our raw materials. Pollution is mostly man made, but it can also be natural. Natural pollution is caused by volcanic eruptions, emission of natural gases, soil erosion, ultraviolet rays, cosmic rays etc.

Water pollution is the release of substances into bodies of water that makes water unsafe for human use and disrupts aquatic ecosystems. Water pollution can be caused by a plethora of different contaminants, including toxic waste, petroleum, and disease-causing microorganisms.

Water pollution, the release of substances into subsurface groundwater or into lakes, streams, rivers, estuaries, and oceans to the point that the substances interfere with beneficial use of the water or with the natural functioning of ecosystems. In addition to the release of substances, such as chemicals, trash, or microorganisms, water pollution may include the release of energy, in the form of radioactivity or heat, into bodies of water.

I. Types and sources of water pollutants

pollution can originate from various sources and can be categorized into different types based on the nature of the pollutants. Here's an overview:

Sources of Water Pollution:

1. **Point Sources:** Pollution that enters water bodies from a single, identifiable source.

Examples include:

- Industrial discharges
- Wastewater treatment plants
- Oil spills
- Leaking septic tanks

2. **Non-point Sources:** Pollution that comes from diffuse sources and is not easily traced back to a single origin. Examples include:

- Agricultural runoff containing pesticides, fertilizers, and animal waste
- Urban runoff containing pollutants from streets, rooftops, and parking lots
- Atmospheric deposition of pollutants like heavy metals and acid rain

3. **Natural Sources:** Some pollution arises from natural processes, although human activities can exacerbate these sources. Examples include:

- Erosion of sediments
- Volcanic eruptions releasing ash and gases
- Dissolved minerals from rocks and soil

Types of Water Pollution:

1. **Chemical Pollution:** Pollution caused by the release of harmful chemicals into water bodies. Examples include:
 - Heavy metals (e.g., lead, mercury, cadmium)
 - Pesticides and herbicides
 - Industrial chemicals (e.g., PCBs, dioxins)
 - Pharmaceuticals and personal care products
2. **Nutrient Pollution:** Pollution resulting from an excess of nutrients, primarily nitrogen and phosphorus, which can lead to eutrophication. Sources include:
 - Agricultural runoff
 - Wastewater discharges
 - Fertilizer use
3. **Biological Pollution:** Pollution caused by pathogens and harmful microorganisms. Sources include:
 - Sewage and untreated wastewater
 - Animal waste
 - Agricultural runoff
4. **Sediment Pollution:** Pollution caused by the erosion and transport of soil particles into water bodies. Sources include:
 - Erosion from construction sites
 - Agricultural activities
 - Deforestation and land clearing
5. **Thermal Pollution:** Pollution caused by the release of heated water into natural water bodies, often from industrial processes or power plants.

Each type of water pollution can have detrimental effects on aquatic ecosystems, human health, and the economy. Addressing water pollution requires comprehensive management strategies that consider both the sources and types of pollutants involved.

Water bodies can be polluted by a wide variety of substances, including pathogenic microorganisms, putrescible organic waste, fertilizers and plant nutrients, toxic chemicals, sediments, heat, petroleum (oil), and radioactive substances. Several types of water pollutants are considered below.

Water pollutants come from either point sources or dispersed sources. A **point source** is a pipe or channel, such as those used for discharge from an industrial facility or a city sewerage system. A **dispersed (or nonpoint) source** is a very broad unconfined area from which a variety of pollutants enter the water body, such as the runoff from an agricultural area. Point sources of water pollution are easier to control than dispersed sources, because the contaminated water has been collected and conveyed to one single point where it can be treated. Pollution from dispersed sources is difficult to control, and, despite much progress in the building of modern sewage-treatment plants, dispersed sources continue to cause a large fraction of water pollution problems.

Domestic sewage

Domestic sewage is the primary source of pathogens (disease-causing microorganisms) and putrescible organic substances. Because pathogens are excreted in feces, all sewage from cities and towns is likely to contain pathogens of some type, potentially presenting a direct threat to public health. Putrescible organic matter presents a different sort of threat to water quality. As organics are decomposed naturally in the sewage by bacteria and other microorganisms, the dissolved oxygen content of the water is depleted. This endangers the quality of lakes and streams, where high levels of oxygen are required for fish and other aquatic organisms to survive. In addition, domestic sewage commonly contains active pharmaceutical ingredients, which can harm aquatic organisms and may facilitate antibiotic resistance. Sewage-treatment processes reduce the levels of pathogens and organics in wastewater, but they do not eliminate them completely .

Domestic sewage is also a major source of plant nutrients, mainly nitrates and phosphates. Excess nitrates and phosphates in water promote the growth of algae, sometimes causing unusually dense and rapid growths known as algal blooms. When the algae die, oxygen dissolved in the water declines because microorganisms use oxygen to digest algae during the process of decomposition (*see also* biochemical oxygen demand). Anaerobic organisms (organisms that do not require oxygen to live) then metabolize the organic wastes, releasing gases such as methane and hydrogen sulfide, which are harmful to the aerobic (oxygen-requiring) forms of life. The process by which a lake changes from a clean, clear condition— with a relatively low concentration of dissolved nutrients and a balanced

aquatic community—to a nutrient-rich, algae-filled state and thence to an oxygen-deficient, waste-filled condition is called eutrophication. Eutrophication is a naturally occurring, slow, and inevitable process. However, when it is accelerated by human activity and water pollution (a phenomenon called cultural eutrophication), it can lead to the premature aging and death of a body of water.

Solid waste

The improper disposal of solid waste is a major source of water pollution. Solid waste includes garbage, rubbish, electronic waste, trash, and construction and demolition waste, all of which are generated by individual, residential, commercial, institutional, and industrial activities. The problem is especially acute in developing countries that may lack infrastructure to properly dispose of solid waste or that may have inadequate resources or regulation to limit improper disposal. In some places solid waste is intentionally dumped into bodies of water. Land pollution can also become water pollution if the trash or other debris is carried by animals, wind, or rainfall to bodies of water. Significant amounts of solid waste pollution in inland bodies of water can also eventually make their way to the ocean. Solid waste pollution is unsightly and damaging to the health of aquatic ecosystems and can harm wildlife directly. Many solid wastes, such as plastics and electronic waste, break down and leach harmful chemicals into the water, making them a source of toxic or hazardous waste.

Of growing concern for aquatic environments is plastic pollution. Since the ocean is downstream from nearly every terrestrial location, it is the receiving body for much of the plastic waste generated on land. Several million tons of debris end up in the world's oceans every year, and much of it is improperly discarded plastic litter. Plastic pollution can be broken down by waves and ultraviolet radiation into smaller pieces known as microplastics, which are less than 5 mm (0.2 inch) in length and are not biodegradable. Primary microplastics, such as microbeads in personal care products and plastic fibers in synthetic textiles (e.g., nylon), also enter the environment directly, through any of various channels—for example, from wastewater treatment systems, from household laundry, or from unintentional spills during manufacturing or transport. Alarming, a number of studies of both freshwater and marine locations have found microplastics in every aquatic organism tested. These tiny plastics are suspected of working their way up the marine food chains, from zooplankton and small fish to large marine predators, and have been found in seafood. Microplastics have also been detected in drinking water. Their health effects are unknown.

Toxic waste

Waste is considered toxic if it is poisonous, radioactive, explosive, carcinogenic (causing cancer), mutagenic (causing damage to chromosomes), teratogenic (causing birth defects), or bioaccumulative (that is, increasing in concentration at the higher ends of food chains). Sources of toxic chemicals include improperly disposed wastewater from industrial plants and chemical process facilities (lead, mercury, chromium) as well as surface runoff containing pesticides used on agricultural areas and suburban lawns (chlordane, dieldrin, heptachlor). (For a more-detailed treatment of toxic chemicals, *see* poison and toxic waste.)

Sediment

Sediment (e.g., silt) resulting from soil erosion or construction activity can be carried into water bodies by surface runoff. Suspended sediment interferes with the penetration of sunlight and upsets the ecological balance of a body of water. Also, it can disrupt the reproductive cycles of fish and other forms of life, and when it settles out of suspension it can smother bottom-dwelling organisms.

Thermal pollution

Heat is considered to be a water pollutant because it decreases the capacity of water to hold dissolved oxygen in solution, and it increases the rate of metabolism of fish. Valuable species of game fish (e.g., trout) cannot survive in water with very low levels of dissolved oxygen. A major source of heat is the practice of discharging cooling water from power plants into rivers; the discharged water may be as much as 15 °C (27 °F) warmer than the naturally occurring water. The rise in water temperatures because of global warming can also be considered a form of thermal pollution.

Petroleum (oil) pollution

Petroleum (oil) pollution occurs when oil from roads and parking lots is carried in surface runoff into water bodies. Accidental oil spills are also a source of oil pollution—as in the devastating spills from the tanker *Exxon Valdez* (which released more than 260,000 barrels in Alaska's Prince William Sound in 1989) and from the Deepwater Horizon oil rig (which released more than 4 million barrels of oil into the Gulf of Mexico in 2010). Oil slicks eventually move toward shore, harming aquatic life and damaging recreation areas.

II. Organic and inorganic pollutants

Organic pollution is a type of chemical pollution caused by carbon pollutants, such as liquid manure, sewage treatment sludge, DDT etc. Some of the major reasons for organic water

pollution are the extensive use of chemicals in the agricultural field in the form of molluscicides, insecticides, herbicides, fungicides, rodenticides, and nematocides; the oil spillages in the water bodies; and the waste generated from the industries like petrochemicals

Inorganic pollutants are the compounds of inorganic by-products arising due to radiant energy and noise, heat, or light. Examples of inorganic pollutants arsenic, cadmium, lead, mercury, chromium, aluminum etc.

Inorganic pollutants are non-biodegradable substances, often stemming from industrial, agricultural, and residential sources. These substances, ranging from heavy metals such as lead, mercury, and arsenic to salts like nitrates, phosphates, and sulphates, enter water bodies through both direct and indirect routes.

These pollutants can be persistent, with long-term negative effects on aquatic ecosystems and human health. Industrial effluents, agricultural runoff, and untreated sewage are significant contributors to this form of pollution. It's therefore paramount to understand their sources and how they impact our lives and the environment.

Sources of Inorganic Pollutants

The primary sources of inorganic pollutants in water are human activities. Industrial processes like mining, smelting, and chemical manufacturing release heavy metals and other inorganic pollutants into water bodies. Agricultural practices contribute nitrates and phosphates from fertilisers and pesticides. Residential areas, through improper waste disposal and sewage, also contribute to this issue.

