ELSEVIER Scopus
OPEN ACCESS
Eurasian Journal of Analytical Chemistry
ISSN: 1306-3057
2018 13(1): 17-24
DOI: 10.53555/ejac.v13i1.1187

A Few Consequences of Polluting Aquatic Ecosystems

Raju Potharaju[1]* and M. Aruna[2]

[1] *Department of Botany, Vivekananda Degree & PG College, Siddipet, Telangana, 505467, India.
[2] Department of Botany, Hydrobiology and Algal Biotechnology Laboratory, Telangana University, Dichpally, Nizamabad, Telangana, 503322, India.

***Corresponding Author:** Raju Potharaju
*Email: rajuvarmabotany@gmail.com

ABSTRACT
The effects of anthropogenic pollution on the aquatic organisms dwelling in freshwater ecosystem at global scale. aquatic ecosystem pollution with particular reference to pathogens in water, sediment and fish and their human health concerns. It highlighted the historical perspective of the relationship between microbes and humans This article is based on categories of different classes/sources of pollutants which affect freshwater organism. This is composed of several sections including metals and metalloids, wastewater and effluents, sediments, nutrients, pharmaceuticals, , pesticides, herbicides, and endocrine disruptors.

Key words: Freshwater pollution; metals and metalloids; microplastics; pesticides and herbicides

INTRODUCTION

In recent years, freshwater ecosystem has experienced serious threats from human activities such as industrial effluents, agricultural activities, urban waste management issues, and increase in urbanization [1]. In addition, climate change impacts resulting changes in abiotic factors such as precipitation and temperature levels have affected the normal function of aquatic ecosystems including reproduction and feeding. These pollution levels have also affected the habitats of aquatic flora and fauna [2].

There are many things that can contaminate water, but some of the most common and significant include things like industrial waste, untreated household waste, human-produced trash dumped at sea, air pollution, deforestation (which causes soil erosion), damaging chemicals used in farming, untreated waste, and so on. Inactive industrial waste, including heavy metals and their by-products, eventually finds its way into the world's oceans and freshwater bodies (lakes, rivers, and ponds), where it poses a threat to aquatic life and humans. Because people eat both the animals and their products, the exposure of the cattle to the polluted water causes these dangerous substances to accumulate in human bodies. Toxic and leading to a host of health problems, these chemicals disrupt human bodily functioning. Major health problems include lowered immunity (which leaves one vulnerable to a wide range of other infectious diseases), inflammation, infertility and other reproductive issues, gastrointestinal and respiratory problems (including hepatotoxicity), cancer, and death. Furthermore, water contamination is the root cause of several infectious disorders, including cholera and typhoid[3], as well as certain malignancies. The list goes on and on; it is believed that polluted water is the primary vector for the transmission of kidney illnesses, dermatitis, dementia, diarrhoea, and many more [4].

From a medical perspective, access to clean water is critical for human health on a global scale. The fact that all forms of life occur in water provides the strongest evidence for this idea, among others. The majority of species—including many harmful ones—and the medium in which life occurs—water—are found in this environment. Some of these organisms are helpful, while others aren't. Building on this background, we find the following assertions made by the WHO: 80% of Human illnesses may spread via water. The fact that most nations throughout the globe do makes the disparity all the more apparent. do not satisfy the World Health Organization's standards for potable water[5]. This is a shame for nations where there is an abundance of naturally occurring fresh water, yet the water is unfit for human consumption due to the brutality of human activity. As a direct consequence of careless human actions and a lack of effective laws, around 3% of all fatalities occur as a direct result of water that is not fit for human consumption [6].

Thus, in order to protect global freshwater aquatic species and ensure the normal functions of ecosystems, it is crucial to identify the main pollution activities, their sources, and their fate in the aquatic environment including their spatial distribution[7]. Achieving these will provide more sustainable and lasting measures of employing a more realistic measures of protecting freshwater aquatic life from anthropogenic activities .Understanding the impact of natural processes may help in developing conservation programs and policies to prevent the disturbance of freshwater environment. The abiotic realm,

(*Correspondence) rajuvarmabotany@gmail.com

together with the biotic realms of plants and animals, is an essential component of the ecosystem in which humans exist. Plants and animals are both immediately impacted by water pollution since water is both an ambient and essential component of the environment that supports life. Pollutants that end up in water bodies have far-reaching effects on aquatic life and the plants and animals that inhabit it. Many aquatic and freshwater creatures that may be consumed by humans—including sea weeds, molluscs, birds of water, and fish—die as a result of water pollution. These birds' populations decline because a lot of toxins build up in their egg shells. [8] Additionally, these compounds build up in human bodies in a variety of tissues after ingesting these plants and animals for sustenance, leading to toxicity, inflammation, immunosuppression, allergies, and a host of other problems [9].

The present research findings from major contributors to freshwater pollution including wastewater, metals and metalloids, industrial effluents, sediments, nutrients, pharmaceuticals, polycyclic aromatic hydrocarbons, flame retardants, persistent organic pollutants, pharmaceuticals and illicit drugs, emerging contaminants, pesticides, herbicides, and endocrine disruptors. In addition, new freshwater pollutant sources such as microplastics and engineered nanoparticles were discussed. The abiotic realm, together with the biotic realms of plants and animals, is an essential component of the ecosystem in which humans exist. Plants and animals are both immediately impacted by water pollution since water is both an ambient and essential component of the environment that supports life. Pollutants that end up in water bodies have far-reaching effects on aquatic life and the plants and animals that inhabit it. Many aquatic and freshwater creatures that may be consumed by humans—including sea weeds, molluscs, birds of water, and fish—die as a result of water pollution. These birds' populations decline because a lot of toxins build up in their egg shells. Additionally, these compounds build up in human bodies in a variety of tissues after ingesting these plants and animals for sustenance, leading to toxicity, inflammation, immunosuppression, allergies, and a host of other problems [10].

METHODOLOGY & DISCUSSION

In order to determine the current state of freshwater ecosystems We took our samples from a freshwater lake. We compared the microelement concentrations in the biota components we looked at to those in freshwater ecosystems that aren't contaminated and to the concentrations in aquatic animals orderly. The extent of human influence on aquatic ecosystems was assessed by comparing the average concentrations of microelements in biological items in affected lakes water to the level of the natural biogeochemical background. In this investigation of biogeochemical things, we looked at plankton, periphyton, aquatic plants, fish, bacteria, and other creatures. Jedy nets with an entrance diameter of 37 cm and a filtering cone made of polyamide with a mesh of 61 µm were used to collect plankton samples from the 0-5 m water layer. Reservoirs, with their mostly stagnant water, were ideal locations for collecting plankton samples with the necessary biomasses. The water samples were sent to a hydrobiology lab for further analysis.

Causes of Water Pollution

As already mentioned, there are many sources of water pollution but some of the representative basis are discusses as follows (fig 1)

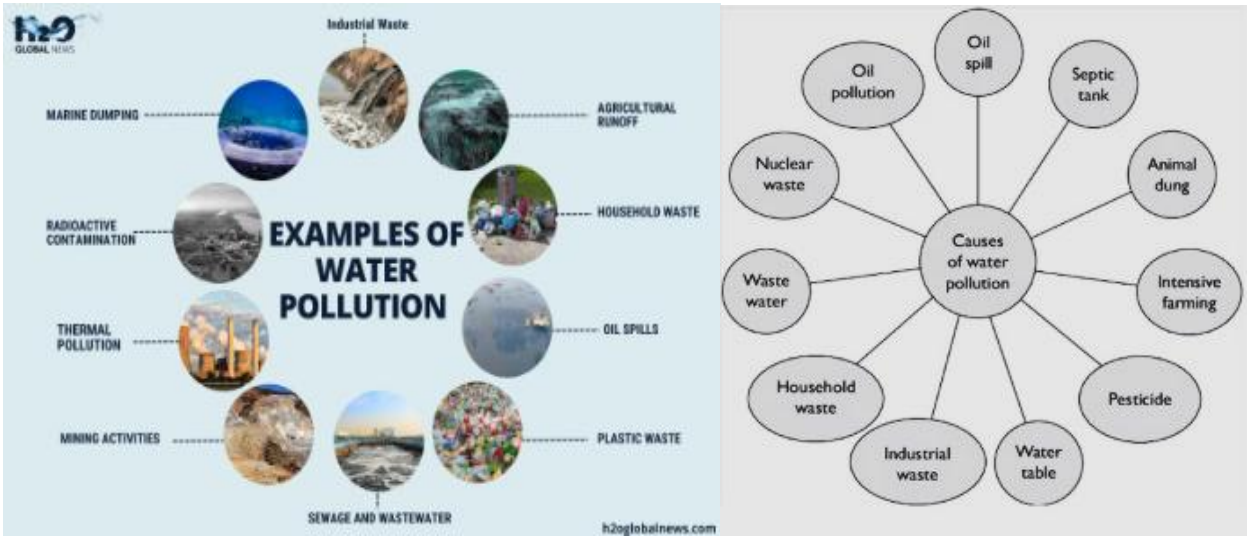

Fig 1. Causes of Water Pollution

Domestic Sewage

It is also called domestic wastewater and sometimes municipal wastewater. It is produced by domestic and community activities of people in the form of waste water. Domestic sewage is generally described by the amount of its production, dynamics of its flow, physical characteristics, chemical constituents, toxin concentration and pathogenic load. Examples of

domestic sewage include greywater (from sinks, tubs, showers etc.), blackwater (The water that comes from flushed toilets, and cleansing activities of human waste) and other chemical substances like soaps and detergents.[11]

Industrialization

Industries generally take cold water and return back hot adding a significant momentum to global warming and climate changes. These effects in turn have harmful effects on the ecosystems which affects human health. Industrial pollution brings forth its effects through industrial wastes such as heavy metals, harmful substances/ chemicals, industrial by-products, organic pollutants etc[12].

Metals and Metalloids- Multimetallic bioaccumulation

Growth rate, metabolic, feeding, and reproductive activities of freshwater isopod (*Asellus aquaticus*) were determined from the exposure to mixture of heavy metals [13].

The outcome of the study has shown that under predatory stress, Cu accumulation rate was observed to be affected by growth, feeding rate, and the activities of the *Asellus aquaticus*. However, concentration-dependent association of the combined Cd + Pb was influenced by the feeding rate of the organism. The study concluded the need for the investigation of how aquatic organisms respond to multistressors as several interactions could occur between predatory stress and mixture of metals.

Pesticides and Fertilizers in Agriculture practice

Pesticides, which are mostly compounds based on sulphur, are widely used in contemporary farming methods. They are used to kill pests since they are possibly poisonous. Because their toxicity is not species-specific, they endanger human development in general and cause a wide range of chronic disorders and birth defects in particular. From a health perspective, the situation is concerning due to the quantity of pesticides employed. As dietary supplements for crops, fertilisers are mostly nitrogen-based compounds. Applying fertilisers correctly, in accordance with regulations, and with care may not be as dangerous as using pesticides, but using too much, as is commonplace these days, is dangerous. Pesticides and fertilisers both have a tendency to flow off into water, where they contaminate bodies of water and pose a significant threat. The runoff from fields and lawns, caused by rain and over-irrigation, ends up in water bodies, where it contaminates them and poses health risks to people. The development of aquatic plants and algae is stimulated by an excess of fertiliser in lakes and other bodies of water, which in turn disrupts the natural flow of rivers and lakes, leading to the formation of stagnant waters that serve as breeding grounds for infectious diseases.

To protect our agricultural output and efficiency, we use pesticides to eradicate diseases and other organisms that pose a hazard. The name "pesticides" refers to compounds that kill pests, however these chemicals are not exclusive to pests. All sorts of creatures, even ones we don't necessarily consider pests, may be poisoned by these chemical poisons. A major threat to ecosystems and the environment is the overuse and lack of regulation of pesticides [14]. Even though the majority of pesticides decompose in the soil, a considerable portion of these toxic substances get up in our water supply. Hypertrophication occurs when nutrients from fertilisers leach into water, which causes an explosion in plant and algae growth, an increase in plant density, and the decay and death of animals, which in turn causes a host of diseases. If pesticides or excessive fertilisers build up in soil or water, they will eventually make their way into the plants that grow on top of it. This is because these substances may be harmful. Vegetables and other items sourced from this area pose a significant risk to human health due to the presence of these toxins [15].(fig 2)

Fig 2. Industrialization Water Pollution: (The Urgent Need for Sustainable Industrial Practices)

Plastics/Polythene Bags- A Major Cause

There is a never-ending supply of polythene products like plastic bags since they don't break down very quickly. It blocks water movement, which causes pollution and the proliferation of pathogens. One of the biggest problems with today's

culture is the use of plastic bags. It poses a serious risk to human health and poses an enormous danger to our water systems. Additionally, it is among the most easily detachable threats that our era has seen. Refraining from using plastic bags is as simple as making a personal choice. Much of the work is done by that. Also, you can get just as many eco-friendly alternatives to plastic bags that are just as handy. Urbanisation, ineffective management, inadequate policymaking, inadequate education, public selfishness, and indifference from both the government and appellate authorities are further contributors to water contamination. Sewage from homes accounts for about 75% of all pollutant runoff, making it one of the leading causes of water contamination. Some examples of such sources are the sugar industry, the textile mill, the metallurgical industry, and the pesticide industry [16]. The vast majority of the world's rivers are now highly polluted, diseased, and home to many infections, while the populations of beneficial creatures have declined dramatically as a result of these waste products.

The rivers and lakes acquire massive amounts of human waste throughout time. There are enough pollutants in untreated and uncontrolled household sewage to contaminate any big, pristine body of water with its abundance of poisons, litter, trash, plastic, and diseases. Incorporating industrial waste and contaminants into this already-high level of pollution makes things much worse. The manufacturing of several harmful compounds by these enterprises not only contaminates surface water sources like lakes, ponds, and rivers, but also penetrates into subterranean water, making it unfit for human consumption. These contaminants also get up in the plants we eat as a result of this kind of seepage. There is an almost endless number of harmful consequences that result from this phenomena. The very poisonous heavy metals constitute a significant part of industrial waste.Industries may only account for a quarter of all water pollution sources, but they are certainly among the most harmful [17].(fig 2).

Fig 2. Plastic wastage located in freshwater canals

It is likely that changes in lifestyles and wants, together with increases in population density, are more detrimental than increases in population size alone. In particular, solid waste becomes more of a problem as the population density rises since more people living in a given region means more pollution . All of this garbage, whether it's solid or liquid, ends up in the waterways. From a Human waste and the subsequent contamination of water sources with these compounds allows a plethora of infectious illnesses to proliferate throughout society. A few of these illnesses are now considered endemic. Many epidemics and fatalities have occurred as a result of this. Cholera, typhoid, malaria, and other devastating epidemic illnesses disproportionately affect infants. A rise in the global population puts more individuals at risk of water contamination since fewer vaccinations and other protective chemicals are available to them. Despite the fact that more people living in a given area should mean more people working those areas' resources, governments have so far failed to fully capitalise on this potential, and as a result, more people living in an area means fewer resources available to the general public[18] . One clear reason for urbanisation is the rise in population density, which in turn leads to worse sanitary conditions, increased production of unclean water tainted with excrement, and more rubbish and other waste products dumped per unit area. The combination of these elements increases the likelihood that people living in metropolitan areas may get water-related illnesses.

Water-borne diseases

In impoverished nations, infectious pathogens cause the majority of water-related deaths and illnesses. These agents infect humans through: -(fig 3)

i. Consuming water contaminated with bacteria, viruses, protozoa, and helminths caused by human or animal waste. Bacterial diseases such as cholera, shigellosis, typhoid, paratyphoid, Escherichia coli, hepatitis, and poliomyelitis fall under this umbrella.
ii. ii. Illnesses linked to insufficient water for bathing, washing hands, washing clothing, and making sure kitchen utensils are clean. Scabies, yaws, skin ulcers, conjunctivitis, and trachoma are all disorders that fall within this group.
iii. iii) Infectious diseases caused by infectious forms that need an aquatic host, such as snails, fish, or skin, and may infect humans if they eat or penetrate human skin. The schistosomiasis, clonorchiasis, and paragonimiasis infections are caused by the cercariae that may be found in seafood such as crabs, crayfish, and fish.
iv. iv. Infectious diseases transmitted by a bug that lives in or near water and bites its hosts. Among them are the mosquito-borne diseases malaria, dengue, yellow fever, filariasis, trypanosomiasis, and onchocerciasis.[19]

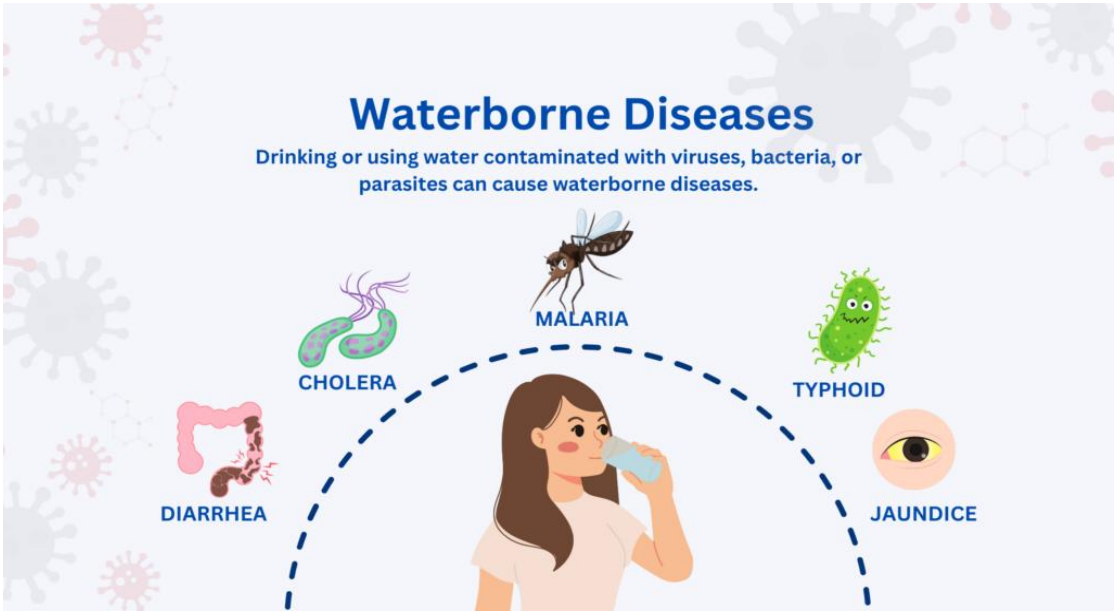

Fig .3 Water born diseases

Human Health and Water Pollution

There is no way to overstate the seriousness of the health risks posed by pollution and other disruptions to environmental equilibrium. Although all living things are indirectly and directly impacted by water pollution, for the sake of this discussion we shall limit our attention to human health. The bulk of human disorders, from the most mild to the most terrible, and even epidemics, have water pollution as its aetiology.

The term "pathogen" describes any kind of living thing that has the potential to cause illness.The many kinds of microorganisms called "pathogens" are what really cause and disseminate illness.

inside living things, including humans. Species, mechanism of transmission, and other factors allow for the categorisation of pathogens. While certain infections are ubiquitous and the illnesses they cause have prompted international efforts to fight them, others are localised to particular regions, climates, and even physical features. Given that a large number of water-borne illnesses are transmitted from person to person, it is crucial to address water pollution as the root cause of many diseases [20].The climatic fluctuations are a result of environmental changes, including global warming. The result is an abundance of floods and excessive rains. While the percentage is larger in underdeveloped nations, all countries are affected by the many illnesses brought on by human-caused floods and eroding rainfalls. Over ten percent of the world's population consumes crops grown in water that has been polluted. The danger of sickness for those who don't consume tainted food is increased as a result of the expanding chain reaction caused by the consumption of tainted food by a large section of the population. This occurs as a result of the illness being transmitted from one person to another. The fact that faeces is a known vector for waterborne illnesses, which pollute fresh water sources [21]speeds up the process of disease transmission even more. Diseases such as diarrhoea, cholera, malaria, typhoid, respiratory illnesses, cancers, skin conditions, genetic disorders, neurological disorders, congenital developmental problems, gastrointestinal disorders, and hepatic diseases are all linked to or caused by water pollution.

The list of diseases is extensive, but here are some examples: [22]. Blue baby syndrome is a group of congenital heart defects that cause cyanosis, a blueish skin discolouration in infants caused by inadequate blood circulation and oxygenation, and thus body hypoxia. Studies have linked nitrogen-containing pollutants to this condition. Microcephaly caused by the Zika virus has also been linked to pesticide usage. Recently, our research elucidated the process by which Zika virus causes developmental brain abnormalities [23]. There is substantial evidence that water contamination causes malignancies, which in turn cause proliferative diseases and a high death rate. This problem is more common in rural communities since the water supply is not adequately cleaned with cleaning techniques. Because economically disadvantaged cultures and people often lack access to clean water and live in unsanitary circumstances, poverty is often cited as one of the key factors

contributing to these conditions, along with rural environments. Infertility among reproductive-aged women as a result of water contamination is one of the most pressing problems. Foetuses exposed to polluted water are also at increased risk for mutations and genetic disorders. Consequently, a plethora of medically concerning problems are present in the newborn population. The crop and cattle that come into touch with polluted or diseased water suffer several detrimental impacts, which ultimately endanger human life. Many aquatic species would suffer from health issues, and the food chain's balance would be upset as a result. Heavy metals, such as iron, may build up in the gills and cause respiratory discomfort in freshwater fish, which is one of its typical roles. Because of this, the pace of mortality and decay of the corpses in the water is accelerated. That provides an ideal environment for the growth and dissemination of several diseases. People may get several illnesses by being exposed to or consuming sick fish. The most effective and generally acknowledged method for categorising water-borne illnesses is based on the kind of pathogen. However, there are other approaches as well. This leads us to the following broad categories: bacterial, viral, and parasitic water-borne illnesses. Each of them will be briefly covered in turn.[24]

Bacterial Diseases

Many illnesses may be acquired by drinking water that is contaminated or has not been disinfected. Diarrhoea is one of these disorders, however it is more of a symptom than an actual sickness. Almost 15% of the world's diarrhoea cases are caused by Campylobacter jejuni, the principal bacterium responsible for the transmission of diarrhoea via contaminated and untreated water. Enteritis, caused by the bacterium C. jejuni, is one of numerous diseases that may manifest as fever, stomach discomfort, and diarrhoea (ranging from loose to bloody stools). The genus Campylobacter is home to this infectious agent. Also shows improvement after using azithromycin, ciprofloxacin, erythromycin, or norfloxacin. Arthritis may also be caused by Campylobacter jejuni. The cholera-causing bacterium Vibrio cholerae is another typical water-polluted illness. Common in brackish environments, this gram-negative bacterium has a form like a comma. [25].Within hours after drinking water contaminated with Vibrio cholerae, you may start vomiting and experiencing diarrhoea. It causes diarrhoea on a regular basis because it secretes cholera toxin, an oligomeric proteinaceous complex with six protein subunits that exerts its effects via adenylate cyclase activity. Many people's fatalities across the globe may be attributed to this particular microbe. Dry mucous membranes, hypotension, a delayed or reduced radial pulse, tachycardia, renal failure, convulsions, coma, and death are all possible complications of V cholera in addition to diarrhoea. To prevent cholera, it is suggested to wash hands often with soap, drink only clean water, avoid open defecation, and prepare meals completely. Anyone planning to visit cholera-stricken regions should also get a vaccination.[26]

Viral Diseases

The liver is the principal organ that viruses in water-borne diseases mostly affect. Hepatotrophic viruses, which predominate in polluted and contaminated water sources, cause hepatic inflammation and damage by specifically targeting the liver. The umbrella term for inflammatory and toxic conditions affecting the liver is hepatitis. Hepatitis is a very diverse illness; some cases show no symptoms at all, while others might have a wide range of symptoms. A relatively chronic illness may be induced by hepatitis, and sometimes it causes acute symptoms. Hepatitis often manifests with a yellowing of the skin and sclera, nausea, vomiting, lack of appetite, stomach discomfort, diarrhoea, soreness on the right side of the abdomen, headaches, and other symptoms. Based on how it progresses over time, chronic and acute hepatitis are the two primary forms of the disease. Although acute hepatitis may sometimes clear up without treatment, in other instances it can develop into chronic hepatitis. Acute liver failure is a possible outcome of acute hepatitis[27]. Cirrhosis, an incurable and fatal form of liver scarring, and liver failure are the end results of untreated hepatitis. Hepatocellular carcinoma, a kind of liver cancer, is another possible outcome of chronic hepatitis. Proper sanitary surroundings, avoiding untreated or polluted water, and having a vaccination are the best ways to prevent hepatitis. Numerous hepatitis strains exist, each with its own vaccination. This diversity is due to the fact that hepatitis is caused by a distinct family of viruses.

Combating polio is one of the World Health Organization's (WHO) most prominent and strictly controlled initiatives. The poliovirus is the causative agent. The prevalence of pulse polio has been significantly reduced because to the widespread implementation of this immunisation scheme. Paralysis (of one or more limbs), nausea, fever, and vomiting are among symptoms that may accompany polio. Muscle growth is also halted. While this chapter focusses on the aforementioned viral infections, there are many other water-borne viral diseases that need consideration. For rotaviruses and adenoviruses are among the several possible infectious agents that may cause gastroenteritis, which manifests itself in a high temperature, nausea, and headache.[28]

Parasitic Diseases

Diseases caused by certain types of organisms known as parasites are collectively referred to as parasitic diseases. Infesting and infecting other living things, parasites deprive their hosts of nutrition and may even cause illnesses. Parasitis is the medical term for parasite-borne diseases. As an example of a parasite illness, cryptosporidiosis is a prime example. Cryptosporidium pavum is the parasite that causes it. Opportunistic infections may occur in hosts who are severely immunocompromised, as a result of this protozoan intracellular parasite. The oral faecal route is used to distribute the organism, which resides within the cells in the intestinal lumen. It contaminates water readily. Crypto (the common name for both the sickness and the parasite) might cause no symptoms at all or mild gastrointestinal distress. Entamoeba histolytica is another parasite that produces illness with same symptoms. Amoebiasis and Galloping amoebia are two names

for the same illness.[29]. It is the stomach lining that these bacteria mostly target. The cysts may infect hosts via polluted water since they are able to contaminate food and water throughout their life cycle. Infection manifests itself within hours or days, causing symptoms such as diarrhoea and fever. It is also important to note that the parasite Giardia lamblia, often called Giardia intestinalis, may cause giardiasis[30]. The small intestine is the host and breeding ground for this flagellated parasite. It clings to the intestinal cell epithelium via an adhesive disc. Consumption of untreated sewage is a typical vector for the development of giardiasis.

Fish pathogens and human diseases

Most bacterial species cause different diseases in fish. Some of them cause diseases in humans. Human diseases that can be caused by bacteria in fish include 1. Food poisoning and gastroenteritis caused by *Samonella, Vibrio* and *Clostridium* spp., and *Campylobacter jejuni* [31]. 2. Diarrhoea caused by *Edwardsiella* sp*., Staphylococus* sp., *Escherichia* sp. and *Aeromonas* sp. [31]. 3. Superficial wound infections, ulcers, etc, due to *Pseudomonas* sp.[32] . 4. Bacillary dysentery (Shigellosis) caused by *Shigella* sp.[32] . 5. *Clonorchiasis*, *Dracunculiasis* and Paragonimiasis due to larvae and *metacercariae* ingested in fish and crustaceans [32] . 6. Cholera caused by *Cholera vibro* [33]. 7. Typhoid and Paratyphoid due to *Samonella typhi* and *Samonella paratyphi*[33].

CONCLUSION & RECOMMENDATIONS

Life cannot exist without water. Regardless matter whether it's on land or in the ocean, all life occurs in water. Therefore, water makes up more than 70% of all living things. Therefore, water is essential, but it also has the potential to be a huge vector for disease. Due to a decline in water quality, these issues have recently become more prevalent. Among these issues are the following: excessive use of plastic and polythene bags; changes in lifestyle; failure to treat sewage; lax government laws and regulations; poverty; and an uneducated populace. It would seem that the vast majority of water-related illnesses are avoidable, with vaccinations being available for a number of them. To stop water contamination and the development of water-borne illnesses, the government has to enact effective rules, and people need to be disciplined and keep themselves clean. rise in population density, industrialisation, and urbanisation. To ameliorate these impacts and ensure good health, the following recommendations have been made

i. In order to reduce the negative effects of pollution and direct human interference with aquatic ecosystems, there has to be regulation.
ii. It is important to keep fish safe from physical, chemical, and biological elements that might harm their health and lead to illnesses or even death.
iii. It is important to promote safety measures to avoid contaminating food and water sources and to properly prepare fish for human consumption.
iv. In order to prevent the proliferation and spread of disease infections, it is generally necessary to provide an appropriate water supply, enhance personal cleanliness, and destroy and regulate disease vectors and their habitats.

More research into the prevalence, severity, treatment options, and most importantly, ways to avoid the spread of fish and human diseases should be prioritized in epidemiological studies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

ACKNOWLEDGEMENTS

We are grateful to Prof. Vidyavati, former Vice Chancellor of Kakatiya University, Warangal for her valuable suggestions and constant encouragement.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

[1] Ademoroti CMA (1996). Environmental Chemistry and Toxicology. Foludex Press Ltd. Ibadan, Nigeria, p. 215.
[2] Agbonlahor DE (1998). Mankind Exploited, Microbes Revolted and their Maker Intervened. Inaugural Lecture (Series 9), Ambrose Alli University, Ekpoma, Nigeria. p. 42.
[3] Rosebury T (1961). Microorganisms indigenous to man. McGraw Hill Book C. inc. New York, USA.
[4] Subasinghe S, Bernoth E (2000). Disease control and Health Management. In: Aquaculture in the 3rd millennium, Bangkok Declaration and Strategy, Bangkok, Thailand. pp. 153-168.
[5] Welcomme RL (1988). International Introduction of inland aquatic species. FAO Fish. Tech. Pap. 294: 318.
[6] Wooten R (1997). Health Management in stocked fish. Inland Fishery Enhancement; Edited by Petre T. pp. 235-243.
[7] Armelagos GT (1998). The Viral Superhighway. Sciences, 38(1): 24-29. Amlacher E (1961). Text book of Fish Diseases. THF Publication, Neptune, New Jersey, USA, p. 302.

[8] World Health Organization (WHO) (1995). Control of Food-borne trematodes infections: Report of WHO Study Group, Manila, Philippines. 18-26 Oct., 1993, Geneva. p. 157

[9] Kamble, S. M. (2014). Water pollution and public health issues in Kolhapur city in Maharashtra. *International Journal of Scientific and Research Publications, 4*(1), 1–6.

[10] Khan, M. A., & Ghouri, A. M. (2011). Environmental pollution: Its effects on life and its remedies. *Journal of Arts, Science and Commerce, 2*(2), 276–285.

[11] Khan, N., Hussain, S. T., Saboor, A., et al. (2013). Physiochemical investigation of the drinking water sources from Mardan, Khyber Pakhtunkhwa, Pakistan. *International Journal of Physical Sciences, 8*(33), 1661–1671.

[12] Khurana, I., & Sen, R. (2008). *Drinking water quality in rural India: Issues and approaches-Water Aid*. India water Portal.

[13] Krishnan, S., & Indu, R. (2006). *Groundwater contamination in India: Discussing physical processes, health and sociobehavioral dimensions*. IWMI-Tata, Water Policy Research Programmes, Anand, India.

[14] Kumar, A., Singh, H. N., Pareek, V., Raza, K., Dantham, S., Kumar, P., Mochan, S., & Faiq, M. A. (2016). A possible mechanism of Zika virus associated microcephaly: Imperative role of retinoic acid response element (RARE) consensus sequence repeats in the viral genome. *Frontiers in Human Neuroscience, 9*(995), 403.

[15] Ademoroti CMA (1987). Contamination of hallow wells in Nigeria from surface contaminant migration. Environ. Int. USA, 13: 491-495.

[16] Akolisa O, Okonji VA (2005). A review of Environmental Implications of Aquaculture Development in Nigeria: Strategies to minimize environmental impacts. Fisheries Society of Nigeria (FISON) Conference Proceedings, 14th-18th, Nov.; 2005, Port Harcourt, Nigeria, pp. 225-230.

[17] Lu, Y., Song, S., Wang, R., et al. (2015). Impacts of soil and water pollution on food safety and health risks in China. *Environment International, 77*, 5–15.

[18] Nel, L. H., & Markotter, W. (2009). New and emerging waterborne infectious diseases. *Encyclopedia of Life Support System, 1*, 1–10.

[19] Owa, F. D. (2013). Water pollution: Sources, effects, control and management. *Mediterranean Journal of Social Sciences, 4*(8), 65–68.

[20] Pawari, M. J., & Gawande, S. (2015). Ground water pollution & its consequence. *International Journal of Engineering Research and General Science, 3*(4), 773–776.

[21] Salem, H. M., Eweida, E. A., & Farag, A. (2000). Heavy metals in drinking water and their environmental impact on human health. *ICEHM, 2000*, 542–556.

[22] Ullah, S., Javed, M. W., Shafique, M., et al. (2014). An integrated approach for quality assessment of drinking water using GIS: A case study of Lower Dir. *Journal of Himalayan Earth Sciences, 47*(2), 163–174.

[23] Ballester, F., & Sunyer, J. (2000). Challenges to public health in the new millennium. *Journal of Epidemiology and Community Health, 54*, 2–5.

[24] Bibi, S., Khan, R. L., Nazir, R., et al. (2016). Heavy metals in drinking water of Lakki Marwat District, KPK, Pakistan. *World Applied Sciences Journal, 34*(1), 15–19.

[25] Briggs, D. (2003). Environmental pollution and the global burden of disease. *British Medical Bulletin, 68*, 1–24.

[26] Chowdhury, S., Annabelle, K., & Klaus, F. Z. (2015). *Arsenic contamination of drinking water andmental health* (pp. 1–28). London: Centre for Economic Policy Research.

[27] Corcoran, E., Nellemann, C., Baker, E., et al. (2010). *Sick water? The central role of wastewater management in sustainable development. A Rapid Response Assessment*. Arendal: United Nations Environment Programme.

[28] Currie, J., Joshua, G. Z., Katherine, M., et al. (2013). Something in the water: Contaminated drinkingwater and infant health. *Canadian Journal of Economics, 46*(3), 791–810.

[29] Desai, N., & Smt Vanitaben. (2014). A study on the water pollution based on the environmental problem. *Indian Journal of Research, 3*(12), 95–96.

[30] Ebenstein, A. Y. (2008). *Water pollution and digestive cancer in China*. Institutions and governanceprograms, pp. 1–45.

[31] Davis BD, Dulbecco R, Eisen HN, Ginsberg H (1967). Microbiology, Harper and Row Publisher, New York, USA

[32] Juneja, T., & Chauhdary, A. (2013). Assessment of water quality and its effect on the health of residents of Jhunjhunu district, Rajasthan: A cross sectional study. *Journal of Public Health and Epidemiology, 5*(4), 186–191.

[33] Nyaku RE, Okayi RG, Ataguba GA, Mohammed A (2007). Diseases associated with Livestock Integrated Fish Farming in Nigeria: A Review. FISON Conference Proceedings. 12-16 Nov., 2007, Kebbi State, Nigeria.