Asian Journal of Basic Science & Research
Volume 6, Issue 3, Pages 51-58, July-September 2024

Assessment of Industrial Wastewater on Environment and Human Health in Nigeria: Effects and Treatments

Grace Martins[1*] & Peter Mafimisebi[2]

[1,2]Department of Environmental Engineering and Hydrogeology, Geoearth Project Ltd., Nigeria.
Corresponding Author Email: kikelomomartins17@gmail.com[*]

DOI: http://doi.org/10.38177/AJBSR.2024.6306

Article Received: 05 July 2024 *Article Accepted: 07 September 2024* *Article Published: 12 September 2024*

ABSTRACT

This paper aims to examines the environmental and health impacts of untreated industrial wastewater effluents in Nigeria. Industrial wastewater is frequently dumped into the environment in underdeveloped nations such as Nigeria with minimal or no treatment, resulting in serious environmental and health issues. Untreated or improperly treated effluents degrade water bodies by promoting eutrophication and creating circumstances conducive to dangerous microorganisms and toxin-producing cyanobacteria. This poses a risk to relaxation center water users and may result in epidemics of water-borne infections. Furthermore, wastewater frequently contains toxic anthropogenic substances, including those that alter endocrine systems. To counteract these effects, it is critical to develop proper wastewater treatment techniques, follow regulations, and conduct regular monitoring.

Keywords: Health; Environment; Industries; Wastewater; Effects; Treatments; Discharge; Water bodies; Water-borne infections; Nigeria.

1. Introduction

Nigeria is known for hosting various industries such as petroleum refining, soap and detergent manufacturing, food and beverage production, brewing, textiles, among others. These sectors produce various waste materials that are frequently released into the environment, leading to pollution in major urban areas like Lagos, Port Harcourt, Ibadan, and Kano. Disposing of untreated or partially treated wastewater into lagoons, rivers, and streams without discrimination worsens the contamination of water bodies by adding nutrients, non-biodegradable organics, heavy metals, and other harmful substances [1]. The growing acknowledgment of the necessity for efficient wastewater treatment prior to release underscores the significance of tackling this environmental issue. Polluted water contains harmful contaminants in high amounts, making it unsuitable for drinking, cooking, bathing, and other purposes [2]. The main source of pollution is attributed to human actions, with typical contaminants being industrial waste, sewage seepage, oil leaks, heavy metals, animal waste, chemical runoff, eroded sediments, deforestation, and agricultural chemicals like fertilizers, herbicides, and pesticides [3]. Approximately one third of the world's renewable freshwater is used by these activities, leading to the introduction of different synthetic and natural contaminants into water sources. Hence, it is essential to treat wastewater effectively prior to discharge into water bodies to ensure clean and safe drinking water availability (Figure 1).

Industrial waste is a major contributor to permanent harm to the environment. If hazardous wastes are not treated properly or are released into sewers, they can contaminate groundwater and bodies of water, harming animals and marine life. Insufficiently managed effluents may result in contamination of the air, soil, and land surfaces as well. Furthermore, improper disposal of industrial wastewater used in crop irrigation can significantly affect crop quality and potentially introduce harmful substances into the food chain. Contamination of water by industrial waste can result in severe waterborne illnesses such as diarrhea, giardiasis, typhoid, cholera, hepatitis, jaundice, and potentially cancer [4]. Many countries are working on creating policies to manage water quality by setting safe limits for pollutants in different water sources like rivers and lakes. Even with improvements in technology and economy for treating wastewater, it is still common for pretreatment standards and pollutant limits to be ignored. This ongoing problem leads to substantial environmental contamination and presents serious health hazards [5].

This paper examines the environmental and health impacts of untreated or inadequately treated industrial wastewater effluents in Nigeria and suggests some ways to address the wastewater management effects on the environment and human health.

Figure 1. Different discharge sources of industrial wastewater in water bodies

1.1. Study Objectives

1. To assess the effects of untreated or inadequately treated industrial wastewater effluents on the quality of receiving water bodies, including the potential for eutrophication, pollution, and habitat degradation.

2. To investigate the health risks posed by untreated wastewater effluents, particularly focusing on waterborne diseases and the proliferation of pathogens and toxin-producing microorganisms.

3. To identify and characterize the types of pollutants present in industrial wastewater effluents, including heavy metals, endocrine-disrupting compounds, and other anthropogenic substances.

4. To evaluate current wastewater treatment processes and technologies used in industrial settings, identifying their effectiveness and limitations in mitigating the adverse impacts of wastewater discharges.

Asian Journal of Basic Science & Research
Volume 6, Issue 3, Pages 51-58, July-September 2024

5. To suggest strategies for enhancing wastewater treatment systems to better comply with regulations and minimize environmental and health risks, including technological advancements and management practices.

6. To suggest strategies for enhancing wastewater treatment systems to better comply with regulations and minimize environmental and health risks, including technological advancements and management practices.

2. Major Pollutants of Industrial Wastewater

The presence of harmful pollutants in industrial wastewater poses dangers to human health, aquatic life, and agriculture. Toxic elements like chromium, zinc, lead, copper, iron, cadmium, nickel, arsenic, and mercury are commonly found in primary pollutants released by industries such as paint and dye manufacturing, textiles, pharmaceuticals, and chemical production [6]. Phenol and phenolic compounds, mainly from oil refineries and drug manufacturers, are significant contaminants in wastewater. Petrochemical industries release non-biodegradable substances like petroleum hydrocarbons and sulfides, which are difficult to treat with biological methods [6,7]. Textile sectors contribute nitrogenous and phosphorus wastes, heavy metals, surfactants, bleaching agents, and alkalis to wastewater. Perfluoroalkyl acids, particularly PFOS and PFOA, present health risks due to their surface protection properties. Overall, the complex composition of industrial pollutants requires chemical treatment for effective breakdown, leading to ongoing organic contamination in effluents.

3. Impacts of wastewater effluents

The quality of wastewater effluents significantly impacts the health of lakes, rivers, and streams. Factors such as the quantity and types of pollutants released, including chemical and biological substances like suspended solids, organic matter, heavy metals, and organochlorines, influence the level of environmental damage. The attributes of the end users of water bodies also play a crucial role [7]. Contaminated wastewater can lead to eutrophication, promoting the growth of toxin-producing cyanobacteria. Exposure to these toxins can result in various health problems like stomach inflammation, liver damage, nerve issues, skin irritation, and even tumors in animals. Relaxation/beach water users and those exposed to polluted water may face health risks [4].

3.1. Impacts on the Environment

Pollution from wastewater discharges can cause various harmful impacts on receiving water bodies such as lower levels of oxygen, changes to their physical structure, the release of harmful substances, and the concentration of toxins in aquatic organisms. Elevated amounts of nutrients from sewage can also add to these problems [8]. Despite the benefits that wastewater can provide for crop production in farming communities, its usage also comes with potential risks. Toxic waste and poor treatment can cause an increase in waterborne illnesses and speed up the deterioration of the environment. Intensive use of polluted wastewater for irrigation can hide harmful effects temporarily, but over time, nutrients can contaminate groundwater, affecting its quality [9]. Excessive nutrients causing eutrophication led to a reduction in dissolved oxygen (DO), while additional components in wastewater also add to the depletion of DO. The decomposition of organic matter by bacteria and the chemical oxidation can greatly deplete dissolved oxygen, resulting in immediate or prolonged impacts as oxygen-demanding substances build up in sediments [9]. The discharge of harmful chemicals into water sources can negatively impact both land and water organisms either immediately or over time. High levels of ammonia, chlorine, or toxic heavy metals and organic contaminants frequently result in acute impacts. Cumulative impacts occur as pollutants gradually accumulate and become problematic once they exceed certain thresholds [9].

3.2. Impacts on Human Health

Unprocessed drinking and recreational waters present notable health dangers because of microbial pollutants like bacteria, viruses, and protozoa. The principal sources of pathogens that can pollute water sources and lead to waterborne illnesses are human and animal waste. These tiny organisms, like bacteria and viruses, can result in severe health issues like heart disease and stomach ulcers [4,10].

Indicator organisms are frequently utilized for evaluating the existence of potential pathogens in sewage since it can be difficult and expensive to pinpoint certain microbial pollutants. Viruses are worrisome because they are hard to treat and highly infectious. Bacteriophages are occasionally used to assess the efficiency of treatment techniques in eradicating enteric viruses. Pathogenic strains of bacteria in wastewater can lead to serious health problems such as diarrhea and dysentery [11,12]. Chlorination, a frequently used technique for wastewater treatment, may generate dangerous chlorinated compounds through interactions with organic materials.

4. Industrial Wastewater Methodology Treatment

Different industries are creating and implementing a variety of technologies and tactics to eliminate pollutants from the wastewater they generate. Listed are a few methods used by large industries that produce wastewater to treat their discharged liquids [13].

4.1. Treatment of Wastewater Containing Heavy Metals

Industries discharge hazardous heavy metals due to chemical use. Traditional removal methods like ion exchange and chemical precipitation often fall short in eliminating heavy metals and consume significant energy. More cost-effective and efficient techniques for improving treated water quality include adsorption, membrane filtration, electrodialysis, and photocatalysis [14]. Adsorption utilizes inexpensive substances like zeolites, iron slags, and biological waste. Modified biopolymers such as chitosan are also effective in heavy metal removal. Techniques like ultrafiltration and reverse osmosis isolate heavy metals, while electrodialysis and photocatalysis use ion-exchange membranes and semiconductors to eliminate metal ions from solutions. These methods help in reducing the presence of harmful metals in water [15].

4.2. Treatment of Wastewater Containing Phenolic Compounds

Phenol and phenolic substances are prevalent and enduring contaminants found in industrial wastewater. Different techniques are available for managing phenolic wastes, such as chemical, physical, electrochemical, and anaerobic biological methods. Electrochemical treatment stands out for its efficacy in eliminating phenolic contaminants [16]. This technique uses electrons to eliminate contaminants, either through direct or indirect means.

Various anodes including Ti/Pt, Ti/Pt/Ir, graphite, Ti/SnO_2–PdO_2–RuO_2, and TiO_2–RuO_2–IrO_2 have been used in electrochemical applications to treat tannery wastewater, landfill leachate, resorcinol, and cresols. In spite of being effective, electrochemical treatment can cause a rise in the levels of adsorbable organic halides (AOX) in the effluents [16]. Hence, it is crucial to implement activated carbon filtration after the treatment to ensure that the effluents comply with environmental discharge regulations.

4.3. Treatment of Wastewater Released from Industries Producing Textile

The textile sector heavily relies on freshwater for multiple processing stages, leading to substantial production of wastewater. Azo dyes, especially, are a major source of wastewater pollution among various pollutants. Conventional methods of physico-chemical treatment comprise adsorption, membrane separation techniques, and ion-exchange methods. Materials like silicon, carbon, and kaolin polymers are utilized in adsorption to eliminate dyes. Membrane separation methods like nanofiltration and reverse osmosis are utilized for purifying water polluted with reactive dyes and other substances [17]. The ion-exchange technique is successful in eliminating negative ions and positive ions dyes. Furthermore, Fenton's reagent, which pairs a potent oxidizing substance with surplus hydrogen peroxide, is employed for color removal, while ozonation targets harmful non-biodegradable substances. The employment of UV treatment in photochemical processes breaks down dyes, while cucurbituril, a polymer made from formaldehyde and glycoluril, can effectively break down a wide range of dyes like basic, acidic, reactive, and disperse dyes.

Furthermore, biological treatments have been successful in breaking down resistant dyes, in addition to traditional methods [17]. Algae aid in dye decomposition by utilizing the dyes as a nitrogen source, thereby aiding in the prevention of eutrophication in aquatic ecosystems. Microalgae are used for bioadsorption and biodegradation in the treatment of effluents from the textile industry. Phytoremediation methods, such as phytotransformation, phytostimulation, phytovolatilization, phytoaccumulation, rhizofiltration, and phytostabilization, are employed for treating textile effluents.

4.4. Treatment of Hypersaline Effluents

Physico-chemical treatment methods are commonly used to handle hypersaline effluents from different industrial sectors. A typical method includes thermal methods like multiple effect evaporators (MEE) to decrease the volume of waste and aid in separating solid salt. Coagulation-flocculation is commonly used as a pre-treatment process to eliminate the colloidal COD portion from hypersaline wastewater. Moreover, desalination can be efficiently accomplished using ion-exchange methods that involve both anionic and cationic exchangers, along with membrane filtration processes such as reverse osmosis and electrodialysis.

5. Conclusion

Effluents from industrial wastewater have a major impact on different water pollution problems. This comprises eutrophication, which encourages too much algae expansion, higher water purification expenses, reduced recreational appeal of water, health dangers to humans and livestock, oxygen reduction, and negative alterations in aquatic ecosystems. It is important to tackle and lessen the harmful effects of wastewater on water bodies due to the large amount that goes through sewage treatment systems every day. Proper treatment before discharge is crucial to adhere to wastewater regulations and guidelines. This can be done by using efficient treatment methods and technologies that reduce threats to human health and the environmental sustainability. Proper discharge of clean wastewater into water bodies necessitates thorough planning, appropriate treatment, consistent monitoring, and compliance with applicable laws. These actions will help make informed, science-driven choices and advance environmental sustainability and the well-being of plants and animals. It is crucial to make sure that regulatory bodies' effluent standards and limits are consistently adhered to.

These future perspectives aim to address the challenges associated with untreated industrial wastewater effluents and promote sustainable practices that safeguard our ecosystem and human health.

6. Future Recommendations

Future studies should concentrate on the following:

(i) Develop innovative treatment methods for enhanced pollutant removal from industrial wastewater, focusing on nanotechnology, membrane filtration, and biological treatment advancements.

(ii) Investigate emerging technologies to manage complex contaminants and improve overall water quality in industrial wastewater.

(iii) Incorporate circular economy principles into industrial operations by reducing waste at the source, reusing and recycling wastewater, and reclaiming valuable resources from pollutants.

(iv) Promote sustainable practices in industries to reduce environmental harm and reliance on traditional treatment methods.

(v) Strengthen regulatory frameworks by addressing existing gaps, imposing stricter wastewater discharge standards, and ensuring full compliance through frequent monitoring and penalties.

(vi) Increase public awareness about the impacts of untreated wastewater through community outreach programs, educational initiatives, and awareness campaigns.

(vii) Engage local communities in wastewater management by encouraging participation in monitoring, reporting, and promoting responsible industrial practices for environmental conservation.

Declarations

Source of Funding

This study did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing Interest and Ethics

The authors declare no competing financial, professional, or personal interests.

Consent for Publication

The authors declare that they consented to the publication of this study.

Authors' Contributions

Both the authors took part in literature review, research, and manuscript writing equally.

Availability of data and material

Supplementary information is available from the corresponding author upon reasonable request.

Acknowledgements

The authors acknowledge Dr. Adesoji Akinade for providing moral support.

References

[1] Schwarzenbach, R.P., Egli, T., Hofstetter, T.B., Von Gunten, U., & Wehrli, B. (2010). Global Water Pollution and Human Health. Annu. Rev. Environ. Resour., 35: 109–136.

[2] Absar, A.K. (2005). Water and Wastewater Properties and Characteristics. In water Encyclopedia: Domestic, Municipal and Industrial Water Supply and Waste Disposal, Lehr, J.H., & Keeley J. (Eds.), John Wiley and Sons, Inc., New Jersey, Pages 903–905.

[3] Aulakh, M.S., Khurana, M.P., & Singh, D. (2009). Water Pollution Related to Agricultural, Industrial, and Urban Activities, and its Effects on the Food Chain: Case Studies from Punjab. J. New Seeds, 10: 112–137.

[4] Wang, Q., & Yang, Z. (2016). Industrial water pollution, water environment treatment, and health risks in China. Environ. Pollut., 218: 358–365.

[5] Momba, M.N., & Mfenyana, C. (2005). Inadequate treatment of wastewater: A source of coliform bacteria in receiving surface water bodies in developing countries- Case Study: Eastern Cape Province of South Africa. In Water Encyclopedia- Domestic, Municipal and Industrial Water Supply and Waste Disposal, Lehr, J.H., & Keeley, J. (Eds.), John Wiley & Sons Inc., Pages 661–667.

[6] Alm, E. (2003). Implication of microbial heavy metal tolerance in the environment. Rev. Under. Res., 2: 1–5.

[7] Obasi, K.O., Chinedu, K., Udebuani, A.C., Okereke, J.N., Ezeji, E.U., & Anyadoh, S.O. (2015). Study on concentrations of selected heavy metals: Cadmium, Lead, Arsenic and Mercury in the soft tissue of Periwinkle (*Tympanotonos fuscatus var radula*) from Brass Island River, Bayelsa State, Nigeria. International Journal of Science and Technology, 4(10): 1–7.

[8] Okereke, C.D. (2007). Environmental Pollution Control (1st Ed.). Barloz Publication, Owerri, Nigeria.

[9] Mahmood, S., & Maqbool, A. (2006). Impacts of Wastewater Irrigation on Water Quality and on the Health of Local Community in Faisalabad. Pak. J. Water Resour., 10(2): 19–22.

[10] Li, X. (2022). Industrial Wastewater Treatment and Its Impact on Public Health: A Systematic Review. Water Research, 224: 119146.

[11] Bakar, H. (2023). Environmental and Human Health Risks Associated with Industrial Wastewater: A Review of Emerging Contaminants. Journal of Hazardous Materials, 442: 130018.

[12] Kamble, S.M. (2014). Water pollution and public health issues in Kolhapur city in Maharashtra. Int. J. Sci. Res., 4: 1–6.

[13] Saeed, T. (2023). Innovative Technologies for Treating Industrial Wastewater: An Assessment of Environmental and Health Impacts. Science of the Total Environment, 858: 159973.

[14] Azimi, A., Azari, A., Rezakazemi, M., & Ansarpour, M. (2017). Removal of heavy metals from industrial wastewaters: a review. Chem Bio Eng Rev., 4: 37–59.

[15] Friedler, E., Butler, D., & Alfiya, Y. (2013). Wastewater composition, Source Separation and Decentralization for Wastewater Management. IWA Publishing, London, UK, Pages 241–257.

[16] Jern, N.W., & Wun, J. (2006). Industrial Wastewater Treatment. Imperial College Press Singapore.

[17] Wang, Z., Xue, M., Huang, K., & Liu, Z. (2011). Textile dyeing waste water treatment. Advances in Treating Textile Effluent, 5: 91–116.