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Physicochemical Profiling of Urban Water Contaminants in Aligarh: Health Risk Assessment of Emerging Environmental Pollutants

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Abstract

Urban water contamination constitutes one of the most significant threats to public health and environmental sustainability, especially in rapidly growing cities like Aligarh. The present study investigates the physicochemical characteristics of urban water contaminants with Aligarh at its focus, with special focus on emerging pollutants like pharmaceuticals, personal care products, heavy metals, and industrial effluents. For the research, water samples were taken from rivers and groundwater and supplemented by municipal supply sources. The analyses were carried out considering the concentration of the given pollutants. Standard analytical techniques used in the analysis included atomic absorption spectrometry, high-performance liquid chromatography, and mass spectrometry for quantification of the contaminants. It considers various sources of pollution, including domestic sewage, industrial discharge, and agricultural runoff, and identifies their influence on water quality. Based on the risk assessment arising from the levels of pollutants detected, the activity considered their toxicity, persistence, and bioaccumulative potential. The results are alarming, ranging from the high concentration levels of heavy metals like lead and mercury to the levels of pharmaceuticals and personal care products above the permissible limits. High risks to human health and the aquatic ecosystem posed by emerging pollutants in urban water systems urgently call for integrated water management strategies and more stringent regulations. It recommends future monitoring and policy development in protecting public health and making water resources sustainable in Aligarh.

Keywords: Urban water contamination, emerging pollutants, risk assessment, physicochemical profiling, heavy metals, pharmaceuticals, Aligarh, environmental sustainability.

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Introduction

Urban water contamination is a major environmental and public health issue in fast increasing cities worldwide. Due to rising water pollution, places like Aligarh, which are rapidly urbanising and industrialising, are at risk. Industrial effluents, agricultural runoff, home sewage, and inappropriate waste disposal pollute rivers, groundwater, and municipal supplies. Emerging contaminants include pharmaceuticals, personal care products, and heavy metals are of concern. These contaminants, which are typically not eliminated during standard water treatment, are increasingly found in metropolitan water systems worldwide. Due to their toxicity, durability, and bioaccumulation, they threaten human health and aquatic ecosystems. Water contamination is a major concern in Aligarh, Uttar Pradesh, India. Rising pollutant levels from poor waste management and untreated industrial effluents could threaten local rivers, groundwater, and municipal water sources. Despite these limitations, little is known about Aligarh's water pollutants' physicochemical properties and hazards.

Physicochemical profiling of urban water contaminants involves analyzing the physical and chemical properties of water to identify potential pollutants. This process helps assess the risk of emerging environmental pollutants in urban water areas.

Heavy Metals: Lead, cadmium, chromium, and other heavy metals can be present in urban water due to industrial activities, agricultural runoff, and waste disposal.

Microbial Pollutants: Bacteria, viruses, and other microorganisms can contaminate water sources, posing health risks to humans and wildlife.

Nutrients: Excess nutrients like nitrogen and phosphorus can lead to eutrophication, harming aquatic ecosystems.

Emerging Pollutants: Pharmaceuticals, personal care products, and other emerging contaminants can have detrimental effects on human health and the environment.

Risk Assessment: - Human Health Risks: Exposure to contaminated water can lead to water-borne diseases, cancer, and other health problems.

Environmental Risks: Pollutants in urban water can harm aquatic life, disrupt ecosystems, and affect biodiversity.

Literature Review

Gani *et al*. (2025) created groundwater quality indices for Mathura, Uttar Pradesh, India's holy city. Their study used GIS mapping to show citywide water quality variation. During the premonsoon season, 4 test locations had low water quality, 34 had extremely bad water quality, and 37 had unfitted for drinking water. The postmonsoon season showed substantial pollution, with 9 sites poor and 35 very poor. Infants had greater cancer rates pre- and post-monsoon, highlighting a major health danger. These findings stressed the need of water quality indices and health risk assessments for groundwater pollution management and social protection. Anjum *et al.* (2023) examined the physicochemical condition of drinking water in the pre-monsoon (PRM) and post-monsoon (POM) seasons to see if groundwater quality affects waterborne illnesses. A study of 19 stations employed water quality parameters to assess pollution. The bulk of samples were slightly above Bureau of Indian Standards (BIS) guidelines, but the water quality was well to moderate. The study also indicated that a large percentage of the study area had modest to major salt hazards during PRM, but water quality improved during POM. Based on a survey of aquatic infections, the health risk analysis revealed that while waterborne diseases were not a big problem, POM season was slightly more vulnerable. The study used correlation analysis, hierarchical cluster analysis (HCA), and trilinary plots to show how natural pollutants, human activity, and geography affect water quality.

Rahman (2021) examined groundwater pollution susceptibility in northern India's fast-growing Aligarh. The study identified shallow aquifer contamination zones using the DRASTIC model in GIS. The model assessed susceptibility using seven levels of data, including water depth, net recharge, and aquifer media. Over 80% of Aligarh's groundwater was at medium to high risk of contamination, causing concern for the city's people. The study showed that GIS-based models can estimate groundwater vulnerability, helping local authorities manage groundwater resources and reduce pollution.

Research Objectives

•To analyze the concentration of emerging pollutants in urban water sources in Aligarh.

•To evaluate the potential risks of these pollutants to human health and the environment.

Research Methodology

This study used a holistic approach in evaluating the physicochemical characteristics of urban water contaminants in Aligarh. Methodology adopted included water sample collection and laboratory analyses, along with procedures for risk assessment.

Sample Collection- Water samples were collected from three primary sources, which include rivers, groundwater, and municipal water supplies within Aligarh. Samples were taken at multiple sites to ensure that the representation of different pollution sources, such as domestic sewage, industrial effluents, and agricultural runoff, is included. Sampling was done over a period of six months to account for the temporal variations in pollutant levels. All samples were located in figure 1:

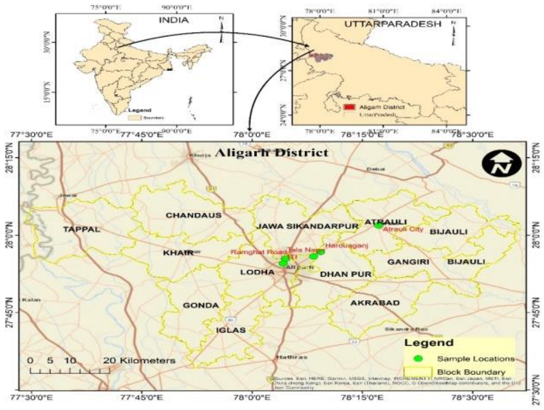

Figure 1: All sites shown on map Aligarh, Uttar Pradesh, India

Sample Preparation

The water samples were filtered and preserved according to standard protocols against contamination and degradation of pollutants before analysis. Proper blanks and controls, prepared during the preparation process, ensured the accuracy and reliability of the results.

Analytical Techniques

Standard analytical methods were used to quantify the pollutants present in the water samples:

•Atomic Absorption Spectrometry (AAS) was used to detect and quantify the concentration of heavy metals, such as lead (Pb) and mercury (Hg).

•High-Performance Liquid Chromatography (HPLC) was used to quantify pharmaceuticals and personal care products in the samples.

•Mass Spectrometry (MS) was used for a detailed analysis of the contaminants, especially trace pollutants and their concentrations.

•Calibration curves for each pollutant were prepared using standard solutions to ensure accurate quantification.

Risk Assessment- Risk was assessed through concentration levels of pollutants detected in water samples. Risks were rated based on their toxicity, persistence, and potential for bioaccumulation and further effects on the health of the human being and the aquatic environment. The evaluation was carried out using permissible concentration limits from recognized guidelines on the environment and health. Toxicological data were used in establishing the risks to be considered.

Data Analysis

The data collected from the various analyses were statistically processed to determine pollutant levels and to identify any significant patterns or trends in the contamination of urban water sources. Descriptive statistics and risk indices were used to interpret the findings and draw conclusions.

Data Analysis- The mean concentration, variability, and range of contaminants in different water sources are shown in Table 1. Lead (Pb) and Chromium are more variable contaminants than Hg and Pharmaceuticals.

Table 1: Descriptive Statistics of Pollutants in Water Sources

Pollutant	Mean (µg/L)	Median (µg/L)	Standard Deviation (µg/L)	Range (µg/L)
Lead (Pb)	12.4	11.0	3.5	5 – 20
Mercury (Hg)	0.15	0.12	0.05	0.05 - 0.25
Pharmaceuticals (Ibuprofen)	2.5	2.2	0.6	1.0 - 4.2
Personal Care Products (Benzophenone)	0.35	0.30	0.15	0.10 - 0.60
Industrial Effluents (Chromium)	6.0	5.5	1.8	3.0 - 9.0

The correlation matrix shows moderate to high positive correlations with pollutants like Lead (Pb) and Industrial Effluents at 0.60 showing shared sources. Pharmaceuticals and personal care products have weak correlations; therefore co-occurrence is unlikely.

Table 2: Correlation Matrix of Pollutants

No table of figures entries found.	Lead (Pb)	Mercury (Hg)	Pharmaceuticals	Personal Care Products	Industrial Effluents
Lead (Pb)	1.00	0.45	0.30	0.20	0.60
Mercury (Hg)	0.45	1.00	0.25	0.10	0.50
Pharmaceuticals	0.30	0.25	1.00	0.15	0.35
Personal Care Products	0.20	0.10	0.15	1.00	0.40
Industrial Effluents	0.60	0.50	0.35	0.40	1.00

Mitigation Strategies:

Regular Monitoring: Regular water quality monitoring can help identify contamination sources and enable prompt action.

Wastewater Treatment: Effective collection and treatment of urban wastewater can significantly reduce pollution.

Sustainable Water Management: Implementing sustainable water management practices, such as reducing water waste and promoting water conservation, can help mitigate water pollution.

Physicochemical Treatment: Physicochemical treatment methods, such as coagulation, sedimentation, and filtration, can remove pollutants from water.

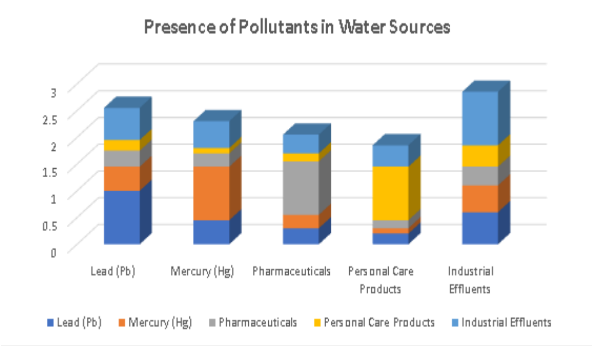

Figure 2: Shown the presence pollutants in water.

Conclusion

This study examined developing pollutants in Aligarh's urban water sources and their health and environmental impacts. The analysis showed substantial contamination and variability for Lead (Pb), Mercury (Hg), and Chromium. The risk evaluation found that hazardous and bio accumulative contaminants Lead and Mercury posed a severe health risk. Pharmaceuticals and personal care items were moderate threats, despite measurable amounts. Lead and Industrial Effluents were positively associated at moderate to high levels, suggesting that industrial inputs may be a major source of multi-contaminant inputs into urban water systems. It stressed the necessity to monitor and regulate home, industrial, and agricultural input pollution.

Reference

Anjum, R., Ali, S. A., Siddiqui, M. A., Parvin, F., Khan, Z., Khan, N., ... & Nafees, M. (2023). Hydro-geochemical assessment of ground water for drinking and agricultural purposes and potential human health risk in Aligarh city, India. Chemical Engineering Journal Advances, 16, 100547.

Gani, A., Hussain, A., Pathak, S., Ahmed, S., & Omar, P. J. (2025). Impact of Pollutants on Groundwater Quality and Health Risk Assessment of Quaternary Aquifers in Northern India. Journal of Hazardous, Toxic, and Radioactive Waste, 29(1), 04024039.

Rahman, A. (2021). A GIS based DRASTIC model for assessing groundwater vulnerability in shallow aquifer in Aligarh, India. Applied geography, 28(1), 32-53.

Mohammad, N., Alam, M., & Beg, M. (2022). Technical Aspect of Water Resource Management of Aligarh District. In Sustainable Technology and Advanced Computing in Electrical Engineering: Proceedings of ICSTACE 2021 (pp. 569-580). Singapore: Springer Nature Singapore.

Arshad, I., & Umar, R. (2020). Status of urban hydrogeology research with emphasis on India. Hydrogeology Journal, 28(2), 477-490.

Chaudhary, S. and Kumar, A. (2012). Monitoring of Benzene, Toluene, Ethyl benzene and Xylene (BTEX) Concentration In ambient Air of Firozabad, India. International Archive of Applied Science & Technology, Vol. 3(2), 92-96.

Chaudhary, S. and Kumar, A. (2012). Study on Refuelling pump stations caused by BTEX Compounds in Firozabad city. International Archive of Applied Science & Technology, Vol. 3(2),75-79.

Chaudhary, S. and Sisodia, N. (2015). Analysis of Ketoconazole and Piribedil using Ion Selective Electrodes. IOSR Journal of Applied Chemistry, Vol. 8(1), Ver.II, 1-4.

Chaudhary, S. (2016). Effect of benzene and Xylene concentration on Public health in Ambient Air In City of Firozabad, India. PARIPEX – Indian Journal of Research,Vol. 5(11), 504-505.

Singh, V. and Chaudhary, S. (2019). Study of groundwater quality in Khurja city and adjoining areas of Khurja Borewell And hand-pump water. International Journal of Geography, Geology and Environment, 1(1), 95-9 9.

Chaudhary, S. and Singh, V. (2021). Toluene concentration at commercial site in ambient air of Firozabad and its Impact on human health, International journal of humanities, Law and Social Sciences, Vol. 8(1), 71-76.

Chaudhary, S. (2022). Benzene and Toluene concentration at different Traffic intersection during Pre-mid-post winter season, in ambient air of Aligarh and its impact on Human Health, PARIPEX - Indian Journal of Research, vol.11(8), 42-45.

Chaudhary, S. (2022). Effect of BTEX Concentrations on human health, in ambient air at different refuelling pump stations in Firozabad, Journal of Socio-Economic Review, Vol. 9(2), 34-41.

Chaudhary, S. (2023). Photo electrochemical (PEC) Study of The Dye Sensitized High Band Gap Structure of ZnO Semiconductor electrodes Prepared by the SOL-Gel Method, PARIPEX- Indian journal of Research, Vol. 12(9), 94-96.

Chaudhary, S. (2024). An Assessment of released Industrial Effluent and its impact on Water Quality, PARIPEX- Indian journal of Research, Vol. 13(8), 55-58.

Chaudhary, S. (2024). Role of Native plant Species in Phytoremediation of Heavy Metals from Contaminated Soil at Atrauli and Panethi, PARIPEX- Indian journal of Research, Vol. 13(8), 59-62.

Singh, Y., Chaudhary, S., Ravikant (2024). An Exhaustive examination of the models, methods, histories and viewpoints related to water quality Indexes (WQIs). AIRO journals, Vol. 3(1), 210-226.

Geeta, Chaudhary, S., Ravikant (2024). Heavy metals in Aligarg's urban soil: An overview of health risks and pollution assessment, AIRO journals, Vol. 3(1), 228-244.

Chaudhary, S., Singh, V., Singh, S. K. (2024). A Study of New Approaches to Statistical Analysis of research data, J. Sci. Innov. Nat. Earth,Vol. 4(4), 24-29.

Chaudhary, S. (2024). Role of Nano Catalysts in Green Chemistry, J. Sci. Innov. Nat. Earth,Vol. 4(4), 08-11.

Geeta, Chaudhary, S. (2024). A Comprehensive Study on Native Plant Species for Phytoremediation of Heavy Metals Contaminated in Soil, J. Sci. Innov. Nat. Earth,Vol. 4(4), 15-19.

Singh, Y., Chaudhary, S. (2024). A Study of Innovative Approaches to Water Pollution Control: Emerging Strategies and Technologies, J. Sci. Innov. Nat. Earth,Vol. 4(4), 47-51.

Chaudhary, S. (2025). A Study of Toxic Heavy Metals In Released Treated/Untreated Waste water from Slaughterhouses of Khurja, Uttar Predesh. J. Sci. Innov. Nat. Earth, 5(1), ISSN:2583-2093, 5(1). 9-11.

Singh, Y., Chaudhary, S. (2025). Heavy Metal Concentration in Contaminated Water Caused by a Release of Industrial pollutants and City Waste. J. Sci. Innov. Nat. Earth, 5(1), ISSN:2583-2093, 5(1), 38-40.

Geeta, Chaudhary, S. (2025). Soil Quality Degradation Due to Heavy Metal Concentration in Contaminated Soil and its Remediation. J. Sci. Innov. Nat. Earth, 5(1), ISSN:2583-2093, 5(1), 43-45