International Journal of Bio-resource and Stress Management

https://ojs.pphouse.org/index.php/IJBSM

Crossref

IJBSM August 2026, 17(8): 01-26

Article AR7105

Review Article

Stress Management

DOI: HTTPS://DOI.ORG/10.23910/1.2026.7105

Incitement of Pollutants in Aquatic Ambience and Anthropological Well-being

A. T. Ramachandra Naik, Narendra Kumar Maurya, Bhooleshwari[1] and Shivam Dubey

Dept. of Aquatic Environment Management, College of Fisheries, Karnataka Veterinary, Animal and Fisheries Sciences University, Mangaluru, Karnataka (575 002), India

Open Access

Corresponding mauryanarendra678@gmail.com

0009-0001-2353-6241

ABSTRACT

Pollutant incitement in aquatic environments is a serious risk to human health and the environment. Numerous sources, such as household sewage, agricultural runoff, industrial effluents, and plastic debris, contribute to aquatic pollution by releasing dangerous pollutants, including pesticides, heavy metals, and microplastics, into bodies of water. By changing ecosystems, causing poisons to bioaccumulate in the food chain, and leading to the demise of sensitive species, these pollutants impair aquatic biodiversity. Additionally, the deterioration of water quality jeopardizes vital ecosystem functions, including climate regulation and water purification. Polluted water supplies expose communities to harmful elements that lead to long-term health problems, including cancer and developmental defects, and they also serve as carriers of illnesses like cholera and dysentery. Because polluted water supplies affect livelihoods reliant on agriculture, tourism, and fishing, the economic effects are as severe. Inadequate sanitation facilities and restricted access to clean water disproportionately harm vulnerable communities, especially in developing nations. A multifaceted strategy is required to mitigate these effects, including increased enforcement of environmental laws, the use of cleaner manufacturing methods, and the encouragement of sustainable activities like water and waste management. To promote a sense of shared responsibility for protecting aquatic environments, public awareness initiatives and stakeholder cooperation are essential. This study examines the complex effects of pollutants on aquatic ecosystems and human health, highlighting the pressing need for coordinated approaches to reduce pollution, encourage sustainable behaviors, and protect the wellbeing of human and natural systems.

KEYWORDS: Anthropology, health, eutrophication, halogens, microbial contaminants, pollutants

***Citation* (VANCOUVER):** Naik et al., Incitement of Pollutants in Aquatic Ambience and Anthropological Well-being. *International Journal of Bio-resource and Stress Management,* 2026; 17(8), 01-26. HTTPS://DOI.ORG/10.23910/1.2026.7105.

Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, author have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The author has declared that no conflict of interest exists.

RECEIVED on 02nd April 2026 RECEIVED in revised form on 24th July 2026 ACCEPTED in final form on 10th August 2026 PUBLISHED on 19th August 2026

1. INTRODUCTION

Water is a necessary component for all life on Earth. It is permissible to state that Earth is the only planet with the ability to support life due to its presence of water (Franks, 2007). Water is essential to life and cannot exist without it. After all, it makes up more than 70% of the Earth (Franks, 2007). Access to water is importent for human survival every day (De Buck et al., 2015). Human activities, including garbage disposal, the release of chemicals, industrial and agricultural effluent, etc., frequently cause water to become polluted (Akhtar et al., 2021). Extreme amounts of pollutants (hazards) in a water body render it unfit for routine human uses (Mushtaq et al., 2020). Water quality deteriorates and aquatic life is impacted (Babuji et al., 2023). There are negative health repercussions when people or animals drink this water to relieve their thirst. Only a tiny fraction of the world's freshwater, less than 0.3%, is fit for routine drinking (Sedlak, 2014). Some of the water pollution can be attributed to direct sources, such as companies, waste management facilities, refineries etc. (Madhav et al., 2020) that dump untreated trash and hazardous by-products into surrounding water sources. India is experiencing an increase in waterborne infections because of the high biological pollution in the water (Albert et al., 2024). Every year, waterborne infections harm 37.7 million people in India and 1.5 million children die from diarrhea (Mahant and Biswal, 2022). Lack of cleanliness is one of the worst causes of water contamination. 90% of sewage is dumped into bodies of water untreated (Tariq and Mushtaq, 2023). Sewage and other effluents totaling 2 million tons per day are released into the water supply (Karri et al., 2021; Giri, 2021). Due to the worsening pollution of freshwater resources brought on by the discharge of significant amounts of wastewater that has either not been adequately treated or has been improperly treated into rivers, lakes, aquifers, and coastal waters (Mishra, 2023), the world's limited water resources are becoming even more scarce. Climate-driven alterations in environmental conditions, particularly shifts in temperature regimes and precipitation patterns, have significantly influenced the functioning of aquatic ecosystems by affecting essential biological processes such as feeding, growth, and reproduction (Grimm et al., 2013; Mishra, 2023). In addition, increasing levels of environmental pollution have contributed to the degradation and modification of habitats supporting diverse aquatic flora and fauna (Malik et al., 2020). A comprehensive understanding of both natural and anthropogenic influences on freshwater ecosystems is therefore essential for developing effective management strategies, conservation measures, and regulatory frameworks aimed at maintaining ecological integrity (Cantonati et al., 2020). Aquatic environments are increasingly exposed to a wide range of contaminants, including excess nutrients and suspended sediments, pharmaceutical residues, polycyclic aromatic hydrocarbons (PAHs), flame-retardant compounds, both licit and illicit drug residues, emerging contaminants, agricultural chemicals such as pesticides and herbicides, endocrine-disrupting substances, and persistent organic pollutants (POPs) (Yadav and Ahmaruzzaman, 2024). Furthermore, novel causes of freshwater pollution include artificial nanoparticles and microplastics (Bexeitova et al., 2024). The term "pollution" is used to describe any unwanted modification to an ecosystem's inherent quality brought on by changes to its physical, chemical, and biological components (Chakraborty and Chakraborty, 2021). One of the most valued sources of high-quality protein for humans is the fish community (Balami et al., 2019). When certain fish species are exposed to chemical contaminants, it responds rapidly and causes several changes to their various body organs and parts, primarily to their gills, kidneys, and liver. The prevalence of antibiotic occurrence and concentration trends in several compartments of aquatic lakes in China were reviewed by (Zhou et al., 2019). About 39 different antibiotics were observed, and among the aquatic creatures, quinine antibiotics posed the most ecotoxicological danger.

2. APPRAISAL OF FICTION

Water pollution comes from both natural and man-made sources, which gives rise to a variety of water pollutants. For people to be healthy and protected from various diseases, these water pollutants must be removed from the water (Saravanan et al., 2021; Lin et al., 2021). Not just India, but the entire world experiences the same problems. The water pollution causes because of the releases of chemicals and metals from factories and businesses (Madhav et al., 2020). According to reports, one of the main causes of this is the discharge of untreated sewage into rivers, which ultimately has an impact on the environment and, ultimately, people (Preisner, 2020). The route along which contaminant accumulates can have serious implications in assessing hazards. The accumulation route at one trophic level can have a major impact on the consequent passage of contaminants throughout the rest of the food chain (Dar et al., 2019). For example, the water contaminated with bio-concentrated zebra mussel, *Dreissena polymorpha*, has a primary effect on fish species.

More than 8 mt of micro-plastic waste were discharged into the ocean by the global land environment and the amount of micro-plastic waste in the land soil and surface water was not accurate (Zhang et al., 2020). Heavy metals and micro-plastic pollutants are common in aquatic environments (Hashmi et al., 2022). Runoff water is mainly contaminated by biocides employed as protective agents in building materials (Kumar, 2020), heavy metals coming from the corrosion of metallic surfaces, pollutants released in gaseous emissions and subject to dry and wet deposition and pollutants escaping from contaminated sites such as poly-chlorinated biphenyls (Weyrauch et al., 2010). Water pollution is greatly influenced by humans. Students and the public should get environmental education so that this issue might be mitigated to some extent. (Sharma et al., 2022) stated that 34 billion m^3 of water are used by the industrial sector each year; by 2050, this amount is expected to increase.

3. ORIGIN OF WATER POLLUTION

'Pollutants' fundamental presence on earth, the evolution of natural products through transformation and their artificial production can all be traced to their origin (Jarrige et al., 2020). It is possible that the particles will naturally form as part of the ecological background exposure levels. Several of them are detoxified or expelled by the organisms (Abbas et al., 2020). By concentrating and transforming naturally existing substances, certain contaminants can be created during their use in home, agricultural, or industrial settings (Rasheed et al., 2019). The generation of sewage and waste waters including pesticides, heavy metals, radionuclides, petrochemical hydrocarbons, and agrochemicals are some notable examples of pollutants that have arisen from this (Weldeslassie et al., 2018). The Figure 1. is a flowchart that shows how hazardous materials, chemicals, pollutants, or other items can leak out.

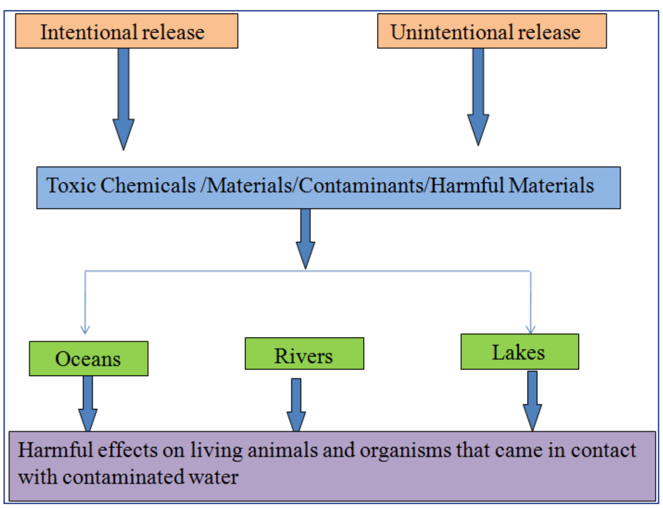

Figure 1: This picture shows how toxic chemical releases can occur and how contaminated water affects both people and animals

The primary causes of water contamination that result in contamination are direct and indirect ones, together with more sources (Ritter et al., 2002) Figure 2.

3.1. Direct pollution

When a factory discharges contaminated water or hazardous chemicals mixed with water into an aquatic body, this is known as direct pollution (Akhtar et al., 2021). The toxic nature of the water can also kill aquatic life (Huntingford et al., 2006). In developed nations, drinking water from rivers or streams is no longer necessary (Postel and Richter, 2012). There are risks associated with drinking tainted water or participating in activities like canoeing on it, since some of them might cause disease or even death (Pakasi, 2018).

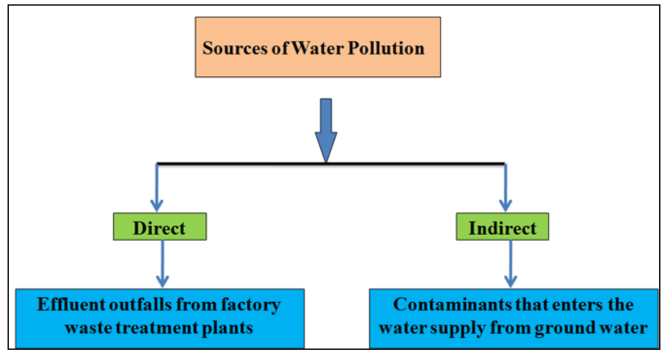

Figure 2: Sources of water pollution

3.2. Indirect pollution

Direct injection of contaminants into the water does not result in indirect water pollution; rather, contaminants that wind up there do (Ritter et al., 2002). As an illustration, consider the pollutants from fertilizers and pesticides that gradually seep into the groundwater, the soil, and finally nearby streams (Sarkar et al., 2024). In addition, smog in the air can result in acid rain, which is particularly dangerous to wildlife and can contaminate lakes, streams and shorelines as well as make the water lethal for organisms that live in and around it (Edo et al., 2024) (Table 1).

4. POLLUTANTS, THEIR SOURCES, AND THE ENVIRONMENTAL EFFECTS

4.1. Nutrients

Nitrogen (N) and phosphorus (P) are the two main nutrients that create water quality problems in rivers and lakes (Badamasi et al., 2019). Farmland, grassland, and forest nutrient losses are significant contributors restricting water quality (Schoumans et al., 2014). Modelling long-term nutrient pollution is essential for environmental management and for assessing the contribution of plants to reducing non-point source pollution (Wang et al., 2022). P and N are the most significant components in these processes, and they can be stored in sediments or flushed into nearby coastal waters (Badamasi et al., 2019; Bechmann and Stalnacke, 2019). In this hypereutrophic system, eutrophication is prevented by high nitrogen accumulation in sediments and by fluxes across the water-sediment interface, which control the nitrogen balance (Zaldívar et al., 2008). In comparison to other coastal

Table 1: Overview of various sources of pollutants, the types of pollutants source, environmental and health effects and mitigation

Sources	Pollutants	Effects	Solution	References
Domestic waste	Organic matter and microorganisms (Total salts, chlorides, nutrients, detergents, and oil)	• Hard detergents produce foam, which limits the oxygen supply to water-borne organisms • Nutrients and Soft detergents are biodegradable, but they may contain high phosphate levels, which can cause eutrophication	Employ biodegradable detergents with low phosphates	Karri et al. (2021)
Untreated Wastewater	Suspended solids NO_3 – and PO_3 4	• If floating materials are biodegradable, microbes can break them down, but their operations demand a lot of oxygen • Decreased light penetration Causes eutrophication	Assist in preventing the farm slurry (liquid manure) from entering rivers and ponds by treating sewage before it enters waterways	Anonymous, 2017
Agricultural run-offs	NO_3– and PO_4^{3-} (in fertilizers) Pesticide and herbicide traces	• Excess amount of NO_3– and PO_4^{3-} results to eutrophication • Pesticide levels begin to accumulate as they transit down the food chain • Pesticide and herbicide accumulation has deadly consequences on aquatic species as well as humans	• Control the use of fertilisers by (a) using them solely during crop growth (b) avoiding using them on void fields (c) avoiding using them when rain is predicted (d) and not disposing of them in rivers Employ biodegradable pesticides, biological pest management techniques, and genetically modified plants to make them resistant to pests so that you can use fewer chemical insecticides	Pericherla et al. (2020)
Animal waste	Bacterial and protozoan microorganisms	If water is utilized to drink, perhaps waterborne diseases like cholera will be appropriately treated	Drink only adequately treated and boiled water	Zilberman et al. (2006)
Industries' effluents	Heavy metals including Cu, Hg, Zn, and Cr	Mercury accumulation in the food chain can result in acute neurological problems in humans. Waste water contains a range of contaminants, including hydrogen sulphide	Before dumping wastewater into bodies of water, it must be treated. Bring a lawsuit to stop the disposal of hazardous garbage	Jain et al. (2021)

regions, such as those in Europe and the USA, there is a greater concentration of nitrogen in the sediments (Oelsner and Stets, 2019). Eutrophication and oxygen depletion in aquatic ecosystems have typically resulted from excessive fertilizer input connected to human activities (Rathore et al., 2016). In this hypereutrophic system, large fluxes across the water-sediment interface control the nitrogen balance and avoid eutrophication.

Eutrophication and high N and P concentrations also occur close to industrial estates and from home effluent discharge in the Santos-São Vincente System (Barletta et al., 2023). When the organic matter decomposes, fertilizer factories, port activities, household wastes, and sewage outfalls are to blame for high organic-P and low dissolved oxygen levels (Berbel et al., 2015). Although nutrient dispersion was shown along the coast, the risk to the biota was increased because of low dissolved oxygen due to excessive nutrient concentrations upstream (Barletta et al., 2019). Figure 3 is a flowchart illustrating the environmental impacts of fine anthropogenic sediment originating from sources like agriculture runoff, urban discharge/sewage, pisciculture, and industry/port activities. These sediments lead to algal blooms, causing coral bleaching/diseases and fish kills. This results in increased water turbidity and reduced oxygen and light, negatively affecting aquatic ecosystems.

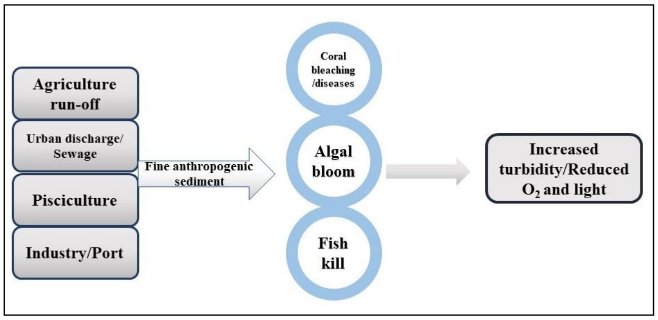

Figure 3: The impact of nutrient pollution on the environment

4.2. Halogens

Chloride, fluoride, bromide, and iodide are the most frequent halides found in natural water (Oke et al., 2023). All natural water sources, including lakes, streams, rivers, and groundwater, contain these ions since they are very soluble in water (Kumar et al., 2022). Halides can be found in hard rock weathering, industrial runoff, herbicides, fertilizers, and other things (Sunitha et al., 2022). Because of their conservative nature, chloride and bromide are used as the source of salinity in coastal aquifers (Madhav et al., 2020). In semi-arid and arid climates with alkaline soil and crystalline igneous rocks, fluoride pollution in groundwater is a prevalent issue (Sreedevi et al., 2002). Health effects are present at fluoride concentrations below (0.6 mg l^{-1}) and above (1.5 mg l^{-1}) these limits in groundwater (Jha et al., 2013). Fluoride concentrations as low as 1.5 mg l^{-1} can result in dental fluorosis, whereas concentrations as high as 3 mg l^{-1} can result in skeletal fluorosis (Veneri et al., 2023). Over 60 million people in India, including 6 million children, suffer from fluorosis because of the high fluoride concentration in the water (Dar and Kurella, 2023; Madhav et al., 2020).

Chloride in water resources is produced by ion exchange processes, halite dissolution, precipitation, farming runoff, untreated industrial effluents, sewage wastes, etc (Salam and Sultana, 2022). Cl levels that are too high degrade the water's quality (Bhateria and Jain, 2016). Moreover, it helps many metals, particularly those used in man-made structures like dams, to corrode. Natural water supplies have bromide-enhanced water in the form of an inorganic salt (Winid, 2015). Freshwater may naturally contain bromide due to rainfall, combustion of leaded gasoline containing ethylene dibromide may result in considerable levels (Vainikka and Hupa, 2012). However aquatic organisms may die because of high Br concentrations. High amounts of bromide in plants might have a negative influence on their development and germination (Madhav et al., 2020).

4.3. Heavy metals

Toxic metals are commonly introduced into aquatic environments through industrial discharges, municipal effluents, and urban runoff, posing potential risks to both human health and aquatic biota (Singh et al., 2022). Rapid industrial development and expanding urbanization have substantially contributed to elevated concentrations of trace elements, particularly heavy metals, in freshwater systems worldwide (Huang et al., 2018). Once released into the environment, these hazardous substances tend to persist and gradually accumulate in soils as well as bottom sediments of aquatic ecosystems (Mohod and Dhote, 2013). Bioaccumulation describes the progressive increase in the concentration of chemical substances within living organisms over time relative to their surrounding environment (Wang, 2016). Furthermore, heavy metals may also enter rivers, lakes, streams, and groundwater through the weathering and leaching of soils caused by acid rain, in addition to inputs from industrial and domestic wastes (Kapoor and Singh, 2021). Figure 4 illustrates the major sources of heavy metals.

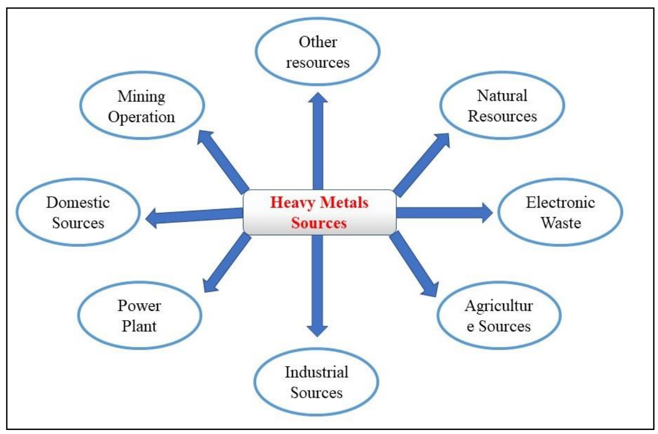

Figure 4: Major sources of HM pollutants

The effects of heavy metal toxicity might include impaired or reduced mental and central nervous system function, decreased energy levels, and harm to the lungs, kidneys, liver, and other essential organs (Ungureanu and Mustatea, 2022). Metals that are highly poisonous even in small amounts include arsenic, lead, cadmium, nickel, mercury, chromium, cobalt, zinc, and selenium (Ungureanu and Mustatea, 2022). A growing number of enterprises are releasing their metal-containing effluents into fresh water without any sufficient treatment, which is a cause for concern regarding the level of heavy metals in our resources (Masindi and Muedi, 2018). Table 2 summarizes various heavy metals, their primary

Table 2: Sources of heavy metals (Source: Anonymous, 2022 and Mahurpawar, 2015)

Heavy metals	Source	Target organs	Clinical effects	Reference
Chromium (Cr)	Mining, industrial coolants, chromium salts manufacturing, leather tanning	Pulmonary, kidney	Ulcer, perforation of nasal septum, respiratory cancer	Naja and Volesky, 2017
Lead (Pb)	lead acid batteries, paints, E-waste, smelting operations, coal- based thermal power plants, ceramics, bangle industry	Nervous system, hematopoietic system, renal	Encephalopathy, peripheral neuropathy, central nervous disorders, anaemia	Assi et al., 2016
Mercury (Hg)	Chlor-alkali plants, thermal power plants, fluorescent lamps, hospital waste (damaged thermometers, barometers, sphygmomanometers), electrical appliances etc.	Nervous system, renal	Proteinuria	Zulaikhah et al., 2020
Arsenic (As)	Geogenic/natural processes, smelting operations, thermal power plants, fuel	Pulmonary nervous system, skin	Perforation of nasal septum, respiratory cancer, peripheral neuropathy: dermatomes, skin, cancer	Tchounwou et al., 2019
Copper (Cu)	Mining, electroplating, and smelting operations	Nervous system, liver	Central and peripheral neuropathies	Taylor et al., 2020; Wang et al., 2024
Nickel (Ni)	Smelting operations, thermal power plants, battery industry	Pulmonary, skin	Cancer, dramatis	Yang and Ma, 2021
Cadmium (Cd)	Zinc smelting, waste batteries, e-waste, paint sludge, incinerations, and fuel combustion	Renal, skeletal, pulmonary	Proteinuria, glucosuria, osteomalacia, aminoaciduria, emphysema	Wang et al., 2021
Zinc (Zn)	Smelting, electroplating	Nervous, pulmonary system	Central nervous system disorders, visual defects and eeg changes, pneumoconiosis	Fujihara and Nishimoto, 2024

sources, the organs they target, and the clinical effects associated with exposure.

4.4. Microplastic

Microplastics (MPs, plastic particles 5 mm) are a developing global problem because of how frequently they are detected in the environment and the harm to living organisms (Gani et al., 2024). Currently, marine systems constitute a topic of more than 96% of microplastics studies (Papadimitriu and Allinson, 2022). Furthermore, contributing to the release of microplastics into the environment are the building industry, landfills, littering, artificial grass and road paints, tyres, agricultural plastic films, personal care and cosmetic products and the packaging industry (Muniv and Supanekar, 2024). Because of its widespread use, poor management and persistence in the environment, plastic garbage is recognized to exert a range of ecological pressures et al., 2018). By 2050, according to estimates from the United Nations Environment Programme (UNEP), there will be more plastic in the oceans than fish (Lebreton and Andrady, 2019). Under residential washing conditions, a 6 kg wash load of acrylic fabric could discharge around 700000 microfibers (Rathinamoorthy and Raja Balasaraswathi, 2022).

Microplastics exposed to toxic algae produce phycotoxins, which may have an indirect negative impact on human health and the economy (Gündogdu et al., 2023). The majority of phytotoxins are delivered by the harmful algae and are then taken up by plankton or benthos (bivalves or crustaceans) through eating. For instance, algal toxins created by the exposure of micro-plastics that effectively accumulate in shellfish and can transfer in the food web and indirectly cause dangerous symptoms in people are the source of diarrhetic and paralytic shellfish poisonings (DSP and PSP) (Smayda, 2019). Algal toxins can build up in marine food webs and move up the trophic chain.

4.4.1. Sources of marine microplastics

There are several different causes of marine microplastic pollution, which can generally be categorized into inland, maritime, and aerial sources (Auta et al., 2017). The most significant routes for the movement of microplastics from inland areas to the ocean are thought to be rivers (Wang et al., 2024; De Arbeloa and Marzadri, 2024). 80% or so of the plastic debris in the ocean comes from the land. Plastic debris in municipal drainage systems and sewage effluents, or improper management of inland areas, is blown into the sea through rivers, and plastic waste from beach-related tourism is discarded directly into the environment (Nabi et al., 2024; Dey et al., 2024).

4.4.2. Harmful effect on human health

✧ The products like toothpaste, face washes, hand cleaners and dental care items that contain polyethylene microplastic particles, which ultimately cause skin damage (Patil et al., 2024).

✧ The ingestion of microplastic and microbead particles can result in absorption through the digestive system (Rathod et al., 2023).

✧ It can cause infertility, obesity, and cancer (Ali et al., 2024).

✧ Chemicals that imitate oestrogen can lead to breast cancer in women (Flaws et al., 2020).

✧ Humans consume microplastics, and the abundance of microplastic contaminants in seafood poses a serious threat to food safety (Smayda, 2019).

4.5. Microbial pollution

The environmental problem of microbial pollution has gotten worse over the past few decades and is now regarded as a major threat to food security (Some et al., 2021). Microbial contamination is a serious issue because it may cause several health problems (Grumezescu and Holban, 2017). Discharges from water treatment facilities, decontamination facilities, hospitals and other industries are the main point sources for microbial contamination of natural aquatic resources (Sharma et al., 2022). Urban activities and pathogen concentrations are connected (Lee et al., 2020). Microbes that cause disease can infect aquatic plants, animals and possibly even humans. Moreover, microbes can reduce the quantity of oxygen in the water, which makes it more difficult for aquatic plants and animals to live (Olmos et al., 2020). Bacteria, viruses, and parasites are examples of microorganisms and they can arise from the following sources:

✧ Sewage that has not been properly cleaned (Naidoo and Olaniran, 2014),

✧ Animal waste runoff (Mallin and Cahoon, 2003),

✧ Industrial sources such as slaughterhouses (Ovuru et al., 2024),

✧ Food and paper mills (Singh et al., 2016),

✧ Some landfills (Lin et al., 2023).

Fecal matter produced by animal production is the main cause of microbiological pollution in agricultural watersheds (Mallin et al., 2015). Both non-point sources, such grazed pastures and grasslands and point sources, like storage facilities and feedlots, have a significant potential for microbial loading (Wei, 2012). In rural watersheds, failed septic systems and wildlife are two non-agricultural causes of microbiological pollution (Wei, 2012).

4.5.1. Harmful effect on human health

Human health is severely impacted by unsafe water (Abdullah et al., 2022; Karri et al., 2021). According to the UNESCO 2021 Global Water Development Report, approximately 300,000 children under the age of five, or 5.3% of all deaths in this age group, die each year from diarrhea brought on by contaminated drinking water, improper sanitation, and poor hand hygiene (Dadi, 2025). According to data from Palestine, individuals who directly consume municipal water are more likely to contract illnesses like diarrhea than those who utilize desalinated and home-filtered drinking water (Edo et al., 2024).

4.6. Oil spill

An oil spill is when oil leaks onto a huge body of water's surface (Zhang et al., 2019). Many types of aquatic life are harmed by oil on ocean surfaces because it prevents enough sunlight from accessing the surface and lowers the concentration of dissolved oxygen (Bacosa et al., 2022). Crude oil destroys the insulating and waterproofing qualities of feathers and fur, which increases the risk of hypothermia in oil-coated birds and marine mammals. Besides that, ingested oil may be hazardous to the afflicted animals and damage to their habitat and rate of reproduction may hinder the long-term recovery of animal populations from the immediate harm brought on by the spill (Elumalai et al., 2024; Asif et al., 2022). Moreover, there may be significant plant damage; mangroves and saltwater marshes are two major coastline ecosystems that commonly experience oil damage (Onyena and Sam, 2020).

Oil typically rises to the water's surface because it has a lower density than seawater. Smaller oil droplets have a neutral relative buoyancy and will stay entrained in the water column unless they coalesce into larger droplets (Brandvik et al., 2017; Boufadel et al., 2020). Huge oil droplets rise more quickly than smaller oil droplets (Eow and Ghadiri, 2002). Tiny oil droplets are more vulnerable to microbiological and physical deterioration. Oil-dispersing compounds reduce the size of the oil droplets and boost their stability, altering the behavior and destiny of the oil.

4.6.1. Largest oil tanker spill in history

The Torrey Canyon catastrophe off Cornwall, England, in 1967 (when 119,000 metric tonnes of crude oil were spilled) (Jupp, 2020), and the Amoco Cadiz tragedy off Brittany, France, in 1978, were two extremely significant oil-tanker spills that occurred in European waters (223,000 metric tonnes of crude oil and ship fuel were spilled) (Vazquez-Botello et al., 2020; Arias and Botte, 2020). Both occurrences had a long-lasting impact on shipping laws and how emergency environmental situations like oil spills are handled (Vazquez-Botello et al., 2020). Although the 1989 Exxon Valdez oil spill in Prince William Sound, Alaska, inflicted significant ecological and economic harm on North America, the amount of oil released places it far below the greatest oil-tanker spills in history (37,000 metric tons) (D'Andrea and Reddy, 2014).

Oil spills cause harm in several different ways. There are a few aftereffects of oil spills, including:

✧ Sunlight does not highlight the ocean's plants and fauna (Buskey et al., 2016).

✧ It affects the entire food chain in the ecosystem (Zhang et al., 2019).

✧ Oil breaks and sinks into the ocean when it spreads in the sea, harming the health of marine life (Blumer et al., 1971).

✧ It taints the ocean's natural environment (Michel and Fingas, 2016).

✧ The beaches are severely impacted by oil spills. The oil has blanketed the birds and the marine creatures (Akpan, 2022).

Because it covers everything that is along the beaches, including sand, animals, grass and other plant life, oil is extremely harmful to the entire environment.

Figure 5 presents a diagram illustrating various control measures of oil spills. The measures are divided into two broad categories on either side of a central circle labelled "Control Measures of Oil Spill." Each method is listed within a rectangle around the central concept.

Control measures of oil spills:

1. *Using oil booms:* Floating barriers used to contain and prevent the spread of oil on the water's surface (Michel and Fingas, 2016).

2. *Using sorbents*: Materials used to absorb or adsorb oil from the water, aiding in clean-up (Bhardwaj and Bhaskarwar, 2018).

3. *Natural recovery:* Allowing the ecosystem to heal naturally without human intervention, usually considered when the impact is less severe (Jones, 1999).

4. *Using manual labour:* Employing people to physically clean affected areas, especially on shorelines or beaches (Moller, 1997).

5. *Hot water and high-pressure washing*: Spraying affected areas with hot water at high pressure to remove oil from rocks, shorelines, and other surfaces (Ogunbiyi et al., 2023).

6. *Chemical stabilization of oil by Elastomizer:* Using chemicals that form a rubber-like substance, which stabilizes the oil, making it easier to clean (Lee et al., 2024).

7. *Bio-remediation*: Utilizing biological agents, such as bacteria, to break down and degrade the oil (Tewari and Sirvaiya, 2015).

8. *Using skimmers:* Machines or tools that skim the surface of the water to collect and remove oil (Fingas, 2016).

9. *Using dispersants*: Chemicals sprayed over oil spills to break the oil into smaller droplets, allowing it to mix with water and degrade more quickly (Chapman et al., 2007).

10. *Using burning in-situ:* Setting fire to the oil spill, which burns the oil on the water's surface and reduces its volume (Ekperusi et al., 2019).

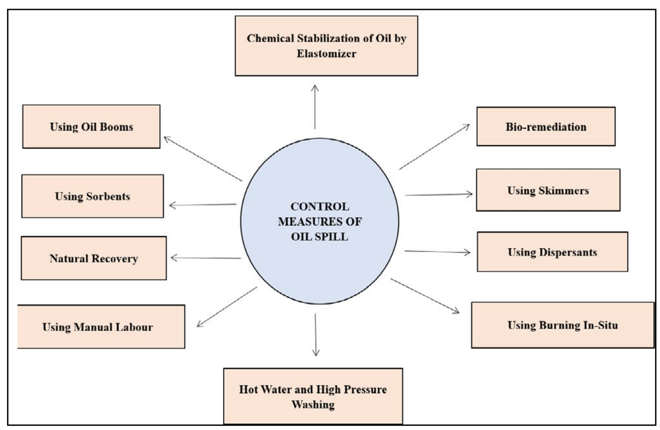

Figure 5: Several techniques for cleaning up an oil spill at sea

4.7. Pesticides

The insecticides are designed to eradicate insects and pests in general; they are not particular. They employ application strategies that ensure the poisons only kill the targeted pests while avoiding the targeted organisms (Zaller, 2020). But these target pests are just animal species that share many characteristics with other animals (Agrawal et al., 2010). One of these characteristics is being susceptible to certain substances. In other words, a material that is hazardous to one species could also be toxic to other animals (Zaller, 2020). Even though they might need a larger dosage to cause harm to humans than pests like insects, many pesticides are dangerous to humans (Yadav and Devi, 2017). The dosages needed to remove a pest have an impact on humans in a number of ways, including interference with sex hormone function and reproductive efficiency (Sharma et al., 2020). Because the pesticides behave as xenohormones, which mimic the effects of endogenous hormones, or because they otherwise disturb endocrine processes, they are all categorized as endocrine disruptors (Benachour et al., 2012). More than half of the water pollution in streams and rivers is caused by chemical leaching and mixing from agricultural practices, according to a 1990 report from the Environmental Protection Agency (EPA) (Cook et al., 1995).

Pesticides are most frequently categorized using the chemical makeup and characteristics of their active components (Hassaan and El Nemr, 2020). There are four main classes of pesticides according to their chemical makeup: pyrethroids, carbamates, organochlorines, and organophosphates. Organochlorine pesticides belong to the oldest group of pesticides synthesized and used (Kamalesh et al., 2023). Most of them are broad-spectrum insecticides for the control of agricultural and domestic insects. They show a long-term persistence in the environment (Jayaprakas et al., 2023). The mechanism of action of organochlorines is to disrupt the nervous system, leading to convulsions and paralysis in insects, which ultimately causes death (Jayaraj et al., 2016). Dichlorodiphenyltrichloroethane (DDT), lindane, endosulfan, aldrin, dieldrin and chlordane are some of the common examples of organochlorines. Even if DDT has been banned in most developed countries for a long time, it is still being used in most tropical developing countries, including India for malaria vector control.

4.7.1. Sources of pesticides

The types of pesticides used vary greatly and there are many ways for them to circulate into lakes, rivers, streams and oceans. Runoff from farmland, leaching, soil erosion, aerosol drift, atmosphere fallout and domestic and commercial sewage, careless empty container dumping, equipment washing and ground infiltration are some of the ways that pesticides may diffuse into aquatic environments. Pesticide pollution threatens over 64% of agricultural land worldwide, with 31% at significant risk. Pesticide pollution can contaminate aquatic ecosystems, endangering phytoplankton, zooplankton and fish, and ultimately posing a risk to human health (Devi et al., 2024). Several studies have shown that even low-dose, continuous intake of pesticide residues can harm the environment, plants, fish, wildlife and other non-target organisms. These effects may include endocrine disruption, neurological damage and birth defects (Costa et al., 2008).

4.7.2. Pesticides' effects on fish health

There have been pesticide residues found in fish and the human body (Akoto et al., 2016). To keep a check on the quality of food or feed being consumed, the government, as well as other organizations have set a maximum residue level (MRL) for every pesticide. Pesticides toxicity adversely affects the normal physiology of gills, liver, kidney, and digestive tract of fish and hence disturbs their functions. Pesticide toxicity caused several histopathological changes (hyperemia, hyperplasia, necrosis, separation of membrane and fusion of lamellae) in fish gills and affected the osmoregulation as well as respiration in fish.

Primarily, pesticides are accumulated into the body of aquatic organisms, including fish by three possible routes (skin, gills, and mouth) (Bansal, 2021). Firstly, pesticides are directly absorbed through fish skin when fish swim into the contaminated waters. Secondly, gills play an important role in pesticides up taking through respiration process and finally, pesticides absorption occurs by mouth through consumption of pesticide-contaminated water as well as prey known as "secondary poisoning." Excessive and uncontrolled pesticide use resulted in food contamination as well as environmental, agricultural, and aquatic pollution.

4.7.3. Pesticides' effects on human health

Pesticide poisoning is thought to kill 300,000 people annually, making it a major global public health hazard. Exposure to pesticides is unavoidable and can occur through a variety of routes (Sabarwal et al., 2018). Customers, farmers, crop merchants, workers in the pesticide industry, and those who transport these dangerous materials are all exposed to different pesticide concentrations (Luo et al., 2016). Pesticides are typically eliminated through the skin, urine and exhaled air, but they can also be spread throughout the human body by circulation (Damalas and Eleftherohorinos, 2011). The possible health hazards connected to pesticides contamination are influenced not only by the toxicity of the substances but also by the level of exposure (Kim et al., 2017). Numerous cancers, such as neuroblastoma, leukemia, soft tissue sarcoma, Burkitt lymphoma, non-Hodgkin lymphoma, Wilms' tumour, lung cancer, ovarian cancer, and rectal cancer, have been found to be more common in people with substantial pesticide exposure (Rodríguez et al., 2017).

4.7.4. Pesticides effects on Environment

Pesticides contribute to a decline in regional biodiversity among aquatic insects and other freshwater invertebrates. The extinction of some species that are especially vulnerable to pesticide exposure is primarily responsible for this decline in biodiversity. Currently, over 1000 pesticides (Lakhani, 2015) in use across many countries unintentionally entering watery environments via a variety of routes, including surface runoff from agricultural and forestry activities and contributions from rainfall, accidental spraying, spills and ongoing discharges from industrial wastewater. The solubility and stability of pesticides significantly influence their distribution, movement, and availability in aquatic environments (Syafrudin et al., 2021). Pesticides contaminate various water sources, including drinking water, lakes, canals, streams, rivers, seas and estuaries, leading to degraded water quality. This degradation incurs substantial financial losses and harms activities like commercial fishing, as well as natural ponds and aesthetically valuable sites (Sankhla et al., 2018). For instance, Runoff of pesticides from agricultural areas negatively impacts the health of both freshwater and marine ecosystems (Sankhla et al., 2018) (Figure 6).

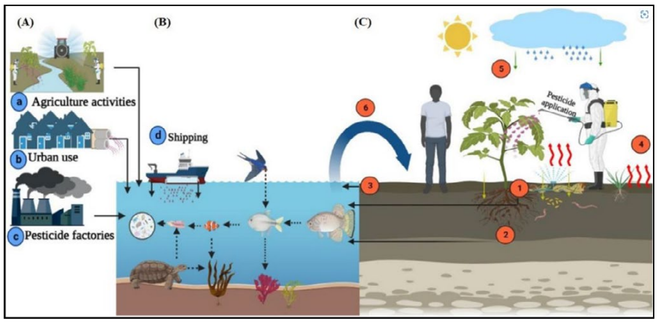

Figure 6: Origins and outcomes of environmental pesticide use that endanger individuals and aquatic biodiversity (Source; Rana et al., 2022)

(A) Chemical pesticides and industrial organic products contaminate water due to

(a) farming

(b) urbanization

(c) factories that produce pesticides and chemicals

(d) transportation

(B) Persistent organic pollutants (POPs) bioaccumulate within the marine food chain

The severe impact of pesticide biomagnification on marine life is illustrated by the detachable arrows linked to the species displayed.

(C) Organic pesticides have negative effects on the aquatic environment through

(1) absorption by plants

(2) leaching to water courses below the root zone

(3) surface runoff and residues on the soil surface

(4) vaporization to the atmosphere

(5) re-deposition by rainfall

(6) reusing contaminated water for water supply and household purposes without treatment. Persistent organic pollutants or POPs.

4.7.5. Prevention strategies

To reduce the adverse impacts of pesticides on human health, the government has taken a number of actions, such as banning highly toxic pesticides, introducing a national implementation plan, encouraging coordinated methods of pest control and restricting the use of hazardous chemicals (Yadav et al., 2015) (Figure 7).

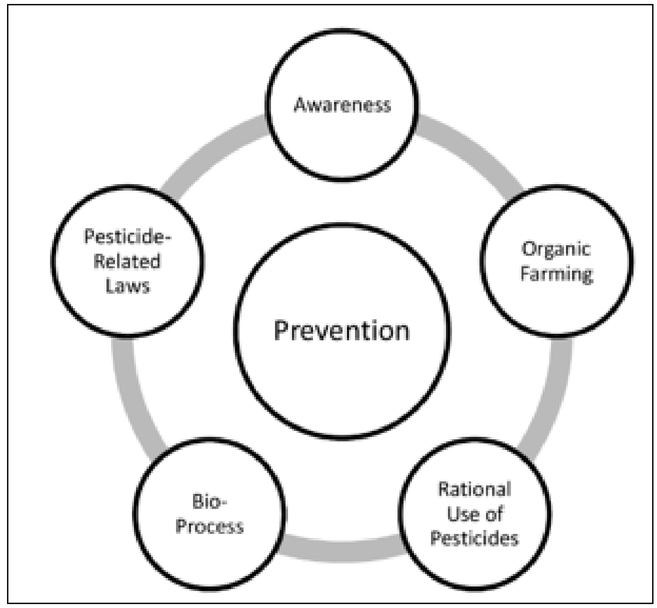

Figure 7: Prevention of pesticide consumption (Source: Rana et al., 2022)

4.7.5.1. Awareness

Farmers often lack awareness of the risks associated with severe pesticide poisoning and the potential long-term effects, such as various neurological disorders. Additionally, many are unfamiliar with modern pesticide application techniques (Ali et al., 2020). While some educated farmers in India have adopted advanced technologies, the majority face challenges in doing so due to limited education or financial resources (Bant et al., 2020). Since farmers are the main consumers of the commodities, agricultural producing companies are now compelled to provide them with training. In their efforts to reduce pests and boost output, farmers disregard health and environmental risks (Ataei et al., 2021).

4.7.5.2. Rational use of pesticides (RUP)

RUP primarily concentrated on the integrated pest management (IPM) and integrated crop management (ICM) subsets, which seek to reduce the adverse impacts of pesticide use by increasing the specificity and accuracy of pesticide application with respect to the products' time and place (Gupta et al., 2010). Integrating all three approaches enhances the potential benefits of RUP, including reduced costs (for labor and pesticides), minimized environmental impact (through efficient spray application and the use of certain substances such as biopesticides), and improved safety (Rani et al., 2020).

4.7.5.3. Bio-processes

Bioremediation has a crucial role in the removal of pesticides from contaminated sites. It is considered an eco-friendly and cost-effective strategy for environmental cleanup. Microorganisms with the ability to break down pesticides are often obtained from sources such as sludge, soil, or aqueous solutions like bio-pesticides and bio-fertilizers (Zhu et al., 2016). To initiate the bioremediation process, bioaugmentation involves introducing microorganisms with specific catabolic capacities into contaminated areas or bioreactors (Perelo, 2010).

4.7.5.4. Adoption and modification of legislation about pesticides

In India, the Ministry of Agriculture oversees the use of pesticides, while the Ministry of Chemicals and Fertilizers controls their manufacturing (Balkrishna et al., 2021). Strict regulations should apply to pesticides, and the bill should contain provisions that forbid the use and sale of Class I pesticides. Based on acute toxicity (Class Ib), the World Health Organization divides pesticides into two categories: extremely harmful (Class Ia) and very hazardous (Class Ib) (Buckley et al., 2021).

4.8. Textile dye

India ranks as the sixth-largest exporter of textiles globally, encompassing a wide range of products, including apparel, home textiles and technical items. The country holds a 4.6% share in the global trade of textiles and apparel. Additionally, India is recognized as the third-largest exporter of textiles and apparel worldwide. The textiles and apparel sector significantly contributes to the Indian economy, accounting for 2.3% of the national GDP, 13% of industrial production, and 12% of total exports (Anonymous, 2024). The textile industry generates varying levels of hazardous contaminants that are emitted into water bodies, posing risks to both human health and the environment. Dyes with low solubility are particularly hazardous as they can be absorbed by organisms and may make its way into the food chain through direct consumption (Klaassen et al., 2013). Industrial applications of textile dyes, frequently used in sectors such as textiles, leather, and paper, contribute significantly to water contamination due to the discharge of effluents containing unused dye materials (Yaseen et al., 2019). With fixing efficiencies usually between 60% and 90%, the dyeing process presents a serious environmental concern. Due to this inefficiency, some 280,000 tonnes of dyes are released into the environment each year, which contributes to the pervasive pollution of water supplies (Akansha et al., 2022). The textile sector, which uses over half of the world's synthetic dyes, is the main driver of the rising demand for these colors (Wang et al., 2022).

4.8.1. What is dye?

In 1856, W.H. Perkin made the discovery of "Mauvine," the first synthetic dye in history. Since then, numerous production of synthetic dyes in vast quantities and are utilized extensively for a range of business applications. (Ajaz et al., 2020) With an annual consumption of 7×105 mt, commercial synthetic dyes are employed in numerous industries, including textiles, leather, paper printing, paint, food, cosmetics, pigments, plastics, and pharmaceuticals (Ahmed et al., 2022). The two kinds of dyes are (1) synthetic dyes and (2) natural dyes. The most of advanced technological disciplines across numerous businesses use synthetic dyes. By measuring the surface area of sewage and activated sludge, these are also utilized to trace ground water (Yagub et al., 2014).

4.8.2. Classification of dye

Considering their solubility, dyes may be categorized. For instance, according to Yagub et al. (2014), insoluble dyes include sulfur, azoic, vat and disperse dyes, while among the soluble dyes are basic and acidic, direct, mordant, metal complex and reactive dyes. However, the primary classification of dyes is determined by their chemical structures, suppliers, and ways of application (Figure 8).

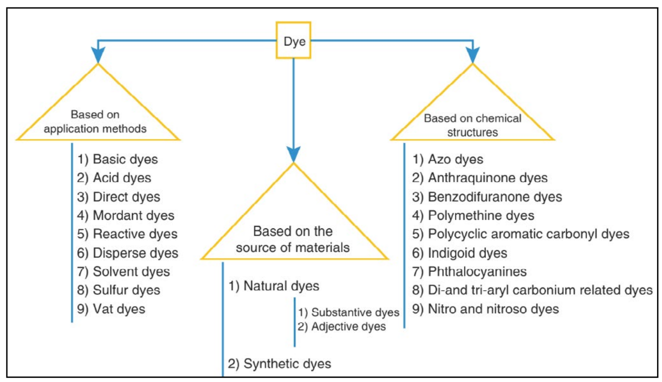

Figure 8: Dyes are categorized according to their chemical structures, suppliers, and techniques of application. (Sid and El-Hawary, 2019)

There are two kinds of dyes, depending on where they come from:

(1) Natural dyes

Minerals, plants, and animals are the three main sources of natural dyes. Most natural dyes are negative. Natural dyes are categorized according to their source as follows: (a) Substantive dyes: These are dyes that are chemically bonded to the fibre without the need for additional chemicals. (a) Adjective dyes: These natural dyes are known as adjective dyes since they require a mordant to become colourfast.

(2) Synthetic dyes

Both organic and inorganic substances are the primary sources of synthetic dyes. These dyes are widely used because they are inexpensive, simple to use, and come in a variety of hues (Raval et al., 2017).

Synthetic dyes are typically divided into three main categories: (1) anionic dyes, which include acid, reactive and direct dyes; (2) cationic dyes, such as basic dyes and (3) non-ionic dyes, including disperse dyes. Table 3 provides a detailed classification of these dyes based on their various applications.

4.8.3. Dyes' harmful impact on the natural environment and human health

Azo dyes, which make up over 70% (almost 9 million tons) of all textile dye production, are the most common dyestuffs used in fabric dyeing (Rawat et al., 2016). Chemical oxygen demand (COD), total dissolved solids (TDS), total suspended solids (TSS), and persistent color are caused by complex synthetic dyes used in the textile industry (Tahir et al., 2021). Because of its harmful effects on colored synthetic azo dyes, wastewater from dyeing businesses poses a significant environmental risk and living things (Khan and Malik, 2018). Water bodies are greatly impacted by this. For example, by preventing sunlight from penetrating deeper water layers, dissolved oxygen levels rapidly decrease, causing significant environmental harm and the loss of aquatic life (Garg and Tripathi, 2017). Water quality deteriorates because of the disruption of photosynthetic activity, which may have harmful impacts on aquatic plants and animals (Lalnunhlimi and Veenagayathri, 2016). The environment may also be harmed by degraded intermediate chemicals that are created during the microbial remediation of azo dyes, such as small-molecule acids, catechols, and aromatic amines (Rawat et al., 2018). Apart from the approximately 4500,000 tons of azo dyes or degraded products (aromatic amines) that are disposed of each year, which raise socioeconomic and environmental issues, they are also possible carcinogens, mutagens and toxins that might disturb the ecological equilibrium of the natural world (Rawat et al., 2016) (Figure 9). It has an impact on pH, salinity, light attenuation, and the dissolved oxygen content in aquatic environments. It plugs soil pores and reduces soil production in land ecosystems. (Chakravarty et al., 2015).

Table 3: Dye classification according to various applications (Kaykhaii et al., 2018)

Dye class	Properties	Application	Toxicity	Chemical class
Basic dye	Water-soluble; cationic dye; applied in weakly acidic dyebaths	Acrylic fibers, wool, silk, paper, nylons, and polyesters materials	Vomiting, skin irritation, mutations, jaundice, cancer	Diazahemicyanine, triarylmethane, cyanine, hemicyanine, thiazine, oxazine, and acridine
Acid dye	Water-soluble; anionic	Silk, nylon, wool	Carcinogenic (benign and malignant tumors)	Anthraquinone, azo, azine, triphenylmethane, xanthene, nitro and nitroso
Direct dye	Water-soluble; anionic; applied directly without mordants (or metal-like chromium and copper)	Rayon, cotton, leather, and nylon	Bladder cancer	Oxazines, polyazo, and phthalocyanines
Reactive dye	Water-soluble; anionic; largest dye class	Cotton, cellulose, nylon and wool	Allergic conjunctivitis; dermatitis	Phthalocyanine, anthraquinone, chlorotriazine, vinyl sulfone
Disperse dye	Very low solubility in water	Cellulose, nylon, acrylic and cellulose acetate	Carcinogenic, skin irritation	Anthraquinone, azo, nitro, styryl and benzodifuranone
Sulfur dye	Water-insoluble; colloidal; organic compounds containing sulfur and sodium sulfide	Rayon and cotton	Prone to allergies, tumors and cancers	Indeterminate structures
Vat dye	Water-insoluble; colloidal; more complex; oldest dyes	Rayon and cotton	Prone to allergies, tumors and cancers	Indigoids and anthraquinone

4.8.4. Dye removal techniques

Various procedures have been implemented over the past few decades to remove various hazardous colors from industrial effluents. Physical, chemical, and biological treatments are the three categories (Sardar et al., 2021).

a) Physical treatment

Various physical methods are employed for dye treatment, including screening, coagulation, precipitation, adsorption,

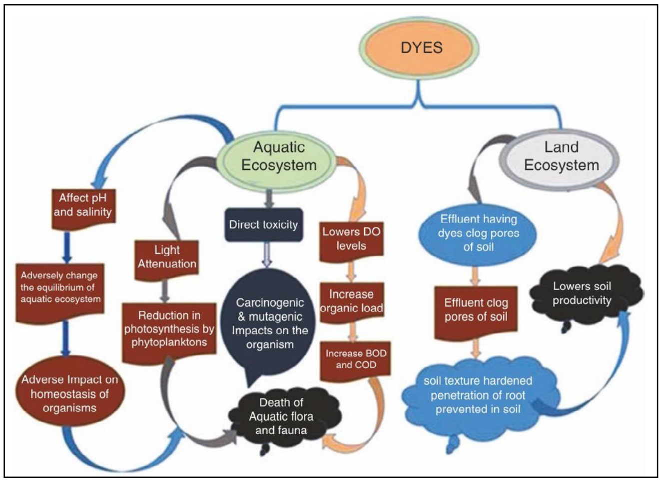

Figure 9: Dyes' effects on terrestrial and aquatic ecosystems

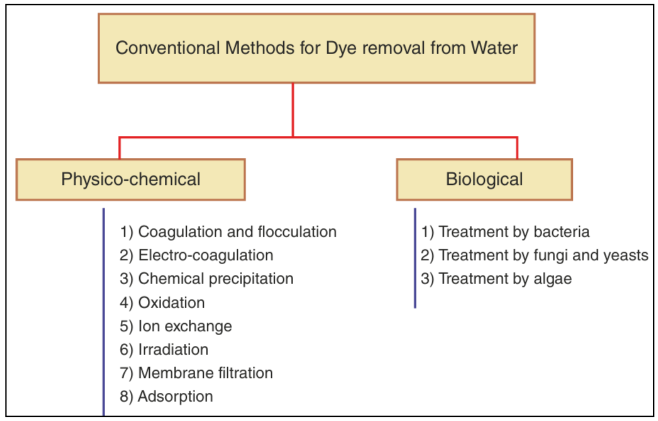

Figure 10: Conventional Physicochemical and Biological Methods for Dye Removal from Wastewater (Ruan et al., 2019)

and membrane filtration. Among these, adsorption is considered the most effective method for dye removal due to its straightforward design, ease of operation, high efficiency, cost-effectiveness, and resistance to toxic substances. However, membrane filtration faces challenges such as membrane fouling and the high cost of membrane replacement.

b) Biological treatment

Anaerobic, aerobic treatment, and anaerobic-aerobic treatment are biological treatment techniques that transform organic contaminants into stable, innocuous compounds. Activated sludge, anaerobic digestion, lagoons, ponds, trickling filtering, and oxidation are all used in aerobic treatment, whereas septic tanks, lagoons, and anaerobic digestion are used in anaerobic treatment (Sardar et al., 2021). Because it does not involve the use of chemicals and uses less energy, biological treatment is one of the most well-known and widely used technologies for dye treatment. It is also inexpensive and environmentally benign (Ahmad et al., 2015).

c) Chemical treatment

Chemical treatment techniques for dye removal include coagulation-flocculation, oxidation, ozonation, Fenton oxidation, photocatalytic oxidation, irradiation, ion exchange and electrochemical processes. While these methods are highly effective for removing dyes, they come with challenges such as high costs, the need for significant electrical energy, and complications in sludge disposal due to the extensive use of chemicals (Ruan et al., 2019) (Figure 10).

5. STATE-WISE GENERATION AND MANAGEMENT OF HAZARDOUS WASTES

Hazardous wastes are those that have at least one of the following characteristics: ignitability, corrosivity, reactivity, or toxicity (Hassan and Saleh, 2022). Hazardous wastes are defined by the Resource Conservation and Recovery Act (RCRA) as any waste or combination of wastes that pose a significant present or potential risk to human health or living things because they are non-degradable or persistent in nature, can be biologically amplified, can be lethal, or may otherwise have other negative cumulative effects (Pichtel, 2014). The management of hazardous wastes has become a specialized discipline because of the complex nature of the problem and the solutions available to humanity (Letcher and Vallero, 2019). The mismanagement examples of hazardous wastes causing disastrous human and environmental consequences are numerous (Saleh, 2016). The net quantity of Hazardous Wastes available for the management, which includes quantity stored at premises as an opening stock, imported quantity of HW and quantity of HW generated during 2021–22 (Anonymous, 2022**)**. Therefore, about 14.47 mmt of net hazardous waste was available for management during 2021–22. 07 States (namely Chattisgarh, Himachal Pradesh, Haryana, Jammu & Kashmir, Jharakhand, Punjab and Telangana) have managed more quantity of HW than their quantity available for management. Similarly, 09 States (namely Assam, Goa, Delhi, Kerala, Madhya Pradesh, Maharashtra, Puducherry, Rajasthan and Tamil Nadu) have managed less quantity of HW than its available quantity or can be say that management details not provided that HW (Anonymous, 2022).

The Table 3 provides an overview of waste generation and management practices across various states in India, listing key metrics such as the number of industries, waste generation, and how the waste is recycled, utilized, or disposed. The data highlights in the table, variance in industrial activity, waste generation, and waste management efficiency across different Indian states.

Gujarat has the highest number of industries (21,264) and leads in total waste generation (4,864,739 metric tonnes)

(Figure 11). It also manages a large amount of waste, recycling, utilizing, and disposing of significant quantities. Maharashtra and Odisha also have high waste generation levels, with notable amounts managed through recycling and disposal. States like Delhi and Goa have fewer industries and generate less waste in comparison to larger states like Gujarat and Maharashtra. Some states, such as Jammu & Kashmir and Uttarakhand, report minimal waste generation and management, with little or no recycling and utilization recorded (Anonymous, 2022).

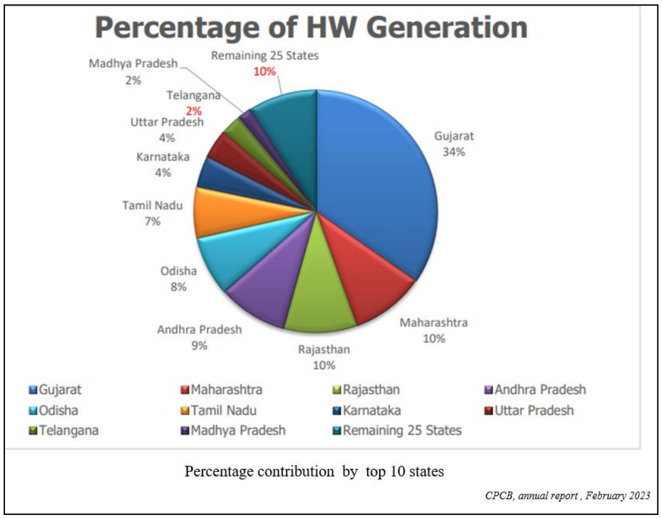

Figure 9: Data showing the percentage contribution of hazardous waste generation by top 10 states

Out of which, about 2.93 mmt of hazardous waste has been disposed of through common and captive TSDFs, 7.59 mmt has been recycled & utilized and about 2.24 mmt has been stored at occupier's premises at the end of financial year (2021-22) (Anonymous, 2022). The same has been illustrated in Table 4.

Table 4: Generation and management of hazardous wastes during 2021-22 (Source: Anonymous, 2022)

Sl. No.	Hazardous waste	Total amount in mmt
1.	Quantity of hazardous waste generated during the financial year	12.35
2.	Quantity of hazardous waste stored at occupiers' s premises at the beginning of financial year	1.79
3.	Quantity of hazardous waste imported	0.33
4.	Quantity of HW disposed	2.93
5.	Quantity of HW Recycled/ Utilized	7.59
6.	Quantity of hazardous waste exported	0.00
7.	Quantity of hazardous waste stored at occupiers premises at the end of financial year	2.24

5.1. *The characteristics of hazardous waste*

There are six main categories into which hazardous waste is divided. Many additional substances or chemicals, either alone or in combination, are included in hazardous waste. Below is a breakdown of the trash categories.

5.1.1. *Radioactive wastes*

Radioactive wastes are compounds that release ionizing radiation, and the waste products that result from these substances are also referred to as radioactive wastes (Darda et al., 2021). Because of the detrimental effects they have on living things, they are nevertheless examined as hazardous waste even though they belong to a different category (Rao et al., 2022). Additionally, they endure in the environment for a very long time. Their persistence in the environment is determined by their half-life (Rao et al., 2022).

5.1.2. *Biomedical wastes*

The two key traits of healthcare waste are toxic and infectivity (Bolan et al., 2023). Biomedical waste falls under the hazardous waste category due to its poisonous nature (Aziz et al., 2022).

5.1.3. *Chemicals*

Chemicals can be salts, metals, organic or synthetic, and acidic or basic. When they are toxic, they are dangerous. A waste stream should be deemed hazardous if it contains these wastes at levels that are equivalent to or higher than threshold values (Wahlstrom et al., 2016).

5.1.4. *Flammable wastes*

This type of trash is once more divided into two groups. A flammable material may be a solid, liquid, or gas (Panda et al., 2010). Examples of flammable wastes include solvents, plasticizers, and organic sludges. These wastes require handling since they are dangerous.

5.1.5. *Explosives*

Like flammables, they require a unique approach to handling. They are created from industrial gasses and produced during the fabrication of munitions (Panda et al., 2010).

5.1.6. *Hazardous household garbage*

We produce a lot of hazardous materials in our daily lives, which are disposed of as mixed rubbish (Inglezakis et al., 2015). They are disposed of with solid garbage from the city. Oil paints, nail polish, latex, paints, batteries, cleaning supplies, electronic trash, pesticides, chlorinated and non-chlorinated solvents, and many more are examples of the hazardous waste produced by homes (Rajalakshmi et al., 2023).

Table 5: The features of hazardous waste and the risks connected with it are compiled in below

Characteristics	Relevant features	Associated risk	References
Ignitability	A fluid with a breakpoint below 60°C (140°F), except for aqueous solutions that contain less than 24% alcohol. A nonliquid that can burn spontaneously and continuously under typical circumstances	That identifies trash that poses a fire risk during routine maintenance. Fires can spread harmful particles across wide regions in addition to the obvious dangers of heat and smoke	Półka, 2020
Corrosivity	A substance that is watery and has a pH of 1.25 or above, or less than 2. A fluid that, at 55°C (130°F), corrodes steel at a pace greater than 0.25 inches annually	It detects wastes that need to be separated from other wastes because to their capacity to dissolve harmful pollutants or that need special containers due to their propensity to corrode common materials	Etim et al., 2024
Reactivity or explosiveness	Usually unstable, it reacts strongly but doesn't explode. It has a strong reaction to water. Combines with water to create an explosive combination. Produces harmful fumes, vapors, or gasses when combined with water. It has a pH of 2 to 12.5 and produces harmful gasses, vapors, or fumes when they contain cyanide or sulfide	Wastes that are prone to spontaneous reactions, strong reactions with air or water, instability to shock or heat, the production of poisonous gasses, or explosions are identified	Kim et al., 2022
Toxicity	The Toxicity Characteristics Leaching Procedure (TCLP), which is intended to create an extract that mimics the leachate that might be generated in a land disposal scenario, will determine this. After that, the extract is examined to see if any of the harmful contaminants are present	It detects wastes that could release toxicants in large enough numbers to seriously endanger the environment or human health if they are not managed effectively	Wang and Tepper, 2021

6. CONCLUSION

Pollutants in aquatic environments have detrimental effects for human health and ecological systems. Because they lack the resources for efficient water treatment, neighborhoods with less funding are frequently more exposed to polluted water. Preventing water pollution is essential to preserving the equilibrium of ecosystems and protecting human health. Environmental laws, sustainable farming methods, and public awareness initiatives must all be part of a coordinated effort. To ensuring ecological sustainability, protecting water resources also guarantees fair access to clean water and a better future for all.

7. REFERENCE

Abbas, Q., Yousaf, B., Ullah, H., Ali, M.U., Ok, Y.S., Rinklebe, J., 2020. Environmental transformation and nano-toxicity of engineered nano-particles (ENPs) in aquatic and te rrestrial organisms. Critical Reviews in Environmental Science and Technology 50(23), 2523–2581. DOI: https://doi.org/10.1080/10643389.2019.1705721.

Abdullah, M., Riaz, A., Rafique, M.A., Bai, H., Nawaz, S., Shah, M.T., Yaseen, G., 2022. Water contamination and its effects on humans: A review. NeuroQuantology, 20(15), 188. Available from: https://www.neuroquantology.com/media/article_pdfs/188-200.pdf.

Agrawal, A., Pandey, R.S., Sharma, B., 2010. Water pollution with special reference to pesticide contamination in India. Journal of Water Resource and Protection 2(5), 432–448. DOI: http://dx.doi.org/10.4236/jwarp.2010.25050.

Ahmad, A., Mohd-Setapar, S.H., Chuong, C.S., 2015 Recent advances in new generation dye removal technologies: novel search for approaches to reprocess wastewater. RSC Advances 5, 30801–30818. DOI: https://doi.org/10.1039/C4RA16959J.

Ahmed, F., Gulzar, T., Kiran, S., Ahmad, I., Fatima, A., Yasir, S., Alhajaim, W.F., Khalil, A., Ul-Islam, M., Bakhsh, E.M., Kamal, T., 2022. Nickel oxide and carboxymethyl cellulose composite beads as catalyst for the pollutant degradation. Applied Nanoscience 12(11), 3585–3595. Available from: https://ui.adsabs.harvard.edu/link_gateway/2022ApNan..12.3585A/doi:10.1007/s13204-022-02345-5.

Ajaz, M., Shakeel, S., Rehman, A., 2020. Microbial use for azo dye degradation-a strategy for dye bioremediation. International Microbiology 23, 149–159. https://doi.org/10.1007/s10123-019-00103-2

Akansha, K., Yadav, A.N., Kumar, M., Chakraborty, D., Ghosh Sachan, S., 2022. Decolorization and degradation of reactive orange 16 by Bacillus stratosphericus SCA1007. Folia Microbiologica, 1–12. DOI: https://doi.org/10.1007/s12223-021-00914-9.

Akhtar, N., Syakir Ishak, M.I., Bhawani, S.A., Umar, K., 2021. Various natural and anthropogenic factors responsible for water quality degradation: A review. Water 13(19), 2660. DOI: https://doi.org/10.3390/w13192660.

Akoto, O., Azuure, A.A., Adotey, K.D., 2016. Pesticide residues in water, sediment and fish from Tono Reservoir and their health risk implications. Springer Plus 5(1), 1849. Available from: https://link.springer.com/content/pdf/10.1186/s40064-016-3544-z.pdf.

Akpan, E.E., 2022. Environmental consequences of oil spills on marine habitats and the mitigating measures-the niger delta perspective. Journal of Geoscience and Environment Protection 10(6), 191–203. DOI: https://doi.org/10.4236/gep.2022.106012.

Albert, V., Ramamurthy, T., Das, S., Dolma, K.G., Majumdar, T., Baruah, P.J., Das, M., 2024. Comprehending the risk of foodborne and waterborne disease outbreaks: Current situation and control measures with special reference to the Indian scenario. Heliyon 10(16), e36344. DOI: https://doi.org/10.1016/j.heliyon.2024.e36344.

Ali, M.P., Kabir, M.M.M., Haque, S.S., Qin, X., Nasrin, S., Landis, D., Holmquist, B., Ahmed, N., 2020. Farmer's behavior in pesticide use: Insights study from smallholder and intensive agricultural farms in Bangladesh. Science of the Total Environment, 747, 141160. DOI: https://doi.org/10.1016/j.scitotenv.2020.141160.

Ali, W., Buriro, R.S., Gandahi, J.A., Chen, Y., ul Aabdin, Z., Bhutto, S., Zou, H., 2024. A critical review on male-female reproductive and developmental toxicity induced by micro-plastics and nano-plastics through different signaling pathways. Chemico-Biological Interactions, 110976. DOI: https://doi.org/10.1016/j.cbi.2024.110976.

Anonymous, 2024. Ministry of Textiles 2024. Annual Report 2023–24. New Delhi: Ministry of Textiles, Government of India. Available from: https://www.texmin.gov.in/static/uploads/2025/06/c2e5058c76951a6f1d7ed31b7465e616.pdf. Accessed Date: 24th November 2024.

Anonymous, 2022. Annual report 2021–2022. Central Pollution Control Board New Delhi: Central Pollution Control Board, Ministry of Environment, Forest and Climate Change, Government of India. Available from: https://cpcb.nic.in/annual-report.php. Accessed Date: 24th November 2024.

Anonymous, 2017. United Nations Environment Programme (UNEP). Frontiers 2017: Emerging Issues of Environmental Concern. Nairobi: United Nations Environment Programme. Available from: https://www.unep.org/resources/frontiers-2017-emerging-issues-environmental-concern. Accessed Date: 30 October 2024.

Arias, A.H., Botte, S.E., 2020. Coastal and deep ocean pollution. London: crc Press. Available from: https://www.routledge.com/Coastal-and-Deep-Ocean-Pollution/Arias-Botte/p/book/9780367504670.

Asif, Z., Chen, Z., An, C., Dong, J., 2022. Environmental impacts and challenges associated with oil spills on shorelines. Journal of Marine Science and Engineering 10(6), 762. DOI: https://doi.org/10.3390/jmse10060762.

Assi, M.A., Hezmee, M.N.M., Sabri, M.Y.M., Rajion, M.A., 2016. The detrimental effects of lead on human and animal health. Veterinary World 9(6), 660. DOI: https://doi.org/10.14202/vetworld.2016.660-671.

Ataei, P., Gholamrezai, S., Movahedi, R., Aliabadi, V., 2021. An analysis of farmers' intention to use green pesticides: The application of the extended theory of planned behavior and health belief model. Journal of Rural Studies 81, 374–384. DOI: https://doi.org/10.1016/j.jrurstud.2020.11.003.

Auta, H.S., Emenike, C.U., Fauziah, S.H., 2017. Distribution and importance of microplastics in the marine environment: A review of the sources, fate, effects, and potential solutions. Environment International 102, 165–176. DOI: https://doi.org/10.1016/j.envint.2017.02.013.

Aziz, H.A., Omar, F.M., Halim, H.A., Hung, Y.T., 2022. Health-care waste management. In: Solid waste engineering and management, Springer International Publishing, 3, 163–229. DOI: https://doi.org/10.1007/978-3-030-96989-9_4.

Babuji, P., Thirumalaisamy, S., Duraisamy, K., Periyasamy, G., 2023. Human health risks due to exposure to water pollution: a review. Water 15(14), 2532. DOI: https://doi.org/10.3390/w15142532.

Bacosa, H.P., Ancla, S.M.B., Arcadio, C.G.L.A., Dalogdog, J.R.A., Ellos, D.M.C., Hayag, H.D.A., Adhikari, P.L., 2022. From surface water to the deep sea: a review on factors affecting the biodegradation of spilled oil in marine environment. Journal of Marine Science and Engineering 10(3), 426. DOI: https://doi.org/10.3390/jmse10030426.

Badamasi, H., Yaro, M.N., Ibrahim, A., Bashir, I.A., 2019. Impacts of phosphates on water quality and aquatic life. Chemistry Research Journal, 4, 124–133. Available from: https://www.researchgate.net/publication/339209495.

Balami, S., Sharma, A., Karn, R., 2019. Significance of nutritional value of fish for human health. Malaysian Journal of Halal Research 2(2), 32–34. DOI: https://doi.org/10.2478/mjhr-2019-0012.

Balkrishna, A., Pandey, J.K., Tripathi, P.K., Joshi, R., Arya, V., 2021. Chemical fertilizers and pesticides in Indian Agriculture: Effect on human health and environment. Biological Forum – An International Journal (3), 407–422. Available from: https://www.researchgate.net/publication/354495039.

Bansal, O.P., 2021. Accumulation of potentially toxic metals and pesticides in fish other seafood and their impact on human. International Journal of Recent Scientific Research 12(8), 42848–42868. DOI: https://doi.org/10.24327/ijrsr.2021.1208.6169.

Bant, D.D., Lokare, L, Kapfo, T.U., 2020. Assessment of safety practices of pesticide use among the farmers in Adargunchi and Noolvi, Karnataka: A cross sectional study. Indian Journal of Public Health Research and Development 11(7), 207–213. DOI: https://doi.org/10.37506/ijphrd.v11i7.10082.

Barletta, M., Lima, A.R., Costa, M.F., 2019. Distribution, sources and consequences of nutrients, persistent organic pollutants, metals and microplastics in South American estuaries. Science of the Total Environment 651, 1199–1218. DOI: https://doi.org/10.1016/j.scitotenv.2018.09.276.

Barletta, M., Melo, R.C., Whitfield, A.K., 2023. Past and present conservation of south American estuaries. Estuarine, Coastal and Shelf Science, 108542. Available from: https://ui.adsabs.harvard.edu/link_gateway/2023ECSS..29508542B/doi:10.1016/j.ecss.2023.108542.

Bechmann, M., Stalnacke, P., 2019. Agricultural nitrogen and phosphorus pollution in surface waters. In Oxford research encyclopedia of environmental science. Available from: https://api.semanticscholar.org/CorpusID:134647358.

Benachour, N., Clair, E., Mesnage, R., Seralini, G.E., 2012. Endocrine disruptors: new discoveries and possible progress of evaluation. Advances in Medicine and Biology, 29, 1–58. Available from: https://www.researchgate.net/publication/220043390_endocrine_disruptors_new_discoveries_and_possible_progress_of_evaluation.

Berbel, G.B.B., Favaro, D.I.T., Braga, E.S., 2015. Impact of harbour, industry and sewage on the phosphorus geochemistry of a subtropical estuary in Brazil. Marine Pollution Bulletin 93, 44–52. DOI: https://doi.org/10.1016/j.marpolbul.2015.02.016.

Bexeitova, K., Baimenov, A., Varol, E.A., Kudaibergenov, K., Zhantikeyev, U., Sailaukhanuly, Y., Berndtsson, R., 2024. Microplastics in freshwater systems: A review of classification, sources, and environmental impacts. Chemical Engineering Journal Advances, 100649. DOI: https://doi.org/10.1016/j.ceja.2024.100649.

Bhardwaj, N., Bhaskarwar, A.N., 2018. A review on sorbent devices for oil-spill control. Environmental Pollution 243, 1758–1771. DOI: https://doi.org/10.1016/j.envpol.2018.09.141.

Bhateria, R., Jain, D., 2016. Water quality assessment of lake water: a review. Sustainable Water Resources Management 2, 161–173. DOI: https://doi.org/10.1007/s40899-015-0014-7.

Blumer, M., Sanders, H.L., Grassle, J.F., Hampson, G.R., 1971. An ocean of oil: a small oil spill. Environment: Science and Policy for Sustainable Development 13(2), 2–12. Available from: https://api.semanticscholar.org/CorpusID:154384064.

Bolan, S., Padhye, L.P., Kumar, M., Antoniadis, V., Sridharan, S., Tang, Y., Bolan, N., 2023. Review on distribution, fate, and management of potentially toxic elements in incinerated medical wastes. Environmental Pollution 321, 121080. DOI: https://doi.org/10.1016/j.envpol.2023.121080.

Boufadel, M.C., Socolofsky, S., Katz, J., Yang, D., Daskiran, C., Dewar, W., 2020. A review on multiphase underwater jets and plumes: Droplets, hydrodynamics, and chemistry. Reviews of Geophysics 58(3). DOI: https://doi.org/10.1029/2020RG000703.

Brandvik, P.J., Johansen, Q., Davies, E.J., Leirvik, F., Krause, D.F., Daling, P.S., Anderson, K., 2017. Subsea dispersant injection (SSDI)-summary findings from a multi-year research and development industry initiative. In International Oil Spill Conference Proceedings 2017(1), 2762–2790. Available from: https://iosc.kglmeridian.com/meridian/iosc/published/rest/pdf-watermark/v1/journals/iosc/2017/1/article-p2762.pdf/watermark-pdf/.

Buckley, N.A., Fahim, M., Raubenheimer, J., Gawarammana, I.B., Eddleston, M., Roberts, M.S., Dawson, A.H., 2021. Case fatality of agricultural pesticides after self-poisoning in sri lanka: a prospective cohort study. The Lancet Global Health 9(6), 854–862. DOI: https://doi.org/10.1016/s2214-109x(21)00086-3.

Buskey, E.J., White, H.K., Esbaugh, A.J., 2016. Impact of oil spills on marine life in the Gulf of Mexico: effects on plankton, nekton, and deep-sea benthos. Oceanography 29(3), 174–181. DOI: https://doi.org/10.5670/oceanog.2016.81.

Cantonati, M., Poikane, S., Pringle, C.M., Stevens, L.E., Turak, E., Heino, J., Znachor, P., 2020. Characteristics, main impacts, and stewardship of natural and artificial freshwater environments: consequences for biodiversity conservation. Water 12(1), 260. DOI: https://doi.org/10.3390/w12010260.

Chakraborty, S.K., Chakraborty, S.K., 2021. River pollution and perturbation: Perspectives and processes. Riverine Ecology Volume 2: Biodiversity Conservation, Conflicts and Resolution, 443–530. DOI: https://doi.org/10.1007/978-3-030-53941-2_5.

Chakravarty, P., Bauddh, K., Kumar, M., 2015. Remediation of dyes from aquatic ecosystems by biosorption method using algae. Algae and Environmental Sustainability, 97–106. DOI: https://doi.org/10.1007/978-81-322-2641-3_8.

Chapman, H., Purnell, K., Law, R.J., Kirby, M.F., 2007. The use of chemical dispersants to combat oil spills at sea: A review of practice and research needs in Europe. Marine Pollution Bulletin 54(7), 827–838. DOI: https://doi.org/10.1016/j.marpolbul.2007.03.012.

Cook, J.L., Baumann, P., Jackman, J.A., Stevenson, D., 1995. Pesticides characteristics that affect water quality. Farm Chemicals Handbook, 95, 429. Available from: https://texashelp.tamu.edu/wp-content/uploads/2016/02/EB-6050-pesticide-properties-water-quality.pdf.

Costa, L.G., Giordano, G., Guizzetti, M., Vitalone, A., 2008. Neurotoxicity of pesticides: a brief review. Frontiers in Bioscience 13(4), 1240–1249. DOI: https://doi.org/10.2741/2758.

Dadi, M., 2025. Air and water pollution: sources, effects, regulatory frameworks, mitigations, solutions, future prospects, and challenges. Blue Sky, Blue Water: Strategies for Protecting Air and Water Quality in the 21st Century, 31–54. DOI: https://doi.org/10.1007/978-3-031-82559-0_2.

Damalas, C.A., Eleftherohorinos, I.G., 2011. Pesticide exposure, safety issues, and risk assessment indicators. International Journal of Environmental Research and Public Health 8(5), 1402–1419. DOI: https://doi.org/10.3390/ijerph8051402.

D'Andrea, M.A., Reddy, G.K., 2014. Crude oil spill exposure and human health risks. Journal of Occupational and Environmental Medicine 56(10), 1029–1041. DOI: https://doi.org/10.1097/jom.0000000000000217.

Dar, F.A., Kurella, S., 2023. Fluoride in drinking water: An in-depth analysis of its prevalence, health effects, advances in detection and treatment. Materials Today: Proceedings. DOI: https://doi.org/10.1016/j.matpr.2023.05.645.

Dar, M.I., Green, I.D., Khan, F.A., 2019. Trace metal contamination: Transfer and fate in food chains of terrestrial invertebrates. Food Webs, 20, 116. DOI: https://doi.org/10.1016/J.FOOWEB.2019.E00116.

Darda, S.A., Gabbar, H.A., Damideh, V., Aboughaly, M., Hassen, I., 2021. A comprehensive review on radioactive waste cycle from generation to disposal. Journal of Radioanalytical and Nuclear Chemistry 329(1), 15–31. DOI: https://doi.org/10.1007/s10967-021-07764-2.

De Arbeloa, N.P., Marzadri, A., 2024. Modeling the transport of microplastics along river networks. Science of the Total Environment 911, 168227. DOI: https://doi.org/10.1016/j.scitotenv.2023.168227.

De Buck, E., Borra, V., De Weerdt, E., Vande Veegaete, A., Vandekerckhove, P., 2015. A systematic review of the amount of water per person per day needed to prevent morbidity and mortality in (post-) disaster settings. PLoS One 10(5), 126395. DOI: https://doi.org/10.1371/journal.pone.0126395.

Dey, U., Chell, S., Mondal, M., Das, K., Raj, D., Pandey, G., Verma, S., 2024. Potential Threat of microplastic pollution on coastal-marine ecosystem–an emerging economic setback and question to blue economy?. Earth Systems and Environment, 1–29. Available from: https://ui.adsabs.harvard.edu/link_gateway/2025ESE.....9.3501D/doi:10.1007/s41748-024-00485-y.

Devi, M.S., Singh, T.B., Gupta, A., 2024. Organophosphate, carbamate and synthetic pyrethroid pesticide residues in muscle tissues of fish from Loktak Lake, a Ramsar Site in Manipur, India. Environmental Research and Technology 7(3), 303–312. DOI: https://doi.org/10.35208/ert.1391806.

Edo, G.I., Itoje-akpokiniovo, L.O., Obasohan, P., Ikpekoro, V.O., Samuel, P.O., Jikah, A.N., Agbo, J.J., 2024. Impact of environmental pollution from human activities on water, air quality and climate change. Ecological Frontiers 44(5), 874–889. DOI: https://doi.org/10.1016/j.ecofro.2024.02.014.

Ekperusi, A.O., Onyena, A.P., Akpudo, M.Y., Peter, C.C., Akpoduado, C.O., Ekperusi, O.H., 2019. *In-situ* burning as an oil spill control measure and its effect on the environment. In SPE Nigeria Annual International Conference and Exhibition. Available from: https://www.researchgate.net/publication/358278116_spe-198777-ms_in-situ_burning_as_an_oil_spill_control_measure_and_its_effect_on_the_environment.

Elumalai, P., Parthipan, P., Gao, X., Cui, J., Kumar, A.S., Dhandapani, P., Choi, M.Y., 2024. Impact of petroleum hydrocarbon and heavy metal pollution on coral reefs and mangroves: a review. Environmental Chemistry Letters 22(3), 1413–1435. Available from: https://ui.adsabs.harvard.edu/link_gateway/2024EnvCL..22.1413E/doi:10.1007/s10311-024-01728-0.

Eow, J.S., Ghadiri, M., 2002. Electrostatic enhancement of coalescence of water droplets in oil: a review of the technology. Chemical Engineering Journal, 85(2-3), 357–368. DOI: https://doi.org/10.1016/S1385-8947(01)00250-9.

Etim, I.I.N., Ikeuba, A.I., Njoku, C.N., 2024. Predictive models of corrosion advances in corrosion modelling: a case study of fuzzy modelling in pipeline coating. In Advances in Corrosion Modelling, 167–188. DOI: https://doi.org/10.1007/978-3-031-60358-7_8.

Fingas, M., 2016. Oil spills and response. Springer Handbook of Ocean Engineering, 1067–1094. DOI: https://doi.org/10.1007/978-3-319-16649-0_43.

Flaws, J., Damdimopoulou, P., Patisaul, H.B., Gore, A., Raetzman, L., Vandenberg, L.N., 2020. Plastics, EDCs and health. Endocrine Society: Washington, DC, USA. Available from: https://www.endocrine.org/-/media/endocrine/files/topics/edc_guide_2020_v1_6bhqen.pdf.

Franks, F., 2007. Water: a matrix of life. Royal society of chemistry, 192. DOI: https://doi.org/10.1039/9781847552341.

Fujihara, J., Nishimoto, N., 2024. Review of zinc oxide nanoparticles: toxicokinetics, tissue distribution for various exposure routes, toxicological effects, toxicity mechanism in mammals, and an approach for toxicity reduction. Biological Trace Element Research 202(1), 9–23. DOI: https://doi.org/10.1007/s12011-023-03644-w.

Gani, A., Pathak, S., Hussain, A., Shukla, A.K., Chand, S., 2024. Emerging pollutant in surface water bodies: a review on monitoring, analysis, mitigation measures and removal technologies of micro-plastics. Environmental Geochemistry and Health 46(7), 1–31. DOI: https://doi.org/10.1007/s10653-024-01992-7.

Garg, S.K., Tripathi, M., 2017. Microbial strategies for discoloration and detoxification of azo dyes from textile effluents. Research Journal of Microbiology 12(1), 1–19. Available from: https://scialert.net/abstract/?doi=jm.2017.1.19.

Giri, S., 2021. Water quality prospective in Twenty First Century: Status of water quality in major river basins, contemporary strategies and impediments: A review. Environmental Pollution 271, 116332. DOI: https://doi.org/10.1016/j.envpol.2020.116332.

Grimm, N.B., Chapin III, F.S., Bierwagen, B., Gonzalez, P., Groffman, P.M., Luo, Y., Williamson, C.E., 2013. The impacts of climate change on ecosystem structure and function. Frontiers in Ecology and the Environment 11(9), 474–482. DOI: https://doi.org/10.1890/120282.

Grumezescu, A.M., Holban, A.M., 2017. Microbial contamination and food degradation, 10. Academic Press. Available from: https://www.researchgate.net/publication/320244516_'microbial_contamination_food_degradation'_handbook_of_food_bioengineering_elsevier.

Gündogdu, S., Rathod, N., Hassoun, A., Jamroz, E., Kulawik, P., Gokbulut, C., Ozogul, F., 2023. The impact of nano/micro-plastics toxicity on seafood quality and human health: facts and gaps. Critical Reviews in Food Science and Nutrition 63(23), 6445–6463. DOI: https://doi.org/10.1080/10408398.2022.2033684.

Gupta, S., Dikshit, A.K., 2010. Biopesticides: An ecofriendly approach for pest control. Journal of Biopesticides, 3, 186. Available from: https://www.cabidigitallibrary.org/doi/full/10.5555/20133182477.

Hashmi, M.Z., Wang, S., Ahmed, Z., 2022. Environmental Micropollutants. Elsevier. Available from: https://shop.elsevier.com/books/environmental-micropollutants/hashmi/978-0-323-90555-8.

Hassaan, M.A., El Nemr, A., 2020. Pesticides pollution: Classifications, human health impact, extraction and treatment techniques. The Egyptian Journal of Aquatic Research 46(3), 207–220. DOI: https://doi.org/10.1016/j.ejar.2020.08.007.

Hassan, A.I., Saleh, H.M., 2022. Toxicity and hazardous waste regulations. In Hazardous Waste Management, 165–182. Elsevier. DOI: https://doi.org/10.1016/B978-0-12-824344-2.00012-4.

Huang, G., Zhang, M., Liu, C., Li, L., Chen, Z., 2018. Heavy metalloids and organic contaminants in groundwater in the Pearl River Delta that has undergone three decades of urbanization and industrialization: Distributions, sources, and driving forces. Science of the Total Environment 635, 913–925. DOI: https://doi.org/10.1016/j.scitotenv.2018.04.210.

Huntingford, F.A., Adams, C., Braithwaite, V.A., Kadri, S., Pottinger, T.G., Sandoe, P., Turnbull, J.F., 2006. Current issues in fish welfare. Journal of Fish Biology 68(2), 332–372. DOI: https://doi.org/10.1111/j.0022-1112.2006.001046.x.

Inglezakis, V.J., Moustakas, K., 2015. Household hazardous waste management: A review. Journal of Environmental Management 150, 310–321. DOI: https://doi.org/10.1016/j.jenvman.2014.11.021.

Yadav, I.C., Devi, N.L., 2017. Pesticides classification and its impact on human and environment. Environmental Science and Engineering 6(7), 140–158. Available from: https://www.researchgate.net/

publication/313445102_pesticides_classification_and_its_impact_on_human_and_environment.

Yadav, I.C., Devi, N.L., Syed, J.H., Cheng, Z., Li, J., Zhang, G., Jones, K.C., 2015. Current status of persistent organic pesticides residues in air, water, and soil, and their possible effect on neighboring countries: A comprehensive review of India. Science of the Total Environment 511, 123–137. DOI: https://doi.org/10.1016/j.scitotenv.2014.12.041.

Yadav, N., Ahmaruzzaman, M., 2024. Recent updates and estimation of emerging contaminants in the environment. In: Occurrence, distribution and toxic effects of emerging contaminantsx, 17–33. CRC Press. Available from: https://www.taylorfrancis.com/chapters/edit/10.1201/9781003335757-2/recent-updates-estimation-emerging-contaminants-environment-nidhi-yadav-md-ahmaruzzaman.

Yagub, M.T., Sen, T.K., Afroze, S., Ang, H.M., 2014. Dye and its removal from aqueous solution by adsorption: a review. Advances in Colloid and Interface Science 209, 172–184. DOI: https://doi.org/10.1016/j.cis.2014.04.002.

Yang, J., Ma, Z., 2021. Research progress on the effects of nickel on hormone secretion in the endocrine axis and on target organs. Ecotoxicology and Environmental Safety 213, 112034. DOI: https://doi.org/10.1016/j.ecoenv.2021.112034.

Yaseen, D.A., Scholz, M., 2019. Textile dye wastewater characteristics and constituents of synthetic effluents: a critical review. International Journal of Environmental Science and Technology 16, 1193–1226. DOI: https://doi.org/10.1007/s13762-018-2130-z.

Jain, R., Thakur, A., Garg, N., Devi, P., 2021. Impact of industrial effluents on groundwater. In: Madhav, S., Singh, P. (Eds.), Groundwater geochemistry: pollution and remediation methods, 193–211. DOI: https://doi.org/10.1002/9781119709732.ch10.

Jayaprakas, C.A., Tom, J., Sreejith, S., 2023. Impact of insecticides on man and environment. In: Mohanan, P.V., Kappalli, S. (Eds.), Biomedical applications and toxicity of nanomaterials, Springer, Singapore, 751–768. DOI: https://doi.org/10.1007/978-981-19-7834-0_28.

Jayaraj, R., Megha, P., Sreedev, P., 2016. Organochlorine pesticides, their toxic effects on living organisms and their fate in the environment. Interdisciplinary Toxicology 9(3–4), 90–100. DOI: https://doi.org/10.1515/intox-2016-0012.

Jarrige, F., Le Roux, T., 2020. The contamination of the earth: A history of pollutions in the industrial age. MIT Press. DOI: https://doi.org/10.7551/mitpress/11947.001.0001.

Jha, S.K., Singh, R.K., Damodaran, T., Mishra, V.K., Sharma, D.K., Rai, D., 2013. Fluoride in groundwater: toxicological exposure and remedies. Journal of Toxicology and Environmental Health, Part B 16(1), 52–66. DOI: https://doi.org/10.1080/10937404.2013.769420.

Jones, C.A., 1999. Compensation for natural resource damages from oil spills: a comparison of US law and international conventions. International Journal of Environment and Pollution 11(1), 86–107. DOI: https://doi.org/10.1504/IJEP.1999.002251.

Jupp, B.P., 2020. Prof David Bellamy, OBE, Hon FLS, 1933–2019. DOI: https://doi.org/10.1080/00207233.2020.1721128.

Kaykhaii, M., Sasani, M., Marghzari, S., 2018. Removal of dyes from the environment by adsorption process. Chemical and Materials Engineering 6(2), 31–35. DOI: https://doi.org/10.13189/cme.2018.060201.

Kamalesh, T., Kumar, P.S., Rangasamy, G., 2023. An insights of organochlorine pesticides categories, properties, eco-toxicity and new developments in bioremediation process. Environmental Pollution, 122114. DOI: https://doi.org/10.1016/j.envpol.2023.122114.

Kapoor, D., Singh, M.P., 2021. Heavy metal contamination in water and its possible sources. In: Kumar, V., Sharma, A., Cerdà, A. (Eds.), Heavy metals in the environment, 179–189. Elsevier. DOI: https://doi.org/10.1016/B978-0-12-821656-9.00010-9.

Karri, R.R., Ravindran, G., Dehghani, M.H., 2021. Wastewater-sources, toxicity, and their consequences to human health. In Soft computing techniques in solid waste and wastewater management, 3–33. Elsevier. DOI: https://doi.org/10.1016/B978-0-12-824463-0.00001-X.

Khan, S., Malik, A., 2018. Toxicity evaluation of textile effluents and role of native soil bacterium in biodegradation of a textile dye. Environmental Science and Pollution Research 25, 4446–4458. DOI: https://doi.org/10.1007/s11356-017-0783-7?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle.

Kim, K.H., Kabir, E., Jahan, S.A., 2017. Exposure to pesticides and the associated human health effects. Science of the Total Environment, 575, 525–535. DOI: https://doi.org/10.1016/j.scitotenv.2016.09.009.

Kim, S.W., Park, S.G., Lee, E.J., 2022. Assessment of the explosion risk during lithium-ion battery fires. Journal of Loss Prevention in the Process Industries, 80, 104851. DOI: https://doi.org/10.1016/j.jlp.2022.104851.

Klaassen, C.D., Amdur, M.O., 2013. Casarett and Doull's toxicology: the basic science of poisons, 1236, 189–190. Available from: https://jawaidzai.wordpress.com/

wp-content/uploads/2013/09/casarett_and_doull__s_toxicology-the_basic_science_of_poisons_7th_edition_2008.pdf.

Kumar, A., Tripathi, V.K., Sachan, P., Rakshit, A., Singh, R.M., Shukla, S.K., Panda, K.C., 2022. Sources of ions in the river ecosystem. In: Madhav, S., Kanhaiya, S., Srivastav, A., Singh, V., Singh, P. (Eds.), Ecological significance of river ecosystems, 187–202. Elsevier. DOI: https://doi.org/10.1016/B978-0-323-85045-2.00011-X.

Kumar, P.S., 2020. Modern treatment strategies for marine pollution. Elsevier. Available from: https://shop.elsevier.com/books/modern-treatment-strategies-for-marine-pollution/kumar/978-0-12-822279-9.

Lakhani, L., 2015. How to reduce impact of pesticides in aquatic environment. Social Issues and the Environment 3(9), 29–38. DOI: https://doi.org/10.29121/granthaalayah.v3.i9SE.2015.3199.

Lalnunhlimi, S., Krishnaswamy, V., 2016. Decolorization of azo dyes (Direct Blue 151 and Direct Red 31) by moderately alkaliphilic bacterial consortium. Brazilian Journal of Microbiology 47(1), 39–46. DOI: https://doi.org/10.1016/j.bjm.2015.11.013.

Lebreton, L.C., Van Der Zwet, J., Damsteeg, J.W., Slat, B., Andrady, A., Reisser, J., 2017. River plastic emissions to the world's oceans. Nature Communications 8(1), 15611. DOI: https://doi.org/10.1038/ncomms15611.

Lee, H., Trinh, B.M., Mekonnen, T.H., 2024. Fabrication of triblock elastomer foams and gelation studies for oil spill remediation. Macromolecular Rapid Communications, 2400232. DOI: https://doi.org/10.1002/marc.202400232.

Lee, S., Suits, M., Wituszynski, D., Winston, R., Martin, J., Lee, J., 2020. Residential urban stormwater runoff: a comprehensive profile of microbiome and antibiotic resistance. Science of the Total Environment 723, 138033. DOI: https://doi.org/10.1016/j.scitotenv.2020.138033.

Letcher, T., Vallero, D.A. 2019. Waste: A handbook for management. Academic Press. DOI: https://doi.org/10.1016/B978-0-12-381475-3.10034-8.

Lin, X., Zhang, S., Yang, S., Zhang, R., Shi, X., Song, L., 2023. A landfill serves as a critical source of microplastic pollution and harbors diverse plastic biodegradation microbial species and enzymes: study in large-scale landfills, China. Journal of Hazardous Materials 457, 131676. DOI: https://doi.org/10.1016/j.jhazmat.2023.131676.

Luo, D., Zhou, T., Tao, Y., Feng, Y., Shen, X., Mei, S., 2016. Exposure to organochlorine pesticides and non-Hodgkin lymphoma: a meta-analysis of observational studies. Scientific Reports 6(1), 25768. DOI: https://doi.org/10.1038/srep25768.

Madhav, S., Ahamad, A., Singh, A.K., Kushawaha, J., Chauhan, J.S., Sharma, S., Singh, P., 2020. Water pollutants: sources and impact on the environment and human health. Sensors in Water Pollutants Monitoring: Role of Material, 43–62. DOI: https://doi.org/10.1007/978-981-15-0671-0_4.

Mahant, V., Biswal, D., 2022. Water-borne diseases classification and prevention. Journal of Advanced Medical and Dental Sciences Research 10(12), 109–113. Available from: https://www.researchgate.net/publication/372563249_original_research_water-borne_diseases_classification_and_prevention.

Mahurpawar, M., 2015. Effects of heavy metals on human health. International Journal of Research -Granthaalayah 530, 1–7. DOI: https://doi.org/10.29121/granthaalayah.v3.i9SE.2015.3282.

Malik, D.S., Sharma, A.K., Sharma, A.K., Thakur, R., Sharma, M., 2020. A review on impact of water pollution on freshwater fish species and their aquatic environment. Advances in Environmental Pollution Management: Wastewater Impacts and Treatment Technologies 1, 10–28. DOI: https://doi.org/10.26832/aesa-2020-aepm-02.

Mallin, M.A., Cahoon, L.B., 2003. Industrialized animal production-a major source of nutrient and microbial pollution to aquatic ecosystems. Population and Environment 24, 369–385. DOI: https://doi.org/10.1023/A:1023690824045.

Mallin, M.A., McIver, M.R., Robuck, A.R., Dickens, A.K., 2015. Industrial swine and poultry production causes chronic nutrient and fecal microbial stream pollution. Water, Air and Soil Pollution 226, 1–13. DOI: https://doi.org/10.1007/s11270-015-2669-y?urlappend=%3futm_source%3dresearchgate.net%26utm_medium%3darticle.

Masindi, V., Muedi, K.L., 2018. Environmental contamination by heavy metals. Heavy Metals, 10, 115–132. DOI: https://doi.org/10.5772/intechopen.76082.

Michel, J., Fingas, M., 2016. Oil spills: causes, consequences, prevention, and countermeasures. In: Fossil fuels: current status and future directions, 159–201. https://doi.org/10.1142/9789814699983_0007.

Mishra, R.K., 2023. Fresh water availability and its global challenge. British Journal of Multidisciplinary and Advanced Studies 4(3), 1–78. DOI: https://doi.org/10.37745/bjmas.2022.0208.

Mohod, C.V., Dhote, J., 2013. Review of heavy metals in drinking water and their effect on human health. International Journal of Innovative Research in Science, Engineering and Technology, 2(7), 2992–2996. Available from: https://www.researchgate.net/publication/251237189_Review_of_heavy_metals_

in_drinking_water_and_their_effect_on_human_health.
Moller, T.H., 1997. The Nakhodka oil spill response-the technical adviser's perspective. In Proceedings of an oil spill symposium on lessons learnt from the Nakhodka incident, held in Tokyo, 10–11. Available from: https://www.pcs.gr.jp/doc/esymposium/12171/97_tosi-h-moller-e.pdf.
Muniv, Y.S., Supanekar, S.P., 2024. Microplastics: Classification, Sources, Characterisation, Fate, and Control Measures. Uttar Pradesh Journal of Zoology 45(5), 136–144. DOI: https://doi.org/10.56557/upjoz/2024/v45i53939.
Mushtaq, N., Singh, D.V., Bhat, R.A., Dervash, M.A., Hameed, O.B., 2020. Freshwater contamination: sources and hazards to aquatic biota. Fresh Water Pollution Dynamics and Remediation, 27–50. DOI: https://doi.org/10.1007/978-981-13-8277-2_3.
Nabi, N., Ahmad, I., Amin, A., Rather, M.A., Ahmed, I., Hajam, Y.A., Abubakr, A., 2024. Understanding the sources, fate and effects of microplastics in aquatic environments with a focus on risk profiling in aquaculture systems. Reviews in Aquaculture 16(4), 1947–1980. Available from: https://www.researchgate.net/publication/381550939_Understanding_the_sources_fate_and_effects_of_microplastics_in_aquatic_environments_with_a_focus_on_risk_profiling_in_aquaculture_systems.
Naidoo, S., Olaniran, A.O., 2014. Treated wastewater effluent as a source of microbial pollution of surface water resources. International Journal of Environmental Research and Public Health 11(1), 249–270. DOI: https://doi.org/10.3390/ijerph110100249.
Naja, G.M., Volesky, B., 2017. Toxicity and sources of Pb, Cd, Hg, Cr, As, and radionuclides in the environment. In: Wang, L.K., Wang, M.S., Hung, Y.T., Nazih, K.S., Chen, J.P. (Eds.), Handbook of advanced industrial and hazardous wastes management, Taylor & Francis, 855–903. Crc Press. Available from: https://www.taylorfrancis.com/chapters/edit/10.1201/9781315117423-27/toxicity-sources-pb-cd-hg-cr-radionuclides-environment-ghinwa-naja-bohumil-volesky.
Oelsner, G.P., Stets, E.G., 2019. Recent trends in nutrient and sediment loading to coastal areas of the conterminous US: Insights and global context. Science of the Total Environment, 654, 1225–1240. DOI: https://doi.org/10.1016/j.scitotenv.2018.10.437.
Ogunbiyi, O., Al-Rewaily, R., Saththasivam, J., Lawler, J., Liu, Z., 2023. Oil spill management to prevent desalination plant shutdown from the perspectives of offshore cleanup, seawater intake and onshore pretreatment. Desalination 564, 116780. DOI: https://doi.org/10.1016/j.desal.2023.116780.
Oke, E.A., Oluyinka, O.A., Afolabi, S.D., Ibe, K.K., Raheem, S.A., 2023. Latest insights on technologies for halides and halogenated compounds extraction/abatement from water and wastewater: Challenges and future perspectives. Journal of Water Process Engineering 53, 103724. DOI: https://doi.org/10.1016/j.jwpe.2023.103724.
Olmos, J., Acosta, M., Mendoza, G., Pitones, V., 2020. *Bacillus subtilis*, an ideal probiotic bacterium to shrimp and fish aquaculture that increase feed digestibility, prevent microbial diseases, and avoid water pollution. Archives of Microbiology 202, 427–435. DOI: https://doi.org/10.1007/s00203-019-01757-2.
Ovuru, K.F., Izah, S.C., Ogidi, O.I., Imarhiagbe, O., Ogwu, M.C., 2024. Slaughterhouse facilities in developing nations: Sanitation and hygiene practices, microbial contaminants and sustainable management system. Food Science and Biotechnology 33(3), 519–537. DOI: https://doi.org/10.1007/s10068-023-01406-x.
Pakasi, L.S., 2018. Health risks associated with recreational water activities. In IOP Conference Series: Materials Science and Engineering, 434, 012329). IOP Publishing. Available from: https://iopscience.iop.org/article/10.1088/1757-899X/434/1/012329.
Panda, A.K., Singh, R.K., Mishra, D.K., 2010. Thermolysis of waste plastics to liquid fuel: A suitable method for plastic waste management and manufacture of value added products-A world prospective. Renewable and Sustainable Energy Reviews 14(1), 233–248. DOI: https://doi.org/10.1016/j.rser.2009.07.005.
Papadimitriu, M., Allinson, G., 2022. Microplastics in the Mediterranean marine environment: a combined bibliometric and systematic analysis to identify current trends and challenges. Microplastics and Nanoplastics 2(1), 8. DOI: https://doi.org/10.1186/s43591-022-00026-2?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle.
Patil, P.M., Mahamuni-Badiger, P., Ingavale, R.R., Patel, P.R., Dhanavade, M.J., 2024. Usage of microplastic beads in pharmaceuticals and cosmetics industry: a review. Microplastic Pollution, 51–72. DOI: https://doi.org/10.1007/978-981-99-8357-5_4.
Perelo, L.W., 2010. In situ and bioremediation of organic pollutants in aquatic sediments. Journal of Hazardous Materials 177(1-3), 81–89. DOI: https://doi.org/10.1016/j.jhazmat.2009.12.090.
Pericherla, S., Karnena, M.K., Vara, S., 2020. A review on impacts of agricultural runoff on freshwater

resources. International Journal on Emerging Technologies 11, 829–833. Available from: https://www.researchgate.net/publication/341151832_A_Review_on_Impacts_of_Agricultural_Runoff_on_Freshwater_Resources.

Pichtel. J., 2014. Waste management practices: Municipal, hazardous and industrial, second addition taylor & Francis group, USA. DOI: https://doi.org/10.1201/b16576.

Półka, M., 2020. An analysis of flammability and explosion parameters of coke dust and use of preliminary hazard analysis for qualitative risk assessment. Sustainability 12(10), 4130. DOI: https://doi.org/10.3390/su12104130.

Postel, S., Richter, B., 2012. Rivers for life: managing water for people and nature. Island press. DOI: https://doi.org/10.1002/rra.820.

Preisner, M., 2020. Surface water pollution by untreated municipal wastewater discharge due to a sewer failure. Environmental Processes 7(3), 767–780. DOI: https://doi.org/10.1007/s40710-020-00452-5.

Rajalakshmi, S., Amzad Basha, K., Asif Jamal, G.A., 2023. A manual on waste management audit. Laser Park Publish House, Coimbatore, Tamil Nadu, India. 163. Available from: https://www.nsfonline.org.in/wp-content/uploads/2023/04/A-Manual-of-Waste-Management-Audit-by-Nature-Science-Foundation-2023-1.pdf.

Rana, A., Sharma, N., Arya, V., 2022. Heavy uses of pesticides in India: a quantitative analysis. The Indian Ecological Society, 49(3), 994–1004. Available from: https://indianecologicalsociety.com/wp-content/themes/ecology/volume_pdfs/1657765289.pdf.

Rani, L., Thapa, K., Kanojia, N., Sharma, N., Singh, S., Grewal, A.S., Srivastav, A.L., Kaushal, J., 2021. An extensive review on the consequences of chemical pesticides on human health and environment. Journal of Cleaner Production 283, 124–657. DOI: https://doi.org/10.1016/j.jclepro.2020.124657.

Rao, T.S., Panigrahi, S., Velraj, P., 2022. Transport and disposal of radioactive wastes in nuclear industry. In: Das, S., Dash, H.R. (Eds.), Microbial biodegradation and bioremediation, Elsevier, 419–440. DOI: https://doi.org/10.1016/B978-0-323-85455-9.00027-8.

Rasheed, T., Bilal, M., Nabeel, F., Adeel, M., Iqbal, H.M., 2019. Environmentally-related contaminants of high concern: potential sources and analytical modalities for detection, quantification, and treatment. Environment International, 122, 52–66. DOI: https://doi.org/10.1016/j.envint.2018.11.038.

Rathinamoorthy, R., Raja Balasaraswathi, S., 2022. Domestic laundry-a major cause of microfiber shedding. In: Microfiber pollution. Sustainable Textiles: Production, Processing, Manufacturing & Chemistry. Springer, Singapore, 107–149. DOI: https://doi.org/10.1007/978-981-19-4185-6_4.

Rathod, N.B., Xavier, K.M., Ozogul, F., Phadke, G.G., 2023. Impacts of nano/micro-plastics on safety and quality of aquatic food products. In: Ozogul, F., (Ed.), Advances in food and nutrition research, 103, 1–40. Academic Press. DOI: https://doi.org/10.1016/bs.afnr.2022.07.001.

Rathore, S.S., Chandravanshi, P., Chandravanshi, A., Jaiswal, K., 2016. Eutrophication: impacts of excess nutrient inputs on aquatic ecosystem. IOSR Journal of Agriculture and Veterinary Science 9(10), 89–96. DOI: https://doi.org/10.9790/2380-0910018996.

Raval, N.P., Shah, P.U., Shah, N.K., 2017. Malachite green "a cationic dye" and its removal from aqueous solution by adsorption. Applied Water Science 7, 3407–3445. DOI: https://doi.org/10.1007/s13201-016-0512-2.

Rawat, D., Mishra, V., Sharma, R.S., 2016. Detoxification of azo dyes in the context of environmental processes. Chemosphere 155, 591–605. DOI: https://doi.org/10.1016/j.chemosphere.2016.04.068.

Rawat, D., Sharma, R.S., Karmakar, S., Arora, L.S., Mishra, V., 2018. Ecotoxic potential of a presumably non-toxic azo dye. Ecotoxicology and Environmental Safety 148, 528–537. DOI: https://doi.org/10.1016/j.ecoenv.2017.10.049.

Ritter, Solomon, K., Paul, S., Ken, H., Patricia, K., Gevan, M., Beth Linton, L., 2002. Sources, pathways, and relative risks of contaminants in surface water and groundwater: a perspective prepared for the Walkerton inquiry. Journal of Toxicology and Environmental Health Part A 65(1), 1–142. DOI: https://doi.org/10.1080/152873902753338572.

Rodriguez, A.G.P., Lopez, M.I.R., Casillas, T.A.D., Leon, J.A.A., Mahjoub, O., Prusty, A.K., 2017. Monitoring of organochlorine pesticides in blood of women with uterine cervix cancer. Environmental Pollution 220, 853–862. DOI: https://doi.org/10.1016/j.envpol.2016.10.068.

Sabarwal, A., Kumar, K., Singh, R.P., 2018. Hazardous effects of chemical pesticides on human health–Cancer and other associated disorders. Environmental Toxicology and Pharmacology 63, 103–114. DOI: https://doi.org/10.1016/j.etap.2018.08.018.

Salam, M.A., Sultana, N., 2022. Pollution of water resources. In: Tiwari, A.K., Kumar, A., Singh, A.K., Singh, T.N., Suozzi, E., Matta, G., Lo Russo, S. (Eds.), Current directions in water scarcity research, Elsevier 5, 355–378. Elsevier. https://doi.org/10.1016/B978-0-323-85378-1.00018-0.

Saleh, H.E.D.M., 2016. Introductory chapter: introduction to hazardous waste management. Management of Hazardous Wastes, 1. DOI: 10.5772/64245

Sankhla, M.S., Kumari, M., Sharma, K., Kushwah, R.S., Kumar, R., 2018. Water contamination through pesticide & their toxic effect on human health. International Journal for Research in Applied Science and Engineering Technology 6(1), 967–970. DOI: https://doi.org/10.22214/ijraset.2018.1146.

Saravanan, A., Kumar, P.S., Jeevanantham, S., Karishma, S., Tajsabreen, B., Yaashikaa, P.R., Reshma, B., 2021. Effective water/wastewater treatment methodologies for toxic pollutants removal: Processes and applications towards sustainable development. Chemosphere, 280, 130595. DOI: https://doi.org/10.1016/j.chemosphere.2021.130595.

Sardar, M., Manna, M., Maharana, M., Sen, S., 2021. Remediation of dyes from industrial wastewater using low-cost adsorbents. In: Inamuddin, Ahamed, M., Lichtfouse, E., Asiri, A. (Eds), Green adsorbents to remove metals, dyes and boron from polluted water. Environmental Chemistry for a Sustainable World, 49. DOI: https://doi.org/10.1007/978-3-030-47400-3_15.

Sarkar, S., Jaswal, A., Singh, A., 2024. Sources of inorganic nonmetallic contaminants (synthetic fertilizers, pesticides) in agricultural soil and their impacts on the adjacent ecosystems. In: Kumar, P., Srivastav, A.L., Chaudhary, V., van Hullebusch, E.D., Busquets, R. (Eds.), Bioremediation of emerging contaminants from soils, Elsevier, 135–161. DOI: https://doi.org/10.1016/B978-0-443-13993-2.00007-4.

Schoumans, O.F., Chardon, W.J., Bechmann, M.E., Gascuel-Odoux, C., Hofman, G., Kronvang, B., Dorioz, J.M., 2014. Mitigation options to reduce phosphorus losses from the agricultural sector and improve surface water quality: a review. Science of the Total Environment, 468, 1255–1266. DOI: https://doi.org/10.1016/j.scitotenv.2013.08.061.

Sedlak, D., 2014. Water 4.0: The past, present, and future of the world? s most vital resource. Yale University Press. Available from: https://www.researchgate.net/publication/287253206_Water_40_The_past_present_and_future_of_the_world's_most_vital_resource.

Sharma, M., Yadav, A., Dubey, K.K., Tipple, J., Das, D.B., 2022. Decentralized systems for the treatment of antimicrobial compounds released from hospital aquatic wastes. Science of The Total Environment, 840, 156569. DOi: https://doi.org/10.1016/j.scitotenv.2022.156569.

Sid, N., EL-Hawary, S., 2019. High-performance natural dyes for cellulosic fibers review – part 1. Journal of Textiles, Coloration and Polymer Science 16(1), 21–33. DOI: https://doi.org/10.21608/jtcps.2019.8154.1018.

Singh, A., Sharma, A., Verma, R.K., Chopade, R.L., Pandit, P.P., Nagar, V., Sankhla, M.S., 2022. Heavy metal contamination of water and their toxic effect on living organisms. In: The toxicity of environmental pollutants. IntechOpen. DOI: 10.5772/intechopen.105075.

Singh, C., Chowdhary, P., Singh, J.S., Chandra, R., 2016. Pulp and paper mill wastewater and coliform as health hazards: a review. Microbiology Research International 4(3), 28–39. Available from: https://www.netjournals.org/pdf/MRI/2016/3/16-017.pdf.

Syafrudin, M., Kristanti, R.A., Yuniarto, A., Hadibarata, T., Rhee, J., Al-Onazi, W.A., Algarni, T.S., Almarri, A.H., Al-Mohaimeed, A.M., 2021. Pesticides in drinking water-a review. International Journal of Environmental Research and Public Health 18(2), 468. DOI: https://doi.org/10.3390/ijerph18020468.

Smayda, T., 2019. Global epidemic of noxious phytoplankton blooms and food chain consequences in large ecosystems. In: Food chains, yields, models, and management of large marine ecosoystems, Taylor & Francis, 275–307. Routledge. Available from: https://www.taylorfrancis.com/chapters/edit/10.4324/9780429042423-13/global-epidemic-noxious-phytoplankton-blooms-food-chain-consequences-large-ecosystems-theodore-smayda.

Some, S., Mondal, R., Mitra, D., Jain, D., Verma, D., Das, S., 2021. Microbial pollution of water with special reference to coliform bacteria and their nexus with environment. Energy Nexus, 1, 100008. DOI: https://doi.org/10.1016/j.nexus.2021.100008.

Sreedevi, P.D., Ahmed, S., Madé, B., Ledoux, E., Gandolfi, J.M., 2006. Association of hydrogeological factors in temporal variations of fluoride concentration in a crystalline aquifer in India. Environmental Geology 50(1), 1–11. Available from: https://www.researchgate.net/publication/50427370_Association_of_hydrogeological_factors_in_temporal_variations_of_fluoride_concentration_in_a_crystalline_aquifer_in_India.

Sunitha, V., Reddy, Y.S., Suvarna, B., Reddy, B.M., 2022. Human health risk assessment (HHRA) of fluoride and nitrate using pollution index of groundwater (PIG) in and around hard rock terrain of Cuddapah, AP South India. Environmental Chemistry and Ecotoxicology 4, 113–123. DOI: https://doi.org/10.1016/j.enceco.2021.12.002

Tahir, M.B., Tufail, S., Ahmad, A., Rafique, M., Iqbal, T., Abrar, M., Nawaz, T., Khan, M.Y., Ijaz, M., 2021. Semiconductor nanomaterials for the detoxification of dyes in real wastewater under visible-light photocatalysis. International Journal of Environmental Analytical Chemistry 101(12), 1735–1749. DOI: https://doi.org/10.1080/03067319.2019.1686494.

Taylor, A.A., Tsuji, J.S., Garry, M.R., McArdle, M.E., Goodfellow, W.L., Adams, W.J., Menzie, C.A., 2020. Critical review of exposure and effects: implications for setting regulatory health criteria for ingested copper. Environmental Management 65, 131–159. DOI: https://doi.org/10.1007/s00267-019-01234-y.

Tariq, A., Mushtaq, A., 2023. Untreated wastewater reasons and causes: a review of most affected areas and cities. International Journal of Chemical and Biochemical Sciences 23(1), 121–143. Available from: https://iscientific.org/wp-content/uploads/2023/04/15-ijcbs-23-23-22.pdf.

Tchounwou, P.B., Yedjou, C.G., Udensi, U.K., Pacurari, M., Stevens, J.J., Patlolla, A.K., Kumar, S., 2019. State of the science review of the health effects of inorganic arsenic: perspectives for future research. Environmental Toxicology 34(2), 188–202. DOI: https://doi.org/10.1002/tox.22673.

Tewari, S., Sirvaiya, A., 2015. Oil spill remediation and its regulation. International Journal of Engineering Research and General Science 1(6), 1–7. Available from: https://www.researchgate.net/publication/283644184_oil_spill_remediation_and_its_regulation.

Ungureanu, E.L., Mustatea, G., 2022. Toxicity of heavy metals. In: Environmental impact and remediation of heavy metals. IntechOpen. DOI: 10.5772/intechopen.102441.

Vainikka, P., Hupa, M., 2012. Review on bromine in solid fuels–Part 2: Anthropogenic occurrence. Fuel 94, 34–51. DOI: https://doi.org/10.1016/j.fuel.2011.11.021.

Vazquez-Botello, A., Ponce-Velez, G., Soto, L.A., Villanueva, S., 2020. Black tides: petroleum in the ocean. In Coastal and Deep Ocean Pollution, 3–40. CRC Press. Available from: https://www.taylorfrancis.com/chapters/edit/10.1201/b22488-2/black-tides-alfonso-vazquez-botello-guadalupe-ponce-velez-luis-soto-susana-villanueva.

Veneri, F., Iamandii, I., Vinceti, M., Birnbaum, L.S., Generali, L., Consolo, U., Filippini, T., 2023. Fluoride exposure and skeletal fluorosis: a systematic review and dose-response meta-analysis. Current Environmental Health Reports 10(4), 417–441. DOI: https://doi.org/10.1007/s40572-023-00412-9.

Wahlstrom, M., Laine-Ylijoki, J., Wik, O., Oberender, A., Hjelmar, O., 2016. Hazardous waste classification: Amendments to the European Waste Classification regulation-what do they mean and what are the consequences?. Nordic Council of Ministers. Available from: https://www.researchgate.net/publication/348845869_Hazardous_waste_classification.

Wang, Y., Yan, Q., Shi, Y., Long, M., 2024. Copper toxicity in animals: a review. Biological Trace Element Research 203, 2675–2686. DOI: https://doi.org/10.1007/s12011-024-04345-8.

Wang, K., Tepper, J.E., 2021. Radiation therapy-associated toxicity: Etiology, management, and prevention. CA: a Cancer Journal for Clinicians 71(5), 437–454. DOI: https://doi.org/10.3322/caac.21689.

Wang, M., Chen, L., Wu, L., Zhang, L., Xie, H., Shen, Z., 2022. Review of nonpoint source pollution models: current status and future direction. Water 14(20), 3217. DOI: https://doi.org/10.3390/w14203217.

Wang, M., Chen, Z., Song, W., Hong, D., Huang, L., Li, Y., 2021. A review on cadmium exposure in the population and intervention strategies against cadmium toxicity. Bulletin of Environmental Contamination and Toxicology 106, 65–74. DOI: https://doi.org/10.1007/s00128-020-03088-1.

Wang, T., Li, B., Shi, H., Ding, Y., Chen, H., Yuan, F., Zou, X., 2024. The processes and transport fluxes of land-based macroplastics and microplastics entering the ocean via rivers. Journal of Hazardous Materials, 133623. DOI: https://doi.org/10.1016/j.jhazmat.2024.133623.

Wang, W.X., 2016. Bioaccumulation and biomonitoring. In: Blasco, J., Chapman, P.M., Campana, O., Hampel, M., Marine Ecotoxicology, 99–119. Academic Press. DOI: https://doi.org/10.1016/B978-0-12-803371-5.00004-7.

Wei, X., 2012. Identification and remediation of microbial contaminants in the headwaters of an agricultural watershed. The Ohio State University. Available from: https://etd.ohiolink.edu/acprod/odb_etd/ws/send_file/send?accession=osu1345550902&disposition=inline.

Weyrauch, P.A., Matzinger, E., Pawlowsky-Reusing, S., Plume, D., von, Seggern, B., Heinzmann, K., Schroeder, P., Rouault, 2010. Contribution of combined sewer overflows to trace contaminant loads in urban streams. Water Research 44(15), 4451–4462. DOI: https://doi.org/10.1016/j.watres.2010.06.011.

Weldeslassie, T., Naz, H., Singh, B., Oves, M., 2018. Chemical contaminants for soil, air and aquatic ecosystem. In: Oves, M., Zain Khan, M., M.I., Ismail, I. (Eds), Modern Age Environmental Problems and their Remediation, Springer, 1–22. DOI: https://doi.org/10.1007/978-3-319-64501-8_1.

Winid, B., 2015. Bromine and water quality–Selected aspects and future perspectives. Applied Geochemistry 63, 413–435. DOI: https://doi.org/10.1016/j.apgeochem.2015.10.004.

Zaldívar, J.M., Viaroli, P., Newton, A., De Wit, R., Ibañez, C., Reizopoulou, S., Murray, N., 2008. Eutrophication in transitional waters: an overview. Transitional Waters Monographs 2(1), 1–78. DOI: https://doi.org/10.1285/i18252273v2n1p1.

Zaller, J.G., 2020. Daily poison. Pesticides-an underestimated danger; Springer Nature: Cham, Switzerland, 315. DOI: https://doi.org/10.1007/978-3-030-50530-1.

Zhang, B., Matchinski, E. J., Chen, B., Ye, X., Jing, L., Lee, K., 2019. Marine oil spills-oil pollution, sources and effects. In: Sheppard, C. (Ed.), World seas: an environmental evaluation, Academic Press, 391–406. DOI: https://doi.org/10.1016/B978-0-12-805052-1.00024-3.

Zhang, J., Chen, H., He, H., Cheng, X., Ma, T., Hu, J., Yang, S., Li, S., Zhang, L., 2020. Adsorption behavior and mechanism of 9-Nitroanthracene on typical microplastics in aqueous solutions. Chemosphere 245, 125628. DOI: https://doi.org/10.1016/j.chemosphere.2019.125628.

Zhou, L. J., Li, J., Zhang, Y., Kong, L., Jin, M., Yang, X., Wu, Q. L., 2019. Trends in the occurrence and risk assessment of antibiotics in shallow lakes in the lower-middle reaches of the Yangtze River basin, China. Ecotoxicology and Environmental Safety 183, 109511. DOI: https://doi.org/10.1016/j.ecoenv.2019.109511.

Zhu, Y., Li, J., Yao, K., Zhao, N., Zhou, K., Hu, X., Zou, L., Han, X., Liu, A., Liu, S., 2016. Degradation of 3-phenoxybenzoic acid by a filamentous fungus Aspergillus oryzae M-4 strain with self-protection transformation. Applied Microbiology and Biotechnology 100(22), 9773–9786. DOI: https://doi.org/10.1007/s00253-016-7847-3.

Zilberman, D., Metcalfe, M., Ogishi, A., 2006. Creative Solutions to the animal waste problem. In: Rice, J.M., Caldwell, D.F., Humenik, F.J. (Eds.), Animal agriculture and the environment: national center for manure and animal waste management white papers. St. Joseph, Michigan: ASABE, 161–180. Available from: https://elibrary.asabe.org/abstract.asp?aid=20252.

Zulaikhah, S.T., Wahyuwibowo, J., Pratama, A.A., 2020. Mercury and its effect on human health: a review of the literature. International Journal of Public Health Science 9(2), 103–114. DOI: https://doi.org/10.11591/ijphs.v9i2.20416.