Role of Environmental Drivers of Water Quality and Waterborne Disease

Nandlal Kumar Pandit
Research Scholar Ph. D. (Microbiology)
Jharkhand Rai University, Ranchi

Abstract: Environmental factors like water quality have a large impact on human health. Water-associated communicable and non-communicable illnesses contribute to the disease burden, which is exacerbated by chemical pollution, solid waste (mostly plastics), bacteria, insects, and other disease-carrying vectors. With the use of the DPSIR conceptual framework and a study of relevant research, this article examines a wide variety of water practitioner-driven health concerns such as infectious illnesses and chemical poisoning. Due to external factors, the water body has changed state: chemical pollution has occurred, microbiological contaminants have entered the water, and vectors are now present. These and other health risks have an impact on people's overall well-being. Affected populations or ecosystems are prompted to respond because of the Impacts. Chemical pollution, microbiological contamination, the emergence of antibiotic resistance, disease vectors, and the cumulative effects of plastics have quite different pathways from drivers to impacts. However, potential responses from the water industry exhibit striking parallels. Interventions in integrated water management could address numerous health concerns' Drivers, Pressures, Impacts, and State at the same time. Water resource planning and management that considers human health may help reduce or avoid negative health effects while also increasing positive health effects.

Keywords- Climate Change, Water Pollution, Water Body, Waterborne Disease, Water Quality

I. INTRODUCTION

Water quality and pollution research is an ever-evolving and dynamic field of study. Waterborne illnesses and its sequelae from acute and chronic exposure to waterborne toxins need precise diagnosis and suitable therapy based on current understanding in order to recognise and treat them. Current reference information is critical due to the increasing virulence of microbial pathogens in water, as well as the addition of approximately 700 new chemical agents used in industry each year, many of which have the potential to contaminate water. In addition, timely and effective responses to water emergencies and security breaches are required. These trends all call for current reference information. When working with patients or communities that are at risk of exposure to contaminants in the water supply, it's critical for everyone involved to have access to reliable and up-to-date information, whether they're students, academics, or health care providers themselves. Water quality concerns and water-related illness information are addressed by several federal regulatory authorities, international health agencies, and educational groups that provide peer-reviewed and constantly updated reference materials online. There are great broad overviews of all elements of water quality and water-related illness provided by these online sites, and they serve as a useful "starting point" for further research into these difficult topics. The EPA Office of Water, the Centers for Disease Control and Prevention (CDC) Healthy Water, and the World Health Organization (WHO) Water, Sanitation and Hygiene websites include the most extensive and helpful materials on water quality and health-related water concerns. These federal regulatory and international health bodies have a staggering amount and variety of authoritative reference resources at their disposal. Additionally, the Agency for Toxic Substances and Disease Registry (ATSDR) website focuses on chemical contaminants in water; the Environmental Protection Agency Science and Technology (EPA) Water website covers wastewater science as well as the US Geological Survey's (USGS) water resources science. There's also a wealth of information available from the American Water Works Association (AWWA), including water treatment technologies, water distribution systems, and water conservation measures. Global challenges such as water pollution and environmental sustainability are also addressed on the UN's Global Issues: Water Division website.

1.1 Climate change

Human health and well-being are increasingly being seen as being jeopardised by climate change, which is no longer only an environmental problem. As a result of climate change, "the advances in public health and development accomplished over the previous half-century risk to be undermined."

Increases in the number of warm days and nights, as well as droughts and excessive rains, have all been linked to human-caused climate change. Drought may concentrate infections in restricted water sources, and high temperatures can affect pathogen survival, replication, and virulence. This has ramifications for waterborne illnesses, since heavy rains can mobilise bacteria and undermine water and sanitation systems. According to the Intergovernmental Panel on Climate Change (IPCC), "if climate change continues as anticipated throughout the representative concentration pathway (RCP) scenarios until mid-century," increasing risks of food- and water-borne illnesses may be expected."

Infections transmitted by water encompass a wide spectrum of pathogens from many taxa, including some that are only found in certain species (viruses, bacteria, protozoa, and helminths). In addition to diarrhoea and other flu-like symptoms, these microorganisms can also cause neurological disorders and liver damage. Waterborne diarrheal illnesses, which account for a large amount of the world's disease burden, are the focus of our attention today. Aside from that, since unsafe or inadequate water facilitates the spread of diarrheal diseases, climate change may modify their prevalence and distribution.

Given the enormous burden of diarrheal illness, even slight changes in the risk of diarrheal disease owing to climate change may have significant effects on population health. diarrheal illnesses are the second highest cause of mortality in children under five globally, as well as the second most significant cause of death and disability in poor and middle-income nations. Diarrhea Pediatric diarrhoea may affect growth and cognitive development in young children, and this can start off a chain reaction of poor health that worsens poverty. Even if the global burden of diarrheal illness is diminishing, global climate change threatens to halt this progress, weakening worldwide efforts to minimise it. This will have a disproportionately large effect on some of the world's most vulnerable people.

Climate change has the potential to have an influence on diarrheal illnesses, as early studies to assess the health effects of anthropogenic climate change have shown. During both wet and dry times, diarrheal illness outbreaks have been shown to concentrate enteric pathogens and precipitation has been shown to mobilise enteric pathogens, allowing contamination of drinking water sources and boosting human-pathogen interaction possibilities in both circumstances. Early epidemiological evidence of the potential for temperature anomalies to change the prevalence of diarrheal sickness was given by increases in Lima, Peru's hospital admissions during an El Nio warming event in the 1990s. Extreme rainfall events have been linked to waterborne illness epidemics in the US and Canada. A study team's attempts at quantifying climate change's potential health implications were limited by "the sparsity of empirical climate-health data," which left unanswered several questions about the empirical links between climate and diarrheal illnesses.

Recent research shows that climate change, notably increases in hot temperatures, heavy rainfall, floods and droughts have the potential to modify the distribution of diarrheal illnesses since these early attempts. Temperature has been shown to be significantly associated with bacterial diarrhoea, but not with viral diarrhoea, as well as evidence of increases in diarrhoea after severe rainfall and floods, which we and others have discovered.

1.2 Water Quality

Several parameters are used to assess water quality, including the quantity of dissolved oxygen, the presence of bacteria, the amount of salt (or salinity), and the number of debris floating in the water (turbidity). Aside from measuring the number of tiny algae and other impurities, water quality may also be assessed by looking for pesticides, herbicides, heavy metals, and other toxins present in the water. Water quality cannot simply be defined as "excellent" or "poor," even when scientific data are employed. So, the decision is usually made based on the intended use of the water, such as drinking, washing a vehicle, or something else entirely. People's health may be jeopardised if their drinking water is contaminated. Ecosystems' health might be jeopardised if their water is contaminated. A thriving marine ecology need high water quality in the Florida Keys. Clean water with minimal nutrients is ideal for seagrass and coral reef populations. Algal development may suffocate corals and seagrass if the water contains too many nutrients. Overgrowth of algae and other detrimental effects are caused by pollutants such as metals, oils, pesticides, and fertilisers that wash off the land into the water. The Water Quality Protection Program in the Florida Keys National Marine Sanctuary generates action recommendations for restoring and maintaining water quality conditions necessary to support healthy plant and animal populations. In order to help protect the sanctuary waters, you can support and participate in wastewater treatment programmes that remove unwanted nutrients and harmful bacteria, use "pump-out" stations for your vessel's sanitation device and use as many "green" products as possible at home. Additionally, you can reduce or eliminate the use of fertilisers, herbicides, pesticides, and other harmful chemicals.

II. LITERATURE REVIEW

Vanaja, (2021), It is critical to have access to clean drinking water in order to reduce the spread of illness caused by exposure to contaminated water. Even if individuals have access to clean water sources, it doesn't imply they will. People's perceptions of water quality influence their choice of a safe source among the options. If water quality is regularly tested and the findings are made available for free to the public, then public views might be based on the objective quality of the water. The impression of water quality is dependent on other variables in rural India, where water quality testing are uncommon and the findings are rarely made public. When individuals do not know the objective quality of water, we utilise data obtained from Jharkhand communities to examine their choices for water sources of supply. We found that people's perceptions of water quality based on flavour and colour are essential in helping them make water source decisions. As well as, families are prepared to spend a lot more for better tasting and coloured water at the source than they do daily. In addition, the likelihood of picking a water source for drinking decreases as the expense of going to the source rises.

Islam et al. (2020), A range of underlying etiologies, including climate, geography, and human factors, are often cited as causes of waterborne pathogen outbreaks. Many recent waterborne epidemics have been linked to Legionella and parasites like Giardia in industrialised nations, with difficulties in treating polluted groundwater or premise plumbing being the most common cause. General trends in epidemics in affluent nations like the United States can be tracked because to agencies like the Centers for Disease Control (CDC) and the Environmental Protection Agency (EPA) that collaborate on monitoring and recordkeeping. In less developed countries like Africa and South Asia, the issue is more complicated, in part because there is less monitoring information available. The current chapter concentrates on this topic of waterborne illness epidemics in underdeveloped countries. As an example, current research on cholera has caused several long-held views about disease epidemiology to be reexamined. In recent cholera outbreaks, the use of untreated surface water and contamination at the point of water consumption have both been linked to the spread of the disease. There are overlapping problems such as groundwater security and sanitary coverage, however, that add further complexity when examining these tenuous relationships. We go into detail about these difficulties, particularly considering recent findings. Using diarrheal illness outbreaks in Bangladesh as a case study, the analysis concludes with a sketch of major intervention efforts to control the spread of waterborne disease epidemics there.

Mishra et al. (2020), In order to achieve water security by 2030, the fundamental goal of the United Nations Sustainable Development Goals is to provide enough water of high quality available to everyone. Water scarcity and declining water quality as a result of global warming pose a danger to the availability of water resources for many purposes. In addition to population growth and land use/land cover changes, rapid urbanisation and economic development are also major contributors to hydrological cycle shifts. It's easy to witness the effects of these worldwide shifts in the floods and draught that waterbodies cause, and in the unsanitary environment/ecosystem and health hazards that polluted waterbodies cause owing to new contaminants. To ensure a water-secure future, sustainable water resource management will be required going forward. The diffusion and adoption of novel water resource management techniques, practises, and technology have been restricted despite recent advances in their development. Connecting social, economic, and environmental systems at various scales is necessary for a comprehensive, long-term strategy to water security concerns. This chapter aims to first depict the current situation of water and wastewater, particularly in Asian countries, followed by a brief sketch of the outreach and challenges of the existing technologies and policy intervention to achieve sustainable water resource management. This is a very important chapter. It also attempts to show the relevance of transdisciplinary research efforts by using some successful case studies, which may lead to major changes in policy interventions needed to achieve water security.

Ahmad et al. (2020), Worldwide, waterborne infections have risen to the status of one of the most pressing public health issues. According to this research, drinkable water quality indices in Peshawar, Pakistan, are spatially distributed. Water samples from all throughout the research region were analysed for physio-chemicals as well as biological components. pH, turbidity, temperature, fluoride concentrations, and bacterial populations were among the factors examined (faecal coliforms). Interpolation using inverse distance weighting (IDW) in GIS was employed for geographical analysis. Test findings showed that faecal coliform counts (per 100 mL) were above WHO minimum standards in 48% of water samples, while fluoride concentrations were above WHO maximum recommended values in 31% of samples. Using ArcGIS, a spatial distribution map was created for the number of faecal coliforms and the fluoride ion concentration to show which villages were the most at danger. According to the findings, around 20% of the region tested positive for faecal coliforms, and about 33% of the area tested positive for fluoride concentrations required treatment. The pH and turbidity levels were determined to be within WHO-recommended ranges. Sanitary inspectors found that inadequate multi-barrier techniques degraded water quality for consumers as a result of their findings. Policymakers will be able to utilise the study's findings to take required corrective steps before it has a significant impact on public health.

Chaudhry et al. (2017), Despite the many advantages of using reclaimed water in drinkable applications, there are worries about the possible chemical and microbiological dangers it presents to the general public. There are four possible Direct Potable Reuse (DPR) scenarios for Norovirus, Cryptosporidium, and Salmonella that we examine in our QMRA Monte Carlo framework. The de facto water reuse scenario is treated wastewater-impacted surface water. Surface source water quality (affected by 0–100% treated wastewater effluent) was evaluated for consumer microbiological hazards. The dangers were also analysed for various mixing ratios (0–100% surface water blended with advanced-treated DPR water) where 50% of the source surface water was wastewater effluent-based wastewater. While all modelled DPR risks were significantly lower, actual reuse risks exceeded the yearly 104 infection risk benchmark. An increase in the danger to the 104 standard was achieved by adding wastewater effluent contaminated surface water to the already cleaned DPR water and mixing it in. By itself, or as an input for DPR, de facto reuse increases microbial risk more than advanced DPR water does. This paradigm, when used with site-specific inputs, may help with project design and public awareness efforts that will help DPR gain credibility.

Ohwo (2019), Consequently, this research examines Yenagoa families' susceptibility to waterborne infections in order to better understand the public health consequences. An online survey was used to collect data from 400 randomly selected families utilising stratified and systematic sampling approaches, as well as on-site observations of the drinking water, sanitation, and hygiene facilities in each home. The response of households to five vulnerability factors determined the susceptibility of households to waterborne illnesses (drinking water source, sanitation facility, hygiene, education, and income). Descriptive statistics, Spearman's rank correlation, and a waterborne disease vulnerability (WDV) model were used to examine the collected data. According to the data, families in Yenagoa were moderately sensitive to waterborne infections, with a WDV of 55.65 percent, according to the researchers. The Spearman's correlation coefficients for sanitation, drinking water sources, and hygiene education were each 0.75, 1, and 0.6. This reveals that families' educational levels have a significant impact on their water source selection, sanitation usage, and hygiene habits. Accordingly, it is advised that both families and the government make significant efforts to enhance the quality of vulnerability drivers, which may help lower homes' susceptibility in Yenagoa to waterborne illness outbreaks.

Hennebique et al. (2019), The zoonosis tularemia is caused by Francisella tularensis, an intracellular Gram-negative bacterium. There is some concern about the pathogenicity of this highly contagious bacteria. Tick bites and contact with the animal reservoir are the most common ways for humans to get infected. Nonetheless, interaction with a polluted hydro-telluric environment might also lead to tularemia instances Worldwide, waterborne tularemia outbreaks and occasional cases have appeared in recent decades, with distinct clinical and epidemiological features. It's an important public health and military issue that these illnesses are spreading. Humans have been exposed to F. tularensis by drinking polluted water or participating in water sports including swimming, canyoning, and fishing. In addition, mosquitoes are the principal tularemia vectors in Sweden and Finland, where mosquito larvae in polluted aquatic settings have been infected. Biofilm development, interactions with free-living amoebae, and a shift to a 'viable but nonculturable' state are all proposed processes by which F. tularensis survives in water, although the relative importance of each is yet unclear. Francisella has expanded its aquatic range significantly in the last decade, with several new species being discovered. Tularemia monitoring and management must take F. tularensis' capacity to live for lengthy periods of time in water into consideration.

García-March et al. (2020), The incidence of infectious marine illnesses is changing as a result of human-caused climate change and global warming. Some of these diseases cause mass mortality and impose significant ecological and economic implications. In the Mediterranean Sea, the fan mussel Pinna nobilis is regarded as a sentinel species to monitor world processes. Fan mussels have been in decline since September 2016, most likely as a result of the protozoan Haplosporidium pinnae. We now know more about the factors influencing the die-spread off's thanks to population dynamic surveys, rescue programmes, larvae collector installations, and measures to protect infected adults from predators. Previous model simulations show that water temperature and salinity may be linked to the disease's manifestation, which is, in turn, greatly influenced by climate change and anthropogenic activities, as well. The lack of natural recruitment suggests that populations of fan mussels are not recovering, but the survival of populations in paralic conditions offers a chance to research the illness and the variables that influence its onset. There are various problems raised by the fan mussel disease epidemic, one of which is whether climate change is mediating host-protozoan dynamics. Is it possible to prevent it by taking proactive steps? If this is the case, which strategies will be the most fruitful? How many more species that aren't getting enough attention might face a mass extinction before it's too late to take any action? This is particularly important since the extinction of keystone species may have ripple effects across the ecosystem.

Mari et al. (2019), Waterborne illnesses are a broad category of infections spread by ingesting or coming into touch with water contaminated with disease-causing microbes. The spread of waterborne illnesses frequently leaves distinct spatial footprints that may be traced back to local eco-epidemic factors such as the presence of water-borne pathogens, human movement, and human exposure. The transmission cycle of aquatic diseases is described using a spatially explicit network model in this study, which helps us predict invasion conditions in metacommunities with realistic spatial structure. This research is focused on defining circumstances under which infections may invade a group of people, leading to an epidemic outbreak. A new methodological framework for studying transient dynamics in ecological systems sensitive to external perturbations has been established lately. Detection of the spatial fingerprints associated with perturbations in a disease-free system that are likely to be magnified the greatest across various time scales is a valuable addition to pathogen invasion research. A cross-disciplinary approach is needed to better understand the dynamics of waterborne illness across time scales relevant to epidemic and/or endemic transmission, since huge parts of the poor world are still unable to handle the burden of these diseases.

Mouly et al. (2018), It is still a public health concern in affluent nations to deal with waterborne disease outbreaks (WBDOs), but to date the French monitoring of WBDOs, which relies on general practitioners to report AGI clusters to health authorities, has a poor sensitivity. To enhance WBDO detection, a detection system based on a space–time technique and health insurance data was created. Using health insurance claims data, this simulation-based research sought to assess the algorithm's efficacy in detecting WBDO. Acute gastrointestinal infection numbers were replicated daily. The baseline data was then overlaid with 2,000 generated WBDO signals. Se and PPV were used to assess the detection algorithm's sensitivity and accuracy. Multiple regression analysis was used to determine the parameters that relate to WBDO detecting accuracy. Multivariate regression About 73% of the simulated WBDOs were discovered (Se = 73.0%). WBDOs accounted for almost nine out of ten observed signals (PPV = 90.5 percent). The likelihood of finding a WBDO grew in proportion to the extent of the epidemic. These findings highlight the need of implementing a nationwide monitoring system in France for WBDOs utilising the detection algorithm.

III. KEY FACTORS THAT INFLUENCE WATER QUALITY

The chemical, physical, and biological composition of water are used to determine water quality. Even in the absence of pollution, river and lake water quality varies with the seasons and geographic location. It's impossible to define excellent water quality in terms of only a few parameters. It is possible to utilise irrigation water that is good for drinking, although irrigation water may not fulfil drinking water standards. In order to preserve water uses, water quality recommendations give fundamental scientific knowledge on water quality indicators and ecologically important toxicological threshold values

3.1 Many factors affect water quality

• Sedimentation
• Runoff
• Erosion
Oxygen that has been dissolved in water
• pH
• Temperature
Organic compounds that have decomposed
• Pesticides
• Dangerous and toxic compounds
• Chemicals such as oils, grease, and other fats
• Detergents
• Trash and garbage

The substances in the air have an impact on the amount of rain that falls. Rain dissolves or traps dust, volcanic gases, and natural gases such as carbon dioxide, oxygen, and nitrogen from the air. Sulfur dioxide, poisonous compounds, and lead are just a few of the things that rain picks up while they're in the air. When rain falls on the earth's surface, it dissolves and picks up other materials as it runs over and through the soil and rocks. Calcium carbonate is abundant in runoff when the soil has large levels of soluble compounds, such as limestone. The metals in ore bodies will be dissolved by water flowing over them. Other human activities have a considerable impact on water quality as well, such as manufacturing and farming. Farming, for example, has the potential to elevate the concentration of nutrients, pesticides, and other dissolved and suspended materials in the environment. Industrial operations may raise metal and harmful chemical concentrations, add silt to the water, raise the temperature, and reduce the amount of dissolved oxygen. Each of these outcomes has the potential to harm the aquatic ecology or render water unusable for current or future use. We must remember that the damage we have done to the Earth via pollution affects not just humans, but also all other species in our ecosystem.

IV. CONCLUSION AND FUTURE WORK

Cholera, Leptospirosis, and Giardiasis are just a few of the infectious diseases that can be traced back to poor water supply, sanitation, and hygiene (e.g. We know that weather and climate influence infectious disease transmission and distribution, and scientists are constantly refining their analytical techniques and statistical models to better understand how weather and climate affect water-associated illnesses. Most recent evidence points to a connection between infectious illness spread and seasonality and geographic location. As people become more concerned about the implications of climate change, researchers are writing more and more about these topics.

World Health Organization (WHO) advises countries on the formulation of health-based objectives and policies as the worldwide authority on public health and water quality. The World Health Organization (WHO) issues several water quality standards, including ones for drinking water, wastewater treatment, and recreational water usage. The drinking water quality criteria are based on risk management and have promoted the Framework for Safe Drinking Water since 2004. To identify and manage risks from catchment to consumer, the Framework recommends that water suppliers develop and implement Water Safety Plans. This will help them identify and manage risks along the way from catchment to consumer. Finally, independent surveillance will help ensure that Water Safety Plans are effective and that health-based targets are met.

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