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ESTIMATION OF PHYSICO-CHEMICAL INDEX AND RESTORATION MEASURES: A CASE STUDY OF NOON RIVER IN KANPUR NAGAR, INDIA

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Abstract: Rivers play a vital role in maintaining ecological balance and supporting local communities and livelihoods. However, increasing anthropogenic pressures have significantly impacted river water quality. This study explores the water quality of the Noon River in Kanpur District, Uttar Pradesh, by analyzing its physico-chemical parameters. The study highlighted the urgent need for regular water quality monitoring and pollution control measures to restore the river's ecological balance. It also emphasizes community participation and sustainable practices to maintain the flow of the river. These findings will provide valuable insights to policymakers to implement effective river conservation strategies, ensuring the long-term health of the river and the well-being of local communities.

Keywords: Anthropogenic activities, Restoration, Small River, Water quality parameters.

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INTRODUCTION

A river is not just a channel that carries water; it is a dynamic, living system that reflects the health of the entire watershed (Chakraborty *et al.,* 2021; Sah, 2025). Rao (1977) classified rivers based on the size of the catchment area, as large/ major rivers (catchment area is 20000 sq. km. or more), medium rivers (catchment area is 2000 to 20000 sq. km.), and small rivers (catchment area is 2000 sq. km. or less). The small rivers constitute a substantial portion of river networks. They act as ecological lifelines, sustaining biodiversity, regulating hydrological cycles, and supporting local communities by replenishing groundwater and ensuring the availability of clean water.

The quantity of water coming in big rivers has decreased over time. The main reason behind the changes in river topology and flow is the man-made changes in the basin and in small rivers that bring water to the large rivers. Ironically, even during the initial efforts of river conservation, more importance was given to the main stem of big rivers rather than small rivers. As a result, the condition

of small rivers deteriorated, and neither could large rivers improve in any significant manner (Amrita *et al*., 2024). Some of the minor rivers, which were perennial, have now, become seasonal, and those which were seasonal rivers have oftentimes disappeared. For any holistic river rejuvenation initiative to succeed, it is crucial to address each of these dimensions in an integrated and coordinated manner. The degradation of small rivers disrupts not only local ecosystems but also impairs the functioning of larger river systems they feed into (Palt *et al*., 2022).

First step in the conservation and revitalization of these small rivers is to identify them. Suitable criteria for the selection of a stream/ river include:

a) The selected stream should be a low-order stream.

b) It must be historically perennial (flowing throughout the year) or at least one that can be converted into a perennial stream by water coming from other regions (e.g. from other river basins, through water supply, through agriculture).

c) It should be located in or near urban areas.

d) It should have a relatively large basin among rivers in that area.

Almost all the fresh water bodies like rivers, lakes, ponds etc. support a rich biodiversity, which is necessary for ecological balance but the indiscriminate human activities including pollution, pesticides are badly influencing them (Madhulekha and Arya, 2016; Prakash and Verma, 2020; Singh *et al.,* 2023). The rivers are vital and vulnerable freshwater ecosystems, critical for the sustenance of all lives. However, the surface water good quality is gradually deteriorating due to anthropogenic activities, industrialization, unsustainable farming, micro-plastics, transportation, urbanization, animal and human excretion, and domestic wastes (Shukla and Arya, 2016; Ahmed and Ismail, 2018; Kalal *et al.,* 2021; Prakash and Verma, 2022; Verma and Prakash, 2022).

The present study deals with the physico-chemical analysis to explore the water quality status, ecosystem management and restoration measures of Noon River in Kanpur, Uttar Pradesh. The results reported here will provide baseline data to Policymakers for framing a suitable remedial action plan.

MATERIALS AND METHODS

Study Area

The Noon River starts from the Kanhaiya Jheel (lake) in the Rahiniyapur village of the Akbarpur block of Kanpur Dehat. It then flows for 48 kilometers in Kanpur Dehat and Kanpur Nagar districts before meeting the Ganga River near Bithoor. The river passes through several villages in the Shivrajpur and Chaubepur development blocks. The river is a lifeline for these villages, meeting their daily water needs.

Sample Collection

The present study was carried out on three different locations (Fig.1; Table 1) of the Noon River, District Kanpur Nagar, Uttar Pradesh. The sampling was done during morning hours, and the water samples were collected in 1 L pre-cleaned polyethylene bottles. All samples were properly labelled with details of the source, date of sampling, time of sampling, and address.

Table 1: Details of water sample collection locations on the bank of the Noon River, Kanpur Nagar.

Location	Location Name	Latitude	Longitude
L1	Noon Nadi Pul, Shahpur Malha	26.642687°	80.164981°
L2	Nonha Kalan, Chaubepur-Bithoor Road	26.618549°	80.223316°
L3	Maharajpur, Bithoor Road	26.577127°	80.249903°

L1 **L2** **L3**

Table 2: Physico-chemical characteristics of Noon River, Kanpur Nagar, Uttar Pradesh.

Sample Analysis

All samples were tested in the laboratory within 24 hours of collection. The physico-chemical parameters selected were pH, Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), chloride (Cl^-), and sulphate ($SO4^{-2}$). Physico-chemical investigation was carried out according to standard methods (APHA, 1998). The analyzed data were compared with the standard values recommended by the CPCB (2017).

RESULTS AND DISCUSSION

Physico-chemical Analysis

To know the physico-chemical properties of a freshwater is very crucial for exploration. The physico-chemical characteristics of river water collected from three locations were analysed and presented in Table 2.

Table 2: Physico-chemical characteristics of Noon River, Kanpur Nagar, Uttar Pradesh.

Parameters	CPCB Permissible limit	Experimental values		
		L1	L2	L3
pH	6.5-8.5	7.2	7.8	7.6
EC (µS/cm)	2250	2050	1590	1234
TDS (mg/l)	500	378	254	347
DO (mg/l)	4-6	4.2	4.8	4.5
BOD (mg/l)	2-3	75	68	70
COD (mg/l)	250	290	215	190
Cl^- (mg/l)	1000	45	38	35
NO^3 (mg/l)	45	4.20	5.30	6.18
SO^4 (mg/l)	400	140	115	108

The physico-chemical parameters are the most important principles in the identification of the nature, quality and type of water for any aquatic ecosystem (Verma, 2019). The pH serves as a valuable guide for understanding the acid-alkali balance of water. The maximum level of pH was found for L2 (7.8), followed by L3 (7.6) and L1 (7.2). A narrow variation of pH was observed for all the locations. The main cause of deterioration in water quality was the high anthropogenic activities, illegal discharge of sewage, industrial effluent, and lack of proper sanitation, unprotected river sites, and urban runoff.

Electrical Conductivity (EC) is a basic indicator of the total mineral content present in water at a time and may be related to problems such as excessive hardness, corrosive characteristics, or

other mineral contamination (Anilkumar *et al.* 2015). The EC values are lower than the CPCB permissible limit in all three locations.

Total dissolved solids (TDS) are the number of solids present in dissolved and suspended form. Maximum levels of total solids were found for L1 (378 mg/l), followed by L3 (347 mg/l) and L2 (254 mg/l). Higher TDS in the water system increases the chemical and biological oxygen demand and ultimately depletes the dissolved oxygen level in the water (Bhosale *et al.* 2023).

Dissolved oxygen (DO) is one of the important parameters in water quality assessment and reflects the physical and biological processes prevailing in waters. In the present study, DO varied from 4.2 to 4.8 mg/l, which is not a great variation and does not exceed the CPCB limit. Biological Oxygen Demand (BOD) is the amount of oxygen used by the microorganisms to decompose the organic material. The maximum level of BOD is found for L1(75 mg/l), followed by L3 (70 mg/l) and L2 (68 mg/l). BOD directly affects the amount of dissolved oxygen in rivers and streams. The higher the BOD, the more oxygen will be demanded from the waste to break down the organics (Shahi and Singh, 2017).

Chemical Oxygen Demand (COD) represents the amount of oxygen required to oxidize all of the organic matter, both biodegradable and non-biodegradable. Maximum values of COD were observed for L1 (290 mg/l), followed by L2 (215 mg/l) and L3 (190 mg/l). The COD values were greater than the limits as prescribed by the CPCB at L1 and L2. The concentration of Chloride, Nitrate, and Sulphate was found to be very lower than CPCB permissible limits at all three sites of the Noon River. This lower limit in the river water could be caused due to urban run-off (Rizwan *et al.* 2016).

RESTORATION MEASURES

River restoration and management is the process of repairing and improving a river's ecosystem and the water quality. This is the process of recovering the degraded, damaged, and destroyed ecosystem of the river by restoring the ecological structure, function, and biotic integrity (Zhang *et al.,* 2020; Yadav, 2025). The purpose of river restoration is to improve the structure and function of the river ecosystem by increasing the biodiversity of the river (Jackson *et al*., 1995). River ecological restoration projects need to improve the entire ecosystem rather than focus solely on improving the water quality. River ecological restoration projects are needed to improve the entire ecosystem rather than focus solely on improving the water quality (Pan *et al.,* 2016; Zhang *et al.,* 2018). Therefore, at present, physical, chemical and biological composite technologies are mainly used to carry out ecological restoration of river ecosystems.

River restoration should be a social and long-term commitment from governments and the public. The Noon River is undergoing rejuvenation efforts through community-driven desilting and excavation efforts to restore its flow and benefit the surrounding agricultural lands. The river has been facing issues with water flow; however, the local authorities are working to restore it. The restoration efforts are driven by the local community, including villagers, social workers, professionals, and administration, who have come together to clear obstacles and restore the riverbed. This includes excavation work and dredging to deepen the riverbed and improve water flow. The goal is to revitalize the river and ensure a continuous water supply for irrigation. The work is being executed under the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), providing employment opportunities and benefiting local farmers. Significant progress has been made in restoring the river's course, with some sections already showing visible signs of water flow.

CONCLUSION

To simplify the task of river monitoring and conservation, focus should be given on small urban and semi-urban streams/tributaries and natural drains, especially those streams/drains that are perennial or can easily become perennial. Such rejuvenation has many immediate benefits in the economic, environmental, aesthetic and cultural spheres, and they affect large population groups. The revival of big rivers is only possible when small rivers and streams connected to a big river are revived first. For this task to be executed,

it is necessary to understand the bottom-up approach and adopt this method for the restoration of rivers.

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