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Assessing the Impacts of Urban Development on the Kothari River, Bhilwara, Rajasthan

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Abstract: The study aims at assessing the impacts of urbanization on Kothari River in Bhilwara city, where rapid growth has significantly altered its ecological and hydrological conditions. Increasing human activities have resulted in serious pollution problems caused by unregulated disposal of bio medical waste, domestic solid waste and untreated liquid waste directly into the river. In addition, rampant encroachment along the riverbanks has further stressed the natural habitat, leading to habitat fragmentation and threatening local biodiversity. Such conditions have accelerated eutrophication, reducing water quality and aquatic productivity. To scientifically analyze these impacts, the research incorporated both primary and secondary data sources, including field surveys, municipal records, interviews and environmental reports. Spatial changes in land use and their effects on the riverine ecosystem were mapped and analyzed using advanced tools such as QGIS and Google Earth Pro software. The study also examines the role of legal and regulatory interventions, particularly the directives of the National Green Tribunal (NGT), which provide a framework for addressing river pollution and restoration measures. The findings suggest that without timely interventions, urban pressures will irreversibly damage the ecological balance of Kothari River. Hence, integrated management and sustainable urban planning are urgently recommended.

Keywords: *Kothari river, Urbanization, Encroachment, Pollution, Biodiversity, Eutrophication.*

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I. INTRODUCTION TO THE KOTHARI RIVER: THE LIFELINE OF BHILWARA

Rivers have always been essential to the growth and development of human societies, acting as crucial sources of water and sustenance. In regions like Rajasthan, characterized by arid to semi-arid climate, rivers become even more vital due to the scarcity of water resources. Kothari river, originating from the Deogarh hills (Rajsamand District) in the Aravalli range is an important tributary of the Banas river system, which itself is a part of the extensive Ganga river system, one of India's largest river basins (Saxena Harimohan, 2018, p. 32). As Kothari river provides essential water for drinking, irrigation and industrial activities and it supports ecology and biodiversity, it is termed as the 'lifeline of Bhilwara'.

Geographically, Bhilwara city is located at the junction of 25°35' North latitude and 74°64' East longitude, placing it politically within the south-eastern part of Rajasthan (Ground Water Department Rajasthan, 2013). The district spans an extensive administrative area of around 10,455 sq. kms., encompassing diverse terrains and communities (District Census Handbook Bhilwara, 2011). It is often referred to as the 'Textile City of Rajasthan' or 'the Manchester of Rajasthan' due to its thriving textile industries, has evolved into a significant industrial hub in the region.

Within the city, the river forms a distinctive 'U-shaped cup' pattern stretching from Arjiya to Sanganer, which influences local settlement and infrastructure development. It serves as a major geographical and hydrological feature of Bhilwara.

Over the past few decades, the city has witnessed a considerable urban expansion driven by industrial growth and increasing population. As urbanization and industrialization continue, the quality of Kothari's water and the health of its ecosystems have faced significant challenges. Rapid urbanization, unchecked industrial growth and widespread encroachment have contributed to pollution and ecological degradation in the river.

II. POPULATION AND URBAN EXPANSION

In Rajasthan, Bhilwara ranks at the seventh position in terms of urban population size, following Jaipur, Jodhpur, Kota, Bikaner, Ajmer and Udaipur. Importantly, Bhilwara's urban population is projected to reach approximately 6.23 lakh (623,000) by 2031, reflecting its expanding role as a regional urban center with increasing demographic and

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economic significance (Bhilwara town population census 2011-24).

Advanced spatial analyses using remote sensing technology have revealed a pronounced increase in built-up areas within Bhilwara, particularly expanding to the north-northwest and west-southwest directions. This expansion has been primarily driven by the development of transportation corridors and robust economic growth, which have facilitated the city's outward growth. Over the three decades from 1991 to 2021, Bhilwara has experienced marked urban sprawl, with rapid urbanization and industrialization occurring not only along the southern banks of the Kothari River but also at its northern end. This growth has led to the widespread conversion of green spaces and wetlands into residential, commercial, industrial and agricultural zones. Such transformation has significantly disrupted the natural hydrological cycle, reducing groundwater recharge capacity while increasing surface runoff. These changes have, in turn, contributed to frequent localized flooding and irregular river flow patterns, posing environmental and infrastructure challenges.

Bhilwara's urban area is divided into 70 wards of which eight wards, namely 57, 58, 60, 61, 62, 63, 64 and 65 directly contribute to household pollution in the Kothari River. These wards include residential areas such as Rama Vihar, Subhash Nagar, RC Vyas, Vijay Singh Pathik Nagar and Sanganer, stretching from west to east as well as commercial areas too. Given the rapid increase in population and urbanization, the municipal council has been upgraded to the Municipal Corporation (Modified Budget 2024-25, Govt. of Rajasthan). This upgrade offers hope for more structured and efficient urban planning in Bhilwara to manage environmental concerns, especially the protection and restoration of the Kothari River ecosystem, alongside supporting sustainable urban growth.

Table 1; Population Prospects of Bhilwara City

Year	Population (in lakhs)
2011	359483
2021	467000
2022	481000
2023	495000
2024	509000
2025	524000
2026	539000
2027	555000
2028	571000
2029	588000
2030	605000
2031	623000

Source: https://www.census2011.co.in/

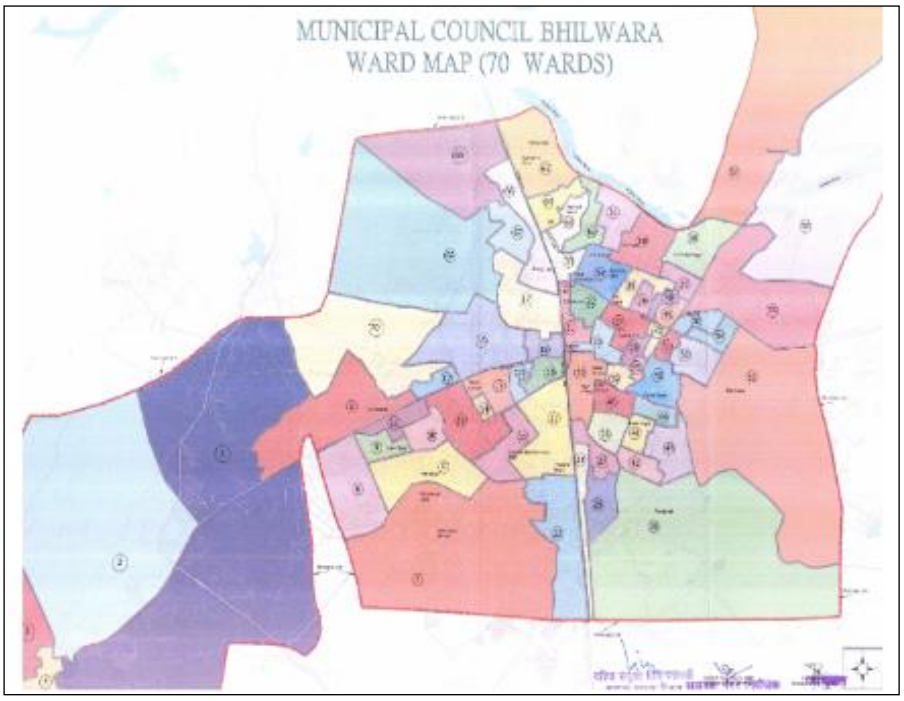

Fig: 1.; Source: Municipal Corporation, Bhilwara

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III. ENCROACHMENT AND ILLEGAL MINING

The lands adjoining the banks of the Kothari River are increasingly falling prey to rampant encroachment, posing a serious threat to the very existence of the river. Both the river's breadth and its natural flow channel are shrinking as a consequence, which heightens the risk of flooding during the monsoon season (Fig:3 and 5). What was once a free-flowing watercourse is now steadily losing its capacity to carry water safely and sustainably (Director of Jaldhara Vikas Sansthan, Bhilwara, personal communication, October 19, 2024).

Researchers have identified ten major encroachments along the Kothari River, designated as A, B, C, D, E, F, G, H, I and J. Among these encroachments F, I and J have been assessed as the most critical due to their greater impact (Fig: 2). These encroachments primarily consist of agricultural lands, residential settlements, hospitals and cremation grounds, all of which directly affect the river ecosystem and surrounding land use.

Adding to this crisis, widespread illegal mining activities are taking place under the cover of darkness. Rocks within the river's midstream zone are being blasted and extracted unlawfully, with the debris subsequently sold in the black market. These destructive practices are altering the riverbed, obstructing the harmony of its flow and further degrading its ecological integrity.

Encroachments are not limited to agricultural or commercial expansion; unauthorized slums and unregulated constructions on the riverbank are also contributing to the river's decline. Such obstructions prevent natural recharge, disrupt groundwater replenishment and destabilize the delicate balance of the ecosystem.

➢ *Solid and Liquid Waste*

The Kothari River is being indiscriminately used as a dumping ground for waste generated by local industries, residential colonies, health care facilities and hotels. It can easily be observable at Paldi, near Unique Village Hotel, Kirkheda and Sanganer areas. A wide variety of solid and hazardous wastes including plastic bags, containers, thermocol, rubber scraps, broken backlights, electronic waste and even biomedical waste are indiscriminately discarded in these locations (Fig: 4).

Further compounding the problem, cattle carcasses and heaps of solid waste have been discovered in the river. The garbage on the banks of the river and in the main flow area is also increasing the risk of diseases like cholera, malaria, chikungunya and diarrhea. Such reckless dumping reflects a deeply negligent attitude not only towards the river but also towards the broader environmental balance of the region.

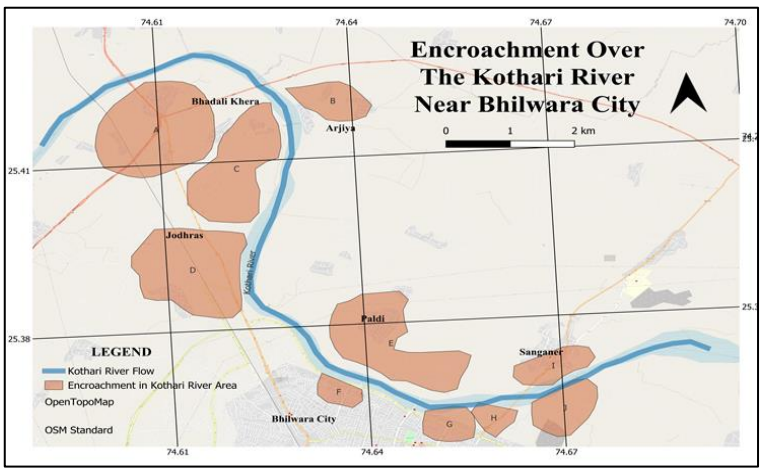

Fig: 2; Major Encroachments over the Kothari River, Bhilwara (As in 2025)


Fig: 3; Flood Situation in the Pathik Colony Near Kothari River Area

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Fig: 4; Dumping Site at Kirkheda

Fig 5 ; Flood in the Kothari River

Fig: 6; Black Sewage Water Flowing Through the Kothari River

At many of these dumping spots, the collected waste is burnt in the open, causing thick plumes of toxic smoke. This unscientific disposal practice has severely deteriorated the local air quality, pushing pollution to dangerous levels.

Such practices have had a direct impact on human health. With rising pollution, particularly in the form of noxious fumes and particulate matter, the prevalence of respiratory disorders has surged among people living near these dumping sites. A recent survey conducted by researchers in nearby settlements, using a random sampling method, revealed that out of a sample of 30 individuals with an age group ranging from 40 to 70 years, 04 were found suffering from severe respiratory illnesses (Table: 1.2). This reflects a disproportionately high incidence, suggesting that unregulated waste disposal along the Kothari River is not only an environmental crisis but also a serious public health emergency.

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Table: 2; Respiratory Disorders Found in Residents near Kothari River Area						
Site	**Sample Size**	**Age (Years)**	**Acute Respiratory Infection**	**Asthma**	**Pulmonary Tuberculosis (TB)**	**Normal**
Paldi	10	40-70	1	0	0	9
Kirkheda	10	40-70	1	1	0	8
Sanganer	10	40-70	0	1	0	9
Total	**30**		**2**	**2**	**0**	**26**

Source: Survey conducted by the researchers.

Untreated sewage carrying mud and foul odors from the city is routinely discharged into the river, severely diminishing its natural quality (Fig: 5). Mishra et al. (2020) reports a continuous decline in water quality in the Kothari River, primarily due to the unchecked release of untreated industrial effluents.

The consequences of such practices have been alarming. The river's water now contains dangerously high concentrations of toxic chemicals, making it unsafe for consumption and posing serious health risks (Babulal Jajoo v. State of Rajasthan, 2022).

The severity of pollution can be gauged from the fact that the river is classified under the 'pink category' which signifies extremely high levels of contamination (Moudgil, 2016). As a result, both the ecosystem and public health are under grave threat, underscoring the urgent need for decisive action to restore the Kothari River to a healthy state.

The unchecked conversion of the riverbanks into dumping yards illustrates a dangerous nexus between environmental degradation and human health hazards. Immediate measures are required to curb illegal dumping, establish scientific waste management practices and restore the ecological integrity of these critical riverine areas.

- *Biomedical Waste*

In the case of Motilal Singhania vs. State of Rajasthan, 2024, it was revealed that the Urban Improvement Trust (UIT), Bhilwara had allotted land along the banks of the Kothari River for the establishment of health care facilities. Investigations found that several of these institutions were illegally discharging biomedical waste into the river, including expired medicines, used needles and syringes, blood-contaminated materials, blades, lancets, broken glass, cotton dressings, bandages, soiled plaster casts and chemical liquid waste.

To address this issue, the National Green Tribunal (NGT) directed the formation of a joint monitoring committee. As per the order, the District Magistrate of Bhilwara and the Rajasthan State Pollution Control Board (RSPCB) were instructed to nominate one representative each. The District Magistrate was further designated as the nodal authority to ensure effective coordination and compliance. In pursuance of this directive, the Sub-Divisional Magistrate, Bhilwara (on behalf of the District Magistrate) and the Regional Officer of the RSPCB, Bhilwara were appointed as official members of the committee (Motilal Singhania Vs Rajasthan State O. A. No. 809/2024 (PB), order dated 27 Aug 2024, p.03).

- *Eutrophication and Loss of Biodiversity*

Illegal occupations, both permanent and temporary, have become widespread along the banks of the Kothari River. Alarmingly, even cultivation is being carried out within the main channel of the river itself. This practice has introduced a new dimension of ecological stress. The excessive use of chemical fertilizers during farming activities along the river has led to a steady accumulation of nutrient residues in the water. As a result, the Kothari River is experiencing nutrient pollution, a form of contamination that disrupts its ecological balance.

This phenomenon of nutrient enrichment commonly leading to eutrophication has severely damaged the river's ecosystem (Shukla, Khire, & Gedam, 2013). Aquatic life forms such as frogs, turtles and fish, which once thrived in its waters, are now facing a survival crisis. The ecological imbalance has also disturbed the river's role as a habitat for migratory birds, which traditionally visited the Kothari River during winters but have now almost disappeared from the landscape.

Recognizing the seriousness of the situation, the National Green Tribunal (NGT) has intervened. In its directive, the NGT has emphasized the need for urgent ecological restoration along the river. It has ordered the plantation of two lakh saplings on both banks as a means to revive the green belt and stabilize the river ecosystem. Furthermore, the development of a regulated riverfront has been mandated to curb illegal activities, prevent further encroachments and promote environmentally sustainable use of the riverine area.

Thus, the unchecked encroachment, harmful agricultural practices and disregard for ecological sensitivity have pushed the Kothari River into a state of critical decline. Without strict enforcement of environmental norms and timely restoration, the river risks losing its ecological character altogether.

IV. FIELD SURVEY AND RESULT OF KOTHARI RIVER WATER

In compliance with the orders issued by the NGT, a survey of the Kothari River was conducted by the State Pollution Control Board on October 18, 2024 in which the results obtained have been expressed through the table.

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Table 3; Water Quality of the Kothari River, Bhilwara	
Parameters	**Results**
pH	7.7
Total Suspended Solids (TSS) mg/l	17
Chemical Oxygen Demand (COD) mg/l	50
Bio-Chemical Oxygen Demand (BOD) mg/l	8.9

Source: RSPCB, Report of the state board analyst/r. no. 821/ Oct 2024

The water of the Kothari River has a pH level of 7.7, which indicates it is slightly alkaline and above the neutral point which means the water contains a higher concentration of hydroxide ions (OH^-) compared to hydrogen ions (H^+), but is still well within the typical range found in natural freshwater systems. Most natural freshwater rivers, lakes and streams have pH values that range from about 6.5 to 8.5, so a pH of 7.7 falls comfortably within the normal and safe range for aquatic life.

At this pH, the water supports most fish and aquatic organisms, as these species generally thrive best in a pH environment between 6.5 and 8.5. Such slightly alkaline conditions often result from natural buffering due to the presence of dissolved minerals like bicarbonates, calcium and magnesium, which help resist sudden changes in acidity. Human activities and surrounding geology can also influence river pH, but a 7.7 reading generally signifies good water quality and does not pose any risk of harmful acidity or extreme alkalinity.

In addition to organic contaminants, the river contains inorganic waste that cannot be broken down biologically but instead undergoes chemical reactions within the water. The extent of this particulate and chemical load is often measured through Total Suspended Solids (TSS). TSS refers to all suspended particles larger than 2 microns, including sand, silt, clay, chemical precipitates and organic debris.

For the Kothari River, the TSS level was recorded at 17 mg/l. According to the World Health Organization (WHO) and CPCB standards, TSS levels below 25 mg/l are generally considered acceptable for potable water sources after conventional treatment. This indicates that while contamination is present, the suspended solids can be effectively removed using standard filtration techniques. After additional treatment and disinfection, such as coagulation, sedimentation and chlorination, the water can potentially be made safe for drinking.

A Chemical Oxygen Demand (COD) value of 50 mg/l in the water of the Kothari River indicates a moderate level of organic and inorganic substances capable of being chemically oxidized. COD measures the total amount of oxygen required to chemically oxidize both biodegradable and non-biodegradable organic matter present in the water.

A COD concentration of 50 mg/l is higher than what is typically found in unpolluted natural river waters, which usually have COD values below 20 mg/l. This suggests that the Kothari River water contains a noticeable amount of organic pollution, possibly from domestic, agricultural, or industrial sources. While this level is not considered severely polluted, it does indicate some degree of water quality impact and may affect sensitive aquatic organisms if persistent. The river may require regular monitoring and management to prevent further increases in organic load and to ensure the health of the aquatic ecosystem.

Water quality assessments of the Kothari River reveal serious concerns related to organic and inorganic pollution. The Biological Oxygen Demand (BOD) has been recorded at 8.9 mg/l, which significantly exceeds the permissible limit for surface water. According to the Central Pollution Control Board (CPCB) classification, a BOD level of ≤ 3 mg/l is considered safe for drinking water sources after conventional treatment and disinfection, while water with BOD above 6 mg/l is deemed highly polluted and unfit for use without advanced treatment (Press Information Bureau, Ministry of Water Resources, 2012). A level of 8.9 mg/l not only reflects the presence of excessive organic matter but also indicates ongoing microbial decomposition, making the water unsafe for drinking from a health perspective (Jagariya, 2022).

V. RECOMMENDATIONS

The river's water quality index shows positive results different from the actual state of its pollution. This is from the view of the researcher because the collection of samples and testing by RSPCB was done in October, 2024. However, the month of October comes after rain and during rainfall, the arrival of clean water in the rivers increases. In such a situation, polluting elements flow into remote areas. In addition, it may also be possible that samples have been taken by RSPCB from the part of the river which is less polluted than the remaining part. In such a situation, samples can be collected from different sites of the river in non-rain months and a separate report of each site can be prepared.

Research conducted in the settlements of Paldi, Kirkheda and Sanganer, located on the banks of the river, has revealed that local residents are having respiratory disorders like acute respiratory infection and asthma due to the burning of solid waste in the open. In this case, recycling of solid waste can be done. Proper monitoring and action can be taken by the concerned department if anyone found guilty of dumping garbage in the river area. Efforts can be made to make public awareness for river conservation by the concerned department by using social media as a tool.

The survey conducted by the researchers found that the classification of waste is being negligent by the health care facilities operated on the Kothari river, under which biomedical waste is being mixed with municipal waste and dumped into the garbage vehicle operated under the Swachh Bharat Abhiyan. Showing seriousness on this issue, a fine has also been charged by the NGT from the Municipal Corporation, Bhilwara (Motilal Singhania Vs Rajasthan State O. A. No. 809/2024 (PB), order dated 27 Aug 2024, p.06). In such a situation, under the provisions described in the

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Biomedical West Policy-2016, all health care facility centers can be used compulsorily as per the prescribed criteria. Teams can also be determined by the competent department for continuous monitoring.

For this, Red bins are typically used for infectious or bio-hazardous waste, yellow for anatomical and contaminated waste, blue for recyclable materials and black for general non-hazardous waste. Green bins are sometimes used for organic or biodegradable waste.

The barcode system has not yet been implemented in hospitals operating along the Kothari river, while under the biomedical waste policy 2016 it is stated that containers or bags in which biomedical waste have been collected and if they have to be sent outside the premises for any purpose, should be given bar code. (Biomedical waste policy-2016, Section 4(i))

The Kothari river area can be demarcated. Permanent and temporary encroachment can be removed immediately on both sides of the river. The movement of migratory birds in the river has also stopped. The river has lost its original form by the disposal of solid and liquid industrial and domestic waste and currently flows as a dirty drain. For this, precise survey and protection of river boundaries must be a priority, enforced by regular monitoring and severe penalties for violation.

Development of extensive green belts, community parks and riverfront projects will help restore ecological function while preventing future encroachments.

Immediate investment is needed in high-capacity sewage and industrial effluent treatment, with real-time monitoring for compliance.

Ban or strict control over sand and gravel mining can be implemented to preserve river morphology and ecosystem health.

VI. CONCLUSION

The condition of the Kothari River reflects the growing conflict between rapid economic growth and the responsibility of environmental care in the urbanizing Bhilwara. Unless deliberate steps are taken through policy reforms, modern technological solutions and meaningful civic involvement the river edges closer to irreversible decline. Today, the call for sustainable urban planning, stringent regulatory measures and active public participation is more pressing than ever. The future of Bhilwara and its river hinges on embracing environmental responsibility, a commitment essential not just for preserving nature, but for safeguarding the city's survival and long-term prosperity.

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