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REVIEW ARTICLE

The Factors That Cause Water Pollution: Issues and Remedies

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ABSTRACT

Water, a vital natural resource, is an excellent solvent for life processes. Its uses range from drinking to industrial and agricultural applications. This review highlights the primary sources of water pollution, the associated health impacts, and the treatment methods for contaminated water. The suitability of water for various purposes depends on its biological and physico-chemical properties. This article addresses innovative ideas and cooperative efforts that focus on maintaining the quality of our water resources for future generations. It also thoroughly examines the difficulties connected with water pollution and the current strategies to manage this environmental issue.It offers insights on how to safeguard water resources by analyzing the effectiveness of present strategies and critically assessing the difficulties facing water management now.

keywords: Water pollution, Pesticides and herbicides, Strategies, Ecosystems, Wastewater treatment.

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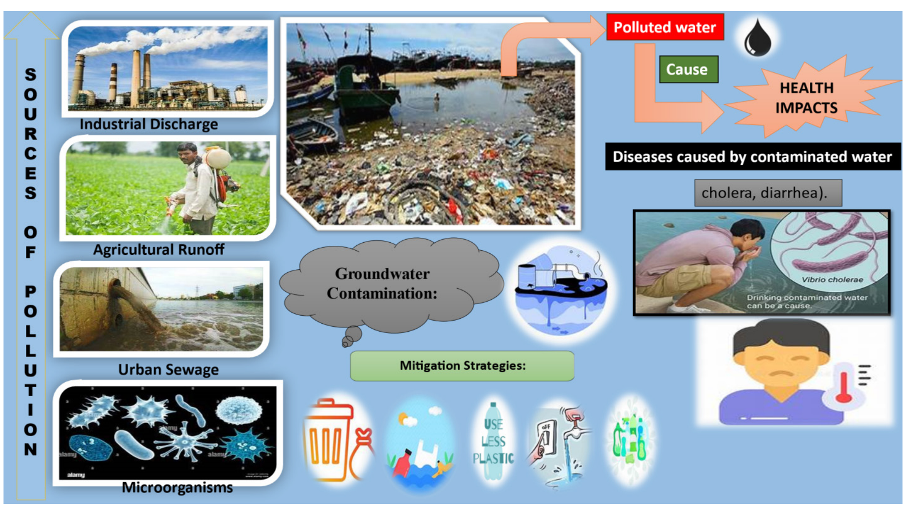

GRAPHIC ABSTRACT

INTRODUCTION

Life on Earth has been established and sustained by a crucial resourceWater.It is vital in all aspects of our lives, from being an essential component of our bodies to playing a significant role in numerous operations (Renuka and Karunyal, 2017) Water is the most essential natural resource necessary for life on Earth (Kristianto, 2017). Approximately 71% of the Earth's surface is covered by water (Vaishnav *et al*., 2017) It is widely recognized that freshwater is essential for our health (Sharma *et al*., 2017). Freshwater serves many purposes, such as drinking, irrigation, recreation, transportation, hydroelectric power, and various domestic, industrial, commercial, and habitat functions for economically significant animals (Igwe *et al*., 2017). Pure water is characterized bybeing colorless, free from turbidity, and lacking any abnormal taste or odor (Iji *et al*., 2024) Water becomes polluted when it contains microorganisms

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from human or animal sources, toxic chemicals, industrial or domestic sewage, as well as organic and inorganic substances. Water pollution occurs when natural water bodies like lakes, rivers, oceans, and groundwater are contaminated by chemical, physical, radioactive, or pathogenic microbial substances, leading to a decline in water quality that negatively impacts any living organisms that consume, use, or inhabit the water (Praveen *et al*., 2016) Groundwater becomes contaminated due to various human activities, such as the extensive use of pesticides, herbicides, and fertilizers, leaking fuel and chemical tanks, industrial chemical spills, household chemical drainage, and poorly managed landfills (Pooja., 2017). Pollutants in the water can also damage aquatic life, reducing biodiversity and disrupting fragile ecosystems. (Bashir *et al*., 2020). Groundwater is the primary source of drinking water for rural populations (Pati *et al*., 2017). Approximately 1.2 billion people worldwide lack access to safe, drinkable, and affordable water for their household needs (Egbuikwem PN, 2017). Diseases such as cholera, diarrhea, dysentery, and hepatitis A are directly connected to unclean and contaminated drinking water. It is estimated that over 842,000 people worldwide die from diarrhea each year (Hasan, 2019).To address this issue, it is crucial to understand the root causes of water pollution and work towards sustainable solutions. Industrial waste significantly contributes to water pollution, as factories and manufacturing industries frequently release harmful chemicals and pollutants into nearby water bodies. This contamination makes the water hazardous for both humans and wildlife. (Siddiqua *et al*., 2022). Agriculture plays a major role in water pollution due to the runoff of pesticides, fertilizers, and animal waste, which can contaminate rivers and lakes. This runoff can lead to algae blooms and oxygen depletion in the water. (Burkholder *et al*., 2007;Ingrao *et al*., 2023).To combat water pollution, regulatory mechanisms need to be established to oversee and control the discharge of pollutants into water sources. Authorities and environmental organizations should enforce clear regulations and penalties for industries and agricultural practices that contribute to water contamination. Additionally, investing in green technologies and sustainable farming methods can significantly reduce the amounts of contaminants entering our water systems. Another important strategy for addressing water pollution is improving public awareness and education. Many people are unaware of how their daily activities, such as disposing of household chemicals down the drain or littering on beaches and rivers, impact water quality. By educating the public about the importance of conserving water resources and the effects of pollution, we can empower individuals to make informed choices and participate in protecting our water bodies. Additionally, advanced technologies and wastewater treatment systems play a critical role in reducing water pollution. High-tech filtration systems can remove contaminants from water sources, making them safe for consumption and easing the burden on natural ecosystems. (Soliman *et al*., 2021).

Investing resources into researching and innovating new treatment methods can help uncover more effective approaches to cleanse polluted water sources and prevent future contamination. Addressing the potential negative health impacts stemming from plastic pollution is crucial (Emenike *et al*., 2023). Water pollution is a multifaceted issue stemming from various sources. A comprehensive approach involving regulatory measures, technological advancements, public education, and research is essential to safeguard water resources and protect human and environmental health globally. Continual assessment of water resource policy is crucial to address the pervasive challenge of water pollution. Various factors, including anthropogenic activities and climatic conditions, influence water quality. Principal threats originate from specific point sources and non-point sources of contamination, exacerbating water quality concerns.

Pollutants

The Royal Commission on Environmental Pollution in the UK, in its third report, defined "Pollution" as the human introduction of substances or energy into the environment that could pose risks to human health, damage living resources and ecosystems, harm structures or amenities, or disrupt legitimate environmental uses. Section 1 (3) of the UK Environment Protection Act, 1990, describes "Pollution" as the release of substances from any process into the environment that could harm humans or other living organisms. Pollution is not limited to physical injury but also includes offenses to human senses or property. Thus, pollution encompasses factors like odors and noise that may not directly cause injury but still contribute to environmental harm and interference with ecosystems (Environmental Protection Act 1990).

The introduction of harmful substances into the environment leads to resource degradation and adverse effects (Nidhi *et al*., 2024), Pollution can have immediate or prolonged detrimental impacts, affecting ecosystems and human health. Biodegradable contaminants cause temporary harm, while certain substances like DDT decompose into other pollutants, perpetuating the contamination cycle (Nidhi *et al*., 2024). Pollutants vary in characteristics, stock pollutants like heavy metals accumulate in the environment over time, posing a burden for future generations (nidhi *et al*., 2024). For instance, carbon dioxide (CO_2) becomes problematic only as its volume increases (Tietenberg,2006). Mitigation strategies, such as dilution or conversion of pollutants into harmless compounds, are essential for reducing their toxicity.

Pollution From a Point Source

The introduction of substances into water bodies originates from specific points termed as point source pollution, (U.S., EPA) This type of contamination is characterized by identifiable and discernible sources, which include sewage treatment facilities, ditches, pipelines, and stormwater drains (Claudia, 2016)Point source pollution stands distinct from other sources of contamination due to its clear and traceable origins within the environment (CM, 2010)

Pollution from non-point sources

Non-point source pollution is characterized by the presence of pollution without a singular, identifiable origin or source (Brian, 2008). It arises from diverse and diffuse origins, encompassing

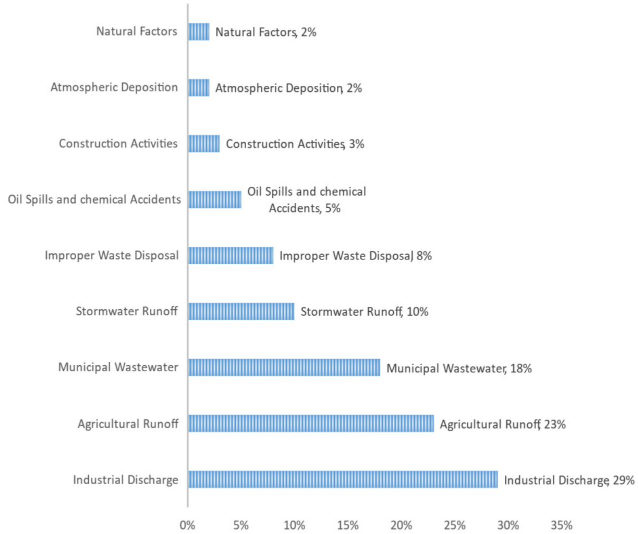

Fig 1: Factors causing water pollution (*Kailasanathan et al., 2024*)

sources such as pesticides, fertilizers, and industrial waste (EPA 2023 and Texas Commission on Environmental Quality, 2013) This form of pollution poses considerable challenges in terms of control and mitigation due to its widespread and multifaceted nature (Indiana Department of Enviromental Management, 2024). Within the United States, non-point source pollution stands as the predominant cause of water contamination (U.S. EPA,2007 ; EPA, 2003). attributing to its pervasive and complex diffusion across various environmental settings (Zheng *et al*., 2014).

Contamination of Groundwater

Groundwater contamination arises when pollutants from the Earth's surface infiltrate subterranean water reservoirs (Ferrer *et al*., 2020).Fecal matter percolating below ground and harboring pathogens renders water unsafe for consumption (Nayebare *et al*., 2022). Pathogen-contaminated groundwater may comprise bacteria, viruses, protozoa, and sporadically helminth eggs (Chahal *et al*., 2016). Consumption of such contaminated water can lead to afflictions like, cholera and diarrhoea (Wolf *et al*., 2015; Li *et al*., 2021;Jennyfer *et al*., 2014). Furthermore, nitrates represent another source of groundwater pollution, culminating in the manifestation of blue baby syndrome (Buitenkamp and Stintzing, 2008,Knobeloch *et al*., 2000).a condition predominantly affecting children in rural Bulgaria and Romania (Li *et al*., 2021). The likelihood of this syndrome escalates notably when nitrate concentrations in groundwater exceed 10 mg/L (10 ppm). Overuse of nitrate-based fertilizers contributes significantly to groundwater pollution, as most nitrates, primarily unused by plants, eventually permeate into groundwater reserves (Khan and Mohammad, 2006; Jackson and Burger, 2008) Excessive fluoride contamination in groundwater leads to dental and skeletal health complications (Lennon *et al*., 2004; Li *et al*., 2021).

Rainfall from urban storms

The phenomenon is attributed to the densely populated nature of urban centers where residential and commercial structures are the primary sources of the issue (Letchinger *et al*., 2000). In urban and suburban landscapes, extensive land coverage by buildings and impermeable surfaces, such as pavement, impedes the infiltration of precipitation or snowmelt into the soilConsequently, stormwater becomes laden with an array of pollutants, including pesticides, gasoline residues, sediment, and lawn fertilizers (Müller *et al*., 2020). This stormwater runoff, directly channeled into rivers and streams, initiates water contamination (Letchinger *et al*., 2000, CBF Pollution runoff,2014) In natural environments, contaminants held within soil pores undergo natural filtration processes, however in urban settings characterized by limited infiltration, these pollutants are swiftly carried into water bodies, thereby

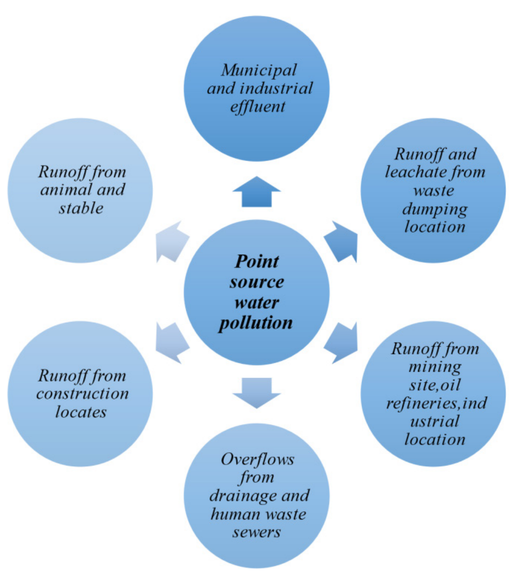

Fig 2: Characteristic of point source of elements to receive water (*Kumaraswamy and Javeed, 2019*)

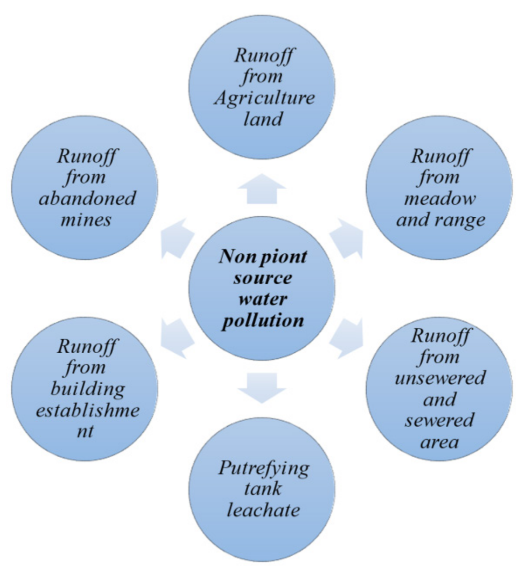

Fig 3: characteristic of non-point sources of elements to receiving water *(Kumaraswamy and Javeed, 2019).*

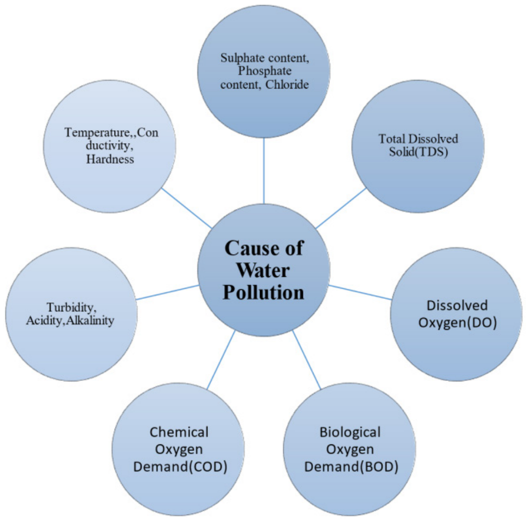

Fig 4: Physico-chemical parameters employed to assess water quality (Yadav *et al*., 2015 and Azeem*et al*., 2016)

Table 1: The daily contribution of human waste is measured in grams per capita (Arceivala and Asolekar 2010).

Physico-chemicalparameters	*Range (g/capital/day)*
BOD	45-54
COD	1.6-1.9 times of BOD
TOC	0.6-1.0 times of BOD
Total N	6-12
Organic N	0.4 of total N
Free ammonia	0.6 of total N
Nitrate	0.0-0.5 of total N
Total P	0.6-4.5
Organic P	0.3 of total P
Inorganic P	0.7 of total P

compromising water quality (Werbowski *et al*., 2021). Moreover, the rapid velocity of stormwater flow exacerbates erosion along water body embankments, leading to further contamination of water resources (Gaffield *et al*., 2003).

Pollutants from Agriculture

In rural regions with lower population densities, rainfall and flooding events contribute to the runoff of pollutants such as pesticides, fertilizers, and eroded soil, eventually finding their way into water bodies (Letchinger*et al*., 2000). Agricultural runoff is a significant contributor to the eutrophication observed in freshwater systems. Eutrophication, prevalent in a majority of lakes in the United States, primarily results from elevated phosphate levels, fostering the proliferation of algae and cyanobacteria. These organisms, in abundance due to high nutrient levels, decrease dissolved oxygen levels in water (Lennon *et al*., 2004).subsequently leading to the accumulation of toxic substances within the food chain (Schmidt *et al*., 2013). Nitrogen-rich fertilizer compounds further exacerbate dissolved oxygen deficiencies in rivers, lakes, and coastal areas, imposing detrimental effects on marine ecosystems. The prohibition of nitrogen fertilizer usage in North America and Northwest Europe since 2006 was an effort to mitigate this impact, as these fertilizers, highly soluble in water, contribute to groundwater pollution through increased runoff and leaching (Van *et al*.,2012). Similarly, pesticide usage contributes to groundwater contamination, particularly those that are water-soluble and prone to leaching, especially in sandy soils (McBride, 1989; Environmental fate of pesticides, 2015). Selenium, a naturally occurring heavy metal in soil, accumulates due to irrigation practices, posing significant risks to human and animal health when it accumulates in the soil and eventually reaches water reserves (Ganje, 1966)

Atmospheric Pollution

The phenomenon stems from minute airborne particulates that, upon precipitation, are deposited into water bodies. These particles carry carbon dioxide, a byproduct of fossil fuel combustion. Upon contact with water molecules, carbon dioxide undergoes a reaction leading to the formation of sulfuric acid. Sulfuric acid production occurs through the interaction of sulfur dioxideemitted by industrial processes and volcanic activitywith water molecules (Junge *et al*., 1958). Combustion of coal and petroleum derivatives also yields sulfur dioxide. Similarly, the combination of water and nitrogen dioxide results in the generation of nitric acid. Particulate matter represents another significant contributor to water body pollution, as rainfall facilitates the transport of these particles into aquatic ecosystems (Letchinger, 2000; Brian, 2008)

Pathogens

Pathogens, microorganisms capable of inducing disease, represent a subset among various microbial species (Saxena *et al*., 2015). While the majority of bacteria present in natural environments are innocuous or non-pathogenic, a select few possess the potential to contaminate drinking water and cause harm (Kristanti *et al*., 2022), Bacterial indicator species serve as a tool to assess water pollution levels (Qazi A.Hussain, 2019). Pathogenic bacteria associated with waterborne diseases encompass species like Burkholderiapseudomallei, Cryptosporidium parvum, Salmonella, Norovirus, Giardia lamblia, as well as parasitic worms like Schistosoma (EPA, 2003; Thomas, 2000)

Herbicides and pesticides

Weed and pest control involve the utilization of herbicides and pesticides (Hussain *et al*., 2008) both contributing significantly to water contamination (EPA, 2006)Their infiltration into groundwater occurs through leaching, influenced by rainfall, irrigation practices, pesticide properties, and soil composition (Perez *et al*., 2019). Leaching is more pronounced in sandy soils when the herbicide demonstrates higher solubility in water. Furthermore, runoff facilitates the transport of insecticides and herbicides into natural water reservoirs (Pradhan *et al*., 2022). The introduction of pesticide residues into these water bodies disrupts indigenous flora and wildlife (Riyaz *et al*., 2021). Particularly hazardous are pesticides exhibiting slow or negligible degradation rates, perpetuating their impact on ecosystems (British Columbia Ministry of Agriculture; Pope *et al*., 2016).

Chemical pollutant

It is generated by industrial entities that discard hazardous chemicals, remaining as a residual output during the manufacturing process. This material stands as a substantial contributor to water body pollution (Bill H, 2010; Maczulak, 2010). Hazardous chemical waste exists in solid, liquid, or gaseous forms, exhibiting characteristics of corrosiveness, ignitability, toxicity, and reactivity (Laboratory chemical waste management guidelines, 2016) Its origins traced back to the Industrial Revolution era (Maczulak, 2010). Remediation of industrial waste chemicals requires specialized treatment facilities, as conventional sewer treatment systems cannot effectively manage such hazardous waste (Singh *et al*., 2023).

Pollution from sediments

Runoff-induced sedimentation significantly impacts water quality by diminishing the capacity of rivers, streams, ditches, and navigation channels (Lisetskii *et al*., 2023). This process disturbs underwater vegetation, reducing light penetration and subsequently disrupting the aquatic food chain, thereby affecting fish and other wildlife reliant on this vegetation. Sedimentation facilitates the transportation and accumulation of pollutants such as phosphate and pesticides within aquatic environments (Dudal R, 1981) Furthermore, sediment particles adhere to fish gills, impeding respiratory functions and culminating in fish mortality. Additionally, silt and sediment from sources like ditches contribute to the pollution of aquatic bodies by introducing harmful substances like pesticides and petroleum compounds (Letchinger, 2000)

Saltwater intrusion

Saltwater intrusion represents a notable concern contributing to groundwater contamination, particularly in coastal areas (Prusty *et al*., 2020). This phenomenon occurs when saline seawater infiltrates the groundwater reservoirs in proximity to the coast (Prusty *et al*., 2020). While this intrusion can occur naturally, human activities, such as excessive pumping of freshwater, exacerbate the incidence of saltwater intrusion (Tran *et al*., 2024). Agricultural practices, drainage systems, and the construction of navigation channels significantly influence and exacerbate saltwater intrusion into freshwater aquifers (Teddy, 2007).

Green infrastructure and nature-based approaches are prominent instances of innovative approaches to water pollution.

The use of natural solutions and green infrastructure is becoming more widely acknowledged as an efficient and long-term way to reduce water pollution (Denchak and Melissa 2019). These methods lessen the detrimental effects of pollutants on aquatic habitats by managing stormwater and wastewater through the use of natural systems and processes (Kim *et al*., 2019) Both urban and rural landscapes can benefit from the addition of vegetated areas, wetlands, and permeable surfaces to improve water quality (Lennon and Mick 2015) increase biodiversity, and mitigate the effects of climate change (Štrbac etal., 2023).The capacity of nature-based solutions and green infrastructure to replicate natural hydrological processes is one of its primary advantages (Singh *et al*., 2020). Rain gardens and green roofs for instance, can collect and absorb rainfall, keeping contaminants out of waterways and lowering runoff (Alves *et al*., 2024), By acting as organic filters, wetlands purge tainted water of germs, nutrients, and debris (Sun *et al*., 2024). These methods preserve water supplies and aid in the restoration of ecosystem health by utilizing the power of nature (Dubois *et al*., 2024).

In addition to enhancing water quality, green infrastructure and nature-based solutions have many other advantages (Rakhshandehroo *et al*., 2017). Urban green spaces may improve air quality (Kruize *et al*., 2019), foster a sense of community (Lange *et al*., 2021) and serve as habitats for wildlife (Rakhshandehroo *et al*., 2017). Trees and vegetation help lessen the impact of the urban heat island, which lowers temperatures and requires less electricity (Aboelata *et al*., 2020). These methods support the development of resilient and sustainable built environments by addressing several environmental issues simultaneously (Epa and US, 2016). Green infrastructure and natural solutions are very beneficial to urban areas because water pollution in these places is often exacerbated by impermeable surfaces and inadequate infrastructure (Matos etal., 2023). Urban planning can improve stormwater management in cities by integrating permeable pavements, bioswales, and green roofs (Grabowski *et al*., 2022) By completing this integration, the strain on sewage systems would be lessened and combined sewer overflows would be less likely. These green elements not only increase urban areasaesthetic value (Yilmaz *et al*., 2016) but also public places and offer chances for recreationas well as learning (Sangwan *et al*., 2022) Natural solutions and ecological infrastructure have many advantages, but there are drawbacks to their application (Monteiro *et al*., 2023) Barriers pertaining to organizations, finances, and regulations could prevent these techniques from being widely adopted. Green infrastructure and nature-based solutions, however, are becoming more and more important in promoting sustainability and resilience in towns and cities (Monteiro *et al*., 2023). Towns can save the environment, raise resident standards of living, and improve water quality by overcoming these obstacles and investing in green infrastructure.

Advancements in environmental remediation technologies

Human and environmental health are seriously threatened by water contamination on a global scale (Shahid *et al*., 2021). Technological developments have been crucial in resolving this issue by developing more effective methods for removing contaminants from water sources. The advancement of these technologies has resulted in the creation of more effective techniques for eliminating contaminants from water sources (Shahid *et al*., 2021).Filtration is among the most widely used techniques (Rahaman *et al*., 2024). Water filtration systems efficiently eliminate pollutants and impurities by using porous materials or membranes (Pachaiappan *et al*., 2022) With its increased sophistication and efficiency, this technology can now remove heavy metals, chemicals, bacteria, and a host of other impurities (Pachaiappan *et al*., 2022). The production of safe drinking water is ensured by the advanced nature of modern filtering systems, which can even remove minute particles (Wu *et al*., 2021).

Another significant development in cleanup technologies is the progress made in chemical remediation techniques (Arfasa *et al*., 2022), By adding particular chemicals, these techniques neutralize pollutants or make it easier for them to be removed from water (Cevallos-Mendoza etal., 2022). This method demonstrates significant effectiveness when used on water sources contaminated with high levels of pollutants or heavy metals (Michael *et al*., 2022).Various innovative chemical processes, such as chlorination and ozonation, have been developed to target specific contaminants and ensure water meets safety standards (Anawar *et al*., 2020) In order to address water pollution, biological treatment techniques have gained popularity recently as environmentally acceptable and sustainable solutions (Lata and Surabhi 2021). These techniques use organic items, such bacteria and plants, to remove pollutants from water sources (Saravanan *et al*., 2021) For example, bioremediation is the process of reintroducing bacteria or other microorganisms into contaminated water to break down pollutants and improve the quality of the water (Bala etal.,2022).

The effectiveness of this method in removing various forms of pollutants, industrial waste, and oil spills has been remarkable (Bala *et al* 2022). Advanced oxidation techniques have become a cutting-edge method of reducing water contamination in recent times (Khader *et al*., 2024). Anaerobic processes convert pollutants into harmless byproducts by using potent oxidizing agents like ozone or hydrogen peroxide (Xue etal., 2023). A wide range of pollutants, such as dyes, insecticides, and medicines, can be effectively removed with this procedure (Malik *et al*., 2024), Furthermore, because they don't leave behind any hazardous residues or byproducts that could contaminate water sources even more, sophisticated oxidation techniques are good for the environment.

Another rapidly developing field that has transformed water pollution cleanup approaches is nanotechnology (Li etal.,2021). Water can be effectively purified by using nanomaterials like carbon nanotubes and nanoparticles, which effectively remove pollutants from the water (Saleem etal.,2020). These materials large surface areas and ability to either absorb or catalyze contaminants make them ideal for water treatment. The treatment of contaminated water sources could be greatly enhanced by nanotechnology, leading to more effective and sustainable solutions (Sayan *et al*., 2013).

The rules and regulations of the government regulating water pollution management.

The United States' primary policy for managing water pollution is the Clean Water Act, which was passed in 1972 (U.S EPA, 2024). This historic law regulates the release of pollutants into aquatic bodies by setting water quality criteria for surface waters. Furthermore, in order to protect water sources from possible contamination, the Clean Water Act mandates the construction of treatment facilities to remove pollutants from effluent before it is released into aquatic habitats. In addition to federal laws like the Clean Water Act, state and local governments play a crucial role in controlling water pollution. Many states have passed water quality standards and laws that are unique to the environmental conditions of the area (Saleh *et al*., 2021). In order to guarantee the protection of water sources and a strict restriction of pollution levels, state rules and federal laws operate in tandem.

Point source pollution, which refers to contamination originating from a single, defined source, like an industrial site or pipeline, is another crucial component of water pollution control that is monitored (Sabater *et al*., 2022). According to the National Pollutant release Elimination System (NPDES), which controls point source pollution, permits are required for the release of toxins into water bodies.These permits help prevent water contamination and maintain water quality by limiting the quantity and types of pollutants that can be emitted.Nonpoint source (NPS) pollution, on the other hand, comes from dispersed sources, such as runoff from fields or cities. Because of its complex origins and difficult to identify, this specific type of pollution offers more regulatory and control issues (Dosi *et al*., 1994) However, laws and policies like the Clean Water Act that promote conservation efforts and best management practices to lower discharge pollution levels are also used to address nonpoint source pollution (Tomczyk *et al*., 2023)

Recently, there has been a greater focus on emerging contaminants that might pollute water sources, such as microplastics, personal care items, and medications (Kumar *et al*., 2022) The existence of these pollutants in the environment may not be adequately addressed by conventional regulations, which creates special difficulties for the control of water pollution. Therefore, to protect water quality from such emerging threats and stop the rise of contaminants, novel regulations, and laws are being developed (Lapworth *et al*., 2023). In addition to regulatory actions, stakeholders and communities also contribute to the management of water pollution through outreach, education, and advocacy programs (Karen Morrison, 2003). To solve the issue of water pollution and put preventative measures in place to save water sources, active involvement and public awareness are crucial. By working together, the public, legislators, and regulators can promote a moresustainable and healthy environment for everybody. A comprehensive strategy is necessary to properly control water pollution because ecosystems, human activities, and water supplies are interdependentPolicies and regulations create the foundation for the implementation of monitoring programs (Cosgrove *et al*., 2015), enforcement mechanisms, and ongoing research to improve water quality standards and protective measures in the face of water pollution issues (Mishra *et al*., 2021). Collaboration between environmental organizations, government agencies, businesses, and communities is essential for managing water pollution effectively and ensuring that future generations have access to clean, safe water (Nti etal., 2023). Overall, by creating the framework required to protect water quality and ensure the long-term viability of water sources, policy and regulation play critical roles in the control of water pollution (Schwarzenbach *et al*., 2010), With the enforcement of laws like the Clean Water Act and regulations related to point and nonpoint source pollution, there has been significant progress made in reducing pollution levels and improving water quality.

However, given the introduction of new contaminants and an increasing number of environmental issues, continued efforts are needed to strengthen water pollution control rules and regulations in order to safeguard water sources, ecosystem health, and communities. Collectively, we can create a more stable and health-conscious atmosphere by supporting diverse, empirically-based approaches.

CONCLUSION

A major global issue, water pollution is brought on by a multitude of factors such as improper domestic chemical disposal, runoff from farms, and industrial waste. The economy, human health, and aquatic ecosystems are all seriously threatened by these pollutants. Along with pesticides, herbicides, and air pollutants, industrial waste is a major cause of water contamination. Contaminated water contains pathogens that can seriously harm human health. Furthermore, the delicate balance within aquatic habitats is disrupted by contamination of the water.In order to solve this problem, a number of strategies can be put in place, such as stricter regulations for the disposal of industrial waste, improved wastewater treatment systems, sustainable farming methods that reduce runoff, and raising public knowledge of appropriate waste management. To stop further degradation of our water supplies, regulations encouraging eco-friendly practices and investments in clean water infrastructure are crucial.Through an integrated strategy engaging corporations, government agencies, and local communities, we can address the root causes of water pollution and strive toward a sustainable and cleaner future for everybody.

COMPETING INTERESTS

The authors declare that we have no competing interests.

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This review paper was completed without any funding support

DATA AVAILABILITY STATEMENT

All the data is collected from the simulation reports and published papers which are appropriately referenced. Where possible, direct links to the datasets and studies have been provided.

For any further information regarding the data, please refer to the original publications cited in this review. Researchers interested in accessing the datasets are encouraged to contact the respective authors of the original studies.

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