Unraveling Water Quality Degradation in Ramgarh Tal, Gorakhpur: A Geographical Study

Harsh Raj Yadav*

*Research Scholar, Dept. of Geography, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur UP.

Abstract:

The rising anthropogenic activities in this area have raised concerns about the quality of water in Ramgarh Tal of Gorakhpur, Uttar Pradesh. The objective of this research is to determine Ramgarh Tal's water quality index (WQI) by a thorough evaluation of several physicochemical factors. A variety of parameters, such as pH, dissolved oxygen (DO), total dissolved solids (TDS), biochemical oxygen demand (BOD), sulfate, nitrate, alkalinity, magnesium, calcium, chloride, and microbiological pollutants, were measured on water samples that were taken from various locations. The findings showed a considerable deterioration in the quality of the water, with increasing pollution levels above allowable limits established by ICMR/BIS guidelines. High nutrient levels, turbidity, and microbiological burdens in the water body have been attributed to the main causes of contamination and eutrophication, which have been identified as industrial discharge, home sewage, and agricultural runoff. A quantitative assessment of the total water quality was obtained by calculating the WQI using accepted techniques, which showed low to bad conditions at the sampled site.

Keywords: Water Quality Index (WQI), physiochemical factors, microbiological, deterioration, pollution, ICMR/BIS, eutrophication.

Introduction:

An essential link between environmental sustainability and human well-being is the management of water resources and land use patterns. Global urbanization and population growth put increasing strain on land and water resources, resulting in a variety of degradations that have far-reaching effects. Under these circumstances, it becomes essential to carry out an extensive geographical analysis in order to comprehend the intricate relationships between land use dynamics and water degradation. Water degradation is the term used to describe a variety of processes that lead to the reduction of both the amount and quality of water, which presents serious problems for both human populations and ecosystems. Water degradation is caused by a number of factors, such as pollution from urban, agricultural, and industrial sources; excessive extraction for home and irrigation use; and alters to natural hydrological regimes brought about by infrastructure development. In the end, these processes may jeopardize the availability of clean and consistent water sources by causing eutrophication of water bodies, pollution contamination, groundwater reserve depletion, and disturbances to aquatic habitats.

Land use practices simultaneously have a significant impact on the sustainability and quality of terrestrial ecosystems. The physical, chemical, and biological characteristics of the land are changed when natural landscapes are converted for infrastructure development, urbanization, and agriculture. This frequently leads to land degradation and the loss of ecosystem services. Unsustainable land use practices result in deforestation, soil erosion, desertification, and habitat fragmentation, which in turn cause biodiversity loss, lower agricultural output, and increased susceptibility to natural disasters like floods and droughts.

Principles from the social sciences, hydrology, geography, and ecology must be integrated in a multidisciplinary approach to comprehend the temporal and spatial patterns of land use and water degradation. At many scales, mapping and tracking changes in land cover, land use, and water quality depend heavily on geographic information systems (GIS), remote sensing technology, and spatial analysis methods. Furthermore, the dynamics of land and water management are shaped by institutional structures, policy frameworks, and socioeconomic variables, underscoring the necessity of multidisciplinary research that takes an integrated approach to studying human-environment interactions.

By conducting a geographical study of water degradation and land use, researchers aim to elucidate the underlying drivers, spatial patterns, and impacts of environmental change, thereby informing evidence-based decision-making and sustainable development interventions. Such studies provide valuable insights into the vulnerabilities and resilience of socio-ecological systems, facilitating the design of adaptive strategies that promote the conservation of natural resources, the enhancement of ecosystem integrity, and the equitable distribution of environmental benefits. Through collaboration between scientists, policymakers, and local communities, geographical research contributes to the pursuit of environmental sustainability and the attainment of the United Nations Sustainable Development Goals (SDGs) related to water, land, and biodiversity conservation.

A numerical term called the Water Quality Index (WQI) is used to express the overall quality of water for a given usage or purpose. By combining several water quality factors into a single value, it offers a more straightforward method of communicating complex water quality information. Water quality index (WQI) calculations generally entail the measurement of multiple physical, chemical, and biological properties of water samples, followed by the allocation of weights to these parameters according to their respective significance to the intended use of the water.

Depending on the assessment's particular goals and the surrounding circumstances, other parameters may be included in the computation of WQI. Nonetheless, standard criteria that are frequently taken into account are pH, dissolved oxygen (DO), total dissolved solids (TDS), turbidity, biochemical oxygen demand (BOD), nutrients (such phosphate and nitrogen), and heavy metals such as mercury, lead, cadmium etc. fecal coliform bacteria and other contaminations. Nevertheless, standard parameters that are frequently taken into account are pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), turbidity, total dissolved solids (TDS), nutrients (like phosphorus and nitrogen), heavy metals (like cadmium, lead, and mercury), fecal coliform bacteria, and other markers of contamination or pollution.

Each relevant parameter is given a sub-index value based on predetermined standards or recommendations once they have been measured or derived from monitoring data. The total WQI score is then determined by averaging these sub-index values, which are subsequently weighted based on their significance. In order to enable understanding and comparison, the resulting WQI value offers a single number that represents the composite water quality status. This number is frequently classified into multiple classes or grading scales (e.g., excellent, good, fair, and bad).

The intended use and the particular scale or categorization system being utilized can affect how WQI values are interpreted. Higher WQI values generally correspond to higher quality water, whereas lower values correspond to lower quality water. The suitability of water for various applications, including agriculture, aquatic ecosystems, recreational activities, and drinking water supply, can be evaluated using WQI values. The global prevalence of water scarcity, pollution, and mismanagement has escalated, endangering aquatic ecosystems and putting millions of people's access to clean drinking water at risk (Gleick, 1998).

Water resource managers, environmental regulators, researchers, and policymakers utilize the WQI extensively to prioritize management measures, assess and monitor water quality, and discover trends and spatial patterns. In addition to assisting in ensuring the preservation and sustainable use of freshwater ecosystems and the availability of clean, dependable water supplies for human consumption and other uses, it is an invaluable tool for planning, managing, and making decisions about the use of water resources.

The watershed or catchment region surrounding a lake, sometimes referred to as the land use surrounding the lake, is a major factor in influencing the condition and standard of the lake environment. Similarly, changes in land use brought about by industrialization, urbanization, and agricultural growth have exacerbated environmental vulnerabilities by causing habitat loss, degraded soil, and a drop in biodiversity (Foley et al. 2005). This region's land use practices have the potential to significantly affect aquatic habitats, water quality, and ecosystem function as a whole. Here's a closer look at the idea of land use around lakes:

- **Urbanization:** As cities grow, they frequently invade lake basins, increasing the amount of impermeable surfaces like parking lots, buildings, and roadways. Urbanization is a phenomenon that can lead to higher concentrations of contaminants entering the lake through stormwater runoff, including silt, nutrients (such nitrogen and phosphorus), heavy metals, and pathogens. Additionally, habitat loss and fragmentation brought on by urban expansion may change the ecosystem's natural equilibrium in lakes.
- **Agriculture and Allied Activities:** Causes of problems with water quality within a lake's watershed include fertilizer and pesticide runoff as well as silt from farmed areas. Overdraft of nutrients, especially nitrogen and phosphorus from fertilizers, can lead to eutrophication in lakes, which can alter aquatic ecosystems and result in algae blooms and oxygen depletion. A lake's sedimentation can also be caused by soil erosion from agricultural land, which can have an impact on the habitat quality and water clarity. Aquaculture is also a major factor for eutrophication in city lakes.
- **Forestry:** Forestry techniques such as clearing forests, logging, and road construction can have an impact on the hydrology and the ecology of lakes in wooded watersheds. Deforestation can increase the danger of erosion of soil, the formation of sediments and nutrient runoff, particularly after heavy rains or logging operations. Forest management strategies that preserve riparian buffers and reduce landscape disturbance can help to offset these effects and safeguard water quality.
- **Recreation and Tourism:** Lake ecosystems may be impacted by recreational activities like swimming, fishing, boating, and lakeside construction. The development of docks, marinas, and waterfront residences is an example of shoreline development that can result in habitat loss, erosion of the shoreline, and an increase in nutrient inputs from septic tanks, fertilizers, and sewage. The natural integrity of lakes and the landscapes around them can be preserved by limiting recreational usage through buffer zones, zoning laws, and sustainable tourism techniques.

A lake's recreational value, ecological health, and water quality are all significantly impacted by the land use surrounding it. Lake Ecosystem sustainability and long-term health depend on effective use of land planning, sustainable management techniques, and stakeholder involvement.

Study Area:

Gorakhpur district is located in the middle north-east in the Gangetic plain. The Gorakhpur district is located between latitude 26°12’N to 27°6’N and longitude 83°04’E to 83°40’E , which is in the eastern section of the plain of Sarayupar. The area of the district is 3,321 km², which is approximately 1.38% of the territory of Uttar Pradesh. The district stretches 105 kilometers from east to west and 158 km from north to south. The district encompasses the state's north-eastern corner as well as a significant portion of the southern boundary line is parallel to the northern bank of the Ghaghara River. The boundary runs beside Sant Kabir Nagar on the west and borders Deoria on the south and east. The district of Mahrajganj is located in the north whereas Azamgarh and Mau are situated in the south of the district.

The Ramgarh Tal's catchment area is around 1632 acres, of which 1235 acres are within the jurisdiction of the Gorakhpur Development Authority (GDA). It has a total size of around 723 hectares. A sizable portion of the city's population depends on the lake for leisure activities, garbage disposal, irrigation, fishing, drinking water, and washing facilities. The lake's state began to decline in the last several years; its area shrank from 964.02 hectares to 723.45 ha, and its depth dropped from 4.5 meters in 1998 to 3.8 meters in 2006. The dumping of garbage, both liquid and solid, has altered the shape, depth, and water quality of the lake due to unchecked eutrophication, sedimentation, and aquatic weed proliferation.

Objectives:

- Calculate the current status of water quality through Water Quality Index (WQI) and its analysis.
- Point out the factors responsible for the degradation of the water quality in the lake.
- To study the land use pattern of the lake and its role in degradation of lake ecosystem.

Data Source and Methodology:

The following study is primarily based on the comparison between primary and secondary data. The former is observed by the scholar by lab testing and later is collected from published research articles, theses and online sources. The encroachment in the lake is estimated from 2003 to 2023 by toposheet NG 44-8 of Gorakhpur on RF 1:250,000 and other GIS based software and MS Excel is used. The sampling station differs in their land use, nutrient input sources and human activities. Maps are drawn with the help of satellite images, Google Earth and also by Q-GIS software.

Fig: WQI Parameters

From the water sample major 11 physical and chemical parameters, including Potential of Hydrogen (pH), Water hardness, Total Dissolved Solids (TDS), Magnesium, Calcium, Total alkalinity, Dissolved Oxygen (DO), Chloride, Nitrates, Biological Oxygen Demand (BOD) and Sulphate were measured in a lab experiment conducted in September 2023 in accordance with procedures provided by Bureau of Indian Standards (BIS) and World Health Organization (WHO) have suggested for drinking water quality criteria, which have been used to determine the WQI.

Table. 1: Water standards and Recommending Agencies

Parameters	Standards(in mg/l)	Recommending Agencies
pH	6.5-8.5	ICMR/BIS
Total Hardness	300	ICMR/BIS
TDS	500	ICMR/BIS
Magnesium	30	ICMR/BIS
Calcium	75	ICMR/BIS
Sulphate	150	ICMR/BIS
Chloride	250	ICMR
Nitrate	45	ICMR/BIS
DO	5.0	ICMR/BIS
BOD	30	BIS
Total Alkalinity	120	ICMR

Source: Indian Standard (1983) Guidelines for Drinking Water Quality, 2nd Edition, Vol. 1, WHO.
Indian Council of Medical Research (1975) Standards for Drinking Water in India, ICMR, New Delhi.

Calculation of Quality Rating and Unit Weighed of Parameters:
The Water Quality Index (WQI) provides an overall water quality number that can be used for any purpose. It is described as a score that reflects the combined impact of different water quality parameters. One of the best ways to communicate with the public, policymakers, and those who are involved in water quality management and trends in water quality is through the use of indices. The water quality index is formulated by using the intended use of water which determines the relative relevance of different factors. The majority of the time, this is done with taking consideration for human consumption.
The WQI has been calculated by using Weighted Arithmetic Index method (Brown et al. 1972) in steps as follows:
Considering **n** number of water quality parameters and corresponding to n^{th} parameter that reflects relative value of this parameter in the sample polluted water with respect to the standard value. Hence the relationship will be as follows:

$$q_n = \frac{100(v_n - v_i)}{(v_s - v_i)}$$

Where: q_n = Quality Rating for n^{th} parameter
v_n = Observed Value for n^{th} parameter
S_n = Standard Value for n^{th} parameter
v_i = Ideal Value for n^{th} parameter

In most of the cases the Ideal Value of maximum parameters is zero ($v_i = 0$). But in pH and Dissolve oxygen the value is 7 and 14.6mg/l respectively.
Hence, Quality Rating for pH (q_{pH}) = 100(v_{pH} - 7) / (8.5 - 7)
Quality Ration for Dissolve Oxygen (q_{DO}) = 100(v_{DO} – 14.6) / (5-14.6)

Calculation of Unit Weighed: The Unit Weighed (w_n) of various water quality parameters is inversely proportional to the provided standards for the corresponding parameters. The w_n values of this study are taken from Krishna et al., 1995.

$$w_n = \frac{K}{S_n}$$

Where: w_n = Unit Weighed of n^{th} parameter
S_n = Standard permissible value of n^{th} parameter
K = Constant of Proportionality $\left[K = \frac{1}{1/S_n}\right]$

Table: 2: Calculation of Water Quality Index (WQI) of Ramgarh Tal 2017 and 2023.

S. No.	Parameters	Standard Values	Observed Value		Quality Rating (q_n)		Unit Weighed (w_n)		$q_n * w_n$	
			2017	2023	2017	2023	2017	2023	2017	2023
1.	**pH**	6.5-8.5	7.70	8.72	46.66	114.67	.2205	.2648	10.29	30.36
2.	**Total Hardness**	300	320	260	106.6	86.67	.0063	.0075	0.67	0.65
3.	**TDS**	500	410	380	82.00	76	.0038	.0045	0.31	0.34
4.	**Magnesium**	30	22	21	73.33	70	.0625	.0750	4.58	5.25
5.	**Calcium**	75	44	38.68	58.66	51.57	.0250	.0300	1.46	1.55
6.	**Sulphate**	150	85	88.34	56.66	58.89	.0125	.0150	0.70	0.88
7.	**Chloride**	250	110	138.67	44	55.47	.0075	.0090	0.33	0.50
8.	**Nitrate**	45	38	37	84.44	82.22	.0417	.0500	3.52	4.11
9.	**DO**	5.0	5.0	6.87	79.16	80.52	.3750	.4502	29.69	36.25
10.	**BOD**	30	21.1	22.48	70.06	74.93	.0625	.0750	4.38	5.62
11.	**Total Alkalinity**	120	120	42.72	58.33	35.6	.0156	.0187	0.91	0.67
	Total				$\sum q_n$= 759.9	$\sum q_n$= 786.54	$\sum w_n$= 0.8329	$\sum w_n$= 0.9997	$\sum q_n * w_n$= 56.84	$\sum q_n * w_n$ =86.18

Source: Data of 2017 is taken from Jaiswal and Yadav, 2023 Encroachment and Deterioration Scenario of lake – A Case Study of Ramgarh Tal, Gorakhpur, Uttar Pradesh
Data of 2023 is calculated by author through Lab Testing.

Final value of Water Quality Index (WQI) is calculated by following relationship:

$$\boldsymbol{WQI = \frac{\sum(q_n \times w_n)}{\sum w_n}}$$

Where: q_n= Quality Rating for n[th] parameter
w_n = Unit Weighed of n[th] parameter

The WQI values for human consumption is classified according to Mishra and Patel, 2001 are as follows:

WQI Values	Status	Grading
0-25	Excellent	A
26-50	Good	B
51-75	Bad/Poor	C
76-100	Very Bad/Very poor	D
>100	Unfit for Drinking	E

WQI of 2017: $\frac{\sum(q_n \times w_n)}{\sum w_n} = \frac{56.84}{0.8329}$ = 68.243 {Lies in the Poor/Bad category for drinking purpose.}

WQI of 2023: $\frac{\sum(q_n \times w_n)}{\sum w_n} = \frac{86.18}{0.9997}$ = 86.188 {Lies in the Very Poor/ Very Bad category for drinking purpose.}

Assessment of Water Quality based on WQI:

WQI is a number which represents the status of the water which is suitable for drinking or suitable for other human purposes. It is derived through the relationship established among the aforementioned parameters given earlier. The WQI value of 2017 and 2023 is taken for comparison as mentioned in Table No.2. The value ranges between 0 to >100 (Mishra and Patel, 2001). The value ranges from 0 to 25 shows the excellent and safest water for drinking while on the other hand the value 100 or more is unfit for drinking or highly polluted water that cannot be even used for other human purposes. Some major changes related to WQI parameters have been noticed that have gone through drastic change in recent years due to increased human interference in the lake or around it.

- **Potential of Hydrogen (pH):** According to ICMR the standard value for pH should be between 6.5-8.5 units, but the value of observed water sample has slightly higher pH i.e. 8.72 while in 2017 it was much lower at 7.70. This shows that the water has become more alkaline in recent years. The major reasons can be agricultural runoff taking lime rich fertilizers and gypsum with it, household wastes, industrial waste water discharge etc.
- **Total Hardness:** Total hardness means the sum of Calcium and Magnesium concentrations. It is expressed as Calcium Carbonate in milligrams per liter (mg/L). The permissible amount of harness should not more than 300 (ICMR, 1975). In 2017 the amount of Total Hardness in the lake was 320 mg/L while in 2023 it is decreased to 260 mg/L. The variation among the ions of Calcium, Magnesium, Iron, and Manganese causes the variation in the total hardness in the water.

- **Total Dissolve Solids (TDS):** As expressed by its name it shows the total dissolved solids substances in the water body, it comprises of organic and inorganic salts such as sodium, calcium, potassium, magnesium and others. TDS value of Ramgarh Tal in 2017 was 410mg/L and decreased to 380mg/L in 2023. The both readings are under the permissible value of ICMR. The major factors which lead to higher TDS in Ramgarh Tal are agricultural runoff, untreated water flow, residential runoff, industrial and commercial discharge. Here we can see the TDS value decreased in recent years, it is only because of good administrative management, sewage treatment plants, spreading awareness among public and due to developing the Tal as a tourist place in near future.
- **Magnesium:** The permissible value for Magnesium in water should not be more than 30mg/L. The study shows that in 2017 the value of magnesium was only 22mg/L and later in 2023 the value slightly decreased to 21mg/L and both the value is under the highest limit of ICMR. Magnesium is essential for human health; magnesium in water is more easily absorbed by the human body than magnesium in food. Persons who drink water with high amount of magnesium are safe from magnesium deficiency syndrome. It also acts as an essential micronutrient for organic matters of lake that results in a healthy lake ecosystem.
- **Calcium:** in 2017 the value of calcium in Ramgarh was 44mg/L but later in 2023 it is decreased to 38.68mg/L and the permissible amount is up to 75mg/L. here we can see that the amount of calcium is much lower than the limit. Various factors like urbanization (impervious surfaces), water pollution, altered hydrology, sedimentation nutrient enrichment and faulty land use practices prohibit the runoff of calcium rich waters to lakes.
- **Sulphate:** Study shows that a slight increase of 3.93% from 85mg/L in 2017 to 88.34mg/L in 2023. The ICMR upper limit of sulphate is 150mg/L but both the readings are under it. The lower level of sulphate is due to source control and pollution prevention, storm water management, wastewater treatment, nutrient management, monitoring and research has helped the government to reduce the sulphate levels in the lake.
- **Chloride:** According to ICMR the permissible value for chloride is 250mg/L but the study shows that in 2017 it was only 110mg/L and in 2023 it was recorded 138.67mg/L. The main attributes of Chloride are industrial discharge, urban runoff, wastewater effluents, land use practices, atmospheric deposition and natural sources.
- **Nitrate:** ICMR recommended the Nitrate present in water should not exceed 45mh/L and in 2017 the amount was 38 and in 2014 it was decreased by 1 mg/L. The sources of Nitrates are fertilizer’s nitrate i.e. ammonium nitrate and urea, nitrogen oxides (NOx), discharge of sewer wastes although it is being trated by the Nagr Nigam Gorakhpur but some residue are being mixed and making it nitrate rich water.
- **Dissolve Oxygen:** The amount of oxygen particles that are dissolved in lake water is known as dissolved oxygen (DO). Since DO is necessary for aerobic respiration the mechanism by which organisms obtain energy from organic matter it is a crucial parameter for the wellbeing and existence of aquatic organisms. The amount of DO in lake water can change based on a number of variables, including salinity, temperature, pressure, and biological activity. Higher the atmosphere's pressure can raise the amount of dissolved oxygen (DO), and colder water can generally store more DO than warmer water. On the other hand, a high salinity might make oxygen less soluble in water. In 2017 the reading shows 5mg/L oxygen dissolved in the water but in 2023 it is increased to 6.87mg/L ultimately causing eutrophication. Here in Ramgarh Tal the high level of DO is due to incoming trace amount of urea, nitrate rich runoffs and commercial untreated water discharge in the lake by car service stations and micro and small industries.

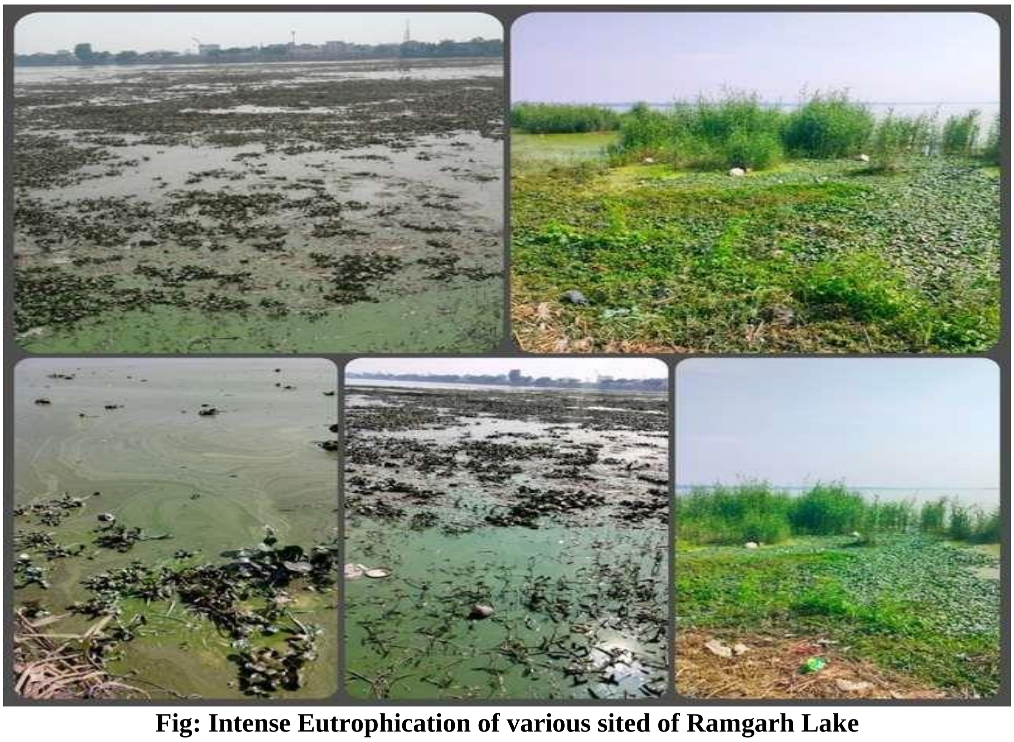

Fig: Intense Eutrophication of various sited of Ramgarh Lake

- **Biological Demand of Oxygen:** According to BIS the highest amount of demand of oxygen should be 30mg/L. In 2017 the value showed 21.1mg/L and in 2023 it was slightly higher to 22.48mg/L. Earlier in 2013 it was recorded 10.30mg/L (Jaiswal & Yadav, 2023). So it is clear that demand of oxygen in the lake has been increasing in recent years due to eutrophication discussed in Dissolve oxygen.
- **Total Alkalinity:** To determine total alkalinity, sample of lake’s water was taken and acid was mixed into it to raise the sample's pH to 4.2. At this pH, the sample's entire compound of alkaline chemicals has been "used up." The outcome is expressed in calcium carbonate milligrams per liter (mg/l). ICMR recommended it to be less than 120mg/L. In 2017 the value was 120mg/L i.e. the highest limit but in 2023, sample showed it only 42.72mg/L. This decrease in the alkalinity was only achieved by putting checks on runoffs and commercial waste dumping.

Fig: Major untreated waste water Inlets of Ramgarh Lake

Fig: Government institutions to cope with degradation of Ramgarh Lake

Conclusion:

This research article is based on the interrelationship among major 11 physio-chemical parameters that is used in assessing the water quality index. The WQI of Ramgarh Tal in 2017 was 68.243 which was according to Mishra and Patel, 2001 falls in Poor/Bad quality or Grade C for drinking purpose while it was deteriorated in 2023 and got the value of 86.188 which falls under Very bad/ Very poor quality or Grade D. The important problem of the region's diminishing water quality is clarified in this report. The study has revealed the concerning levels of pollution in Ramgarh Tal and found numerous sources of contamination through thorough analysis and inquiry. The results highlight the critical need for efficient management plans and legislative actions to stop more deterioration and protect the health and welfare of the nearby communities that depend on this water source. Additionally, the study emphasizes how crucial it is for stakeholders to work together and conduct continuous monitoring in order to handle the intricate problems brought on by the region's declining water quality.

Government and environmental stakeholders can cooperate to restore and preserve the integrity of Ramgarh Tal and ensure future generations have access to sustainable and secure water resources by implementing targeted interventions and raising awareness. Furthermore, the study emphasizes how many environmental elements that affect Ramgarh Tal's water quality are interrelated. Urbanization, industrial discharge, and agricultural runoff are a few examples of the factors that have been found to contribute significantly to pollution, highlighting the necessity for comprehensive solutions to these intricate problems. The study's conclusions can also direct the creation of policies and the distribution of funds for focused actions meant to enhance the quality of the water.

The study on Ramgarh Tal's water quality index (WQI) not only highlights the need for immediate action and identifies the sources of contamination, but it also offers important insights into the general condition of this important body of water. Through the computation of the WQI, the research provides a numerical value that encompasses several aspects related to water quality, facilitating an all-encompassing evaluation of its state. The calculated WQI score is an important metric that shows how far degradation has progressed and helps to prioritize management actions. The research, which focuses on the water quality index (WQI) of Ramgarh Tal, advances our knowledge of the dynamics of water quality and acts as a spur to action. It gives stakeholders a foundation on which to work together to create sustainable management plans that includes pollution prevention, water treatment, and conservation methods. Beside the lake, conservation steps like Sewage Pumping Stations by Ministry of Environment Forest and Climate change under National Lake Conservation Plan (NLCP) has been implemented to cope with pollution of water and degradation. In the end, the knowledge gained from this study can direct initiatives to maintain and repair Ramgarh Tal's ecological integrity, guaranteeing the water resource's continuous existence as a vital supply for ecosystem health and human use.

References:

1. Mishra P. C. and Patel R. K., Study of the pollution load in the drinking water of Rairangpur, a small tribal dominated town of North Orissa, Indian J. Environment and Ecoplanning, 5(2): 293-298, (2001).
2. Mahapatra, D.G., Chanakya, H.N. and Ramchandra, T.V., 2011, Role of Macrophytes in Sewage Fed Urban Lake,I*nstitute of Integrative Omics and Applied Biotechnology Journal* (IIOABJ), Vol. 2,Issue 8, pp. 1-9.
3. Pandey, A.K., Prakash, C., 2016, Monthly Variation in Physicochemical Parameters of Water of Ramgarh Lake, Gorakhpur(India), *Journal of Experimental Zoology*,Vol.19, No.1, pp. 111-121.
4. Pant, M.C., Sharma, P.C., Sharma, A.P. and Gupta, P.K., 1985, The Himalayan Lake Ecosystem, in edited by Singh, J.S., *Environmental Regeneration in Himalaya-Concepts and Strategies*, Published by the Central Himalyan Environment Association and Gyanodaya Prakashan, Naini: Tal India, pp. 339-348.
5. Sharma, V.N., 2001, The Status of Ramgarh lake, Gorakhpur, *Geographical Review of India*, Kolkata, Vol. 63(1), March, pp. 68-77.
6. Singh, A and Sharma, V.N., 2018, A Stewardship of Ramgarh Lake In Gorakhpur District: Uses, Problems And Management, Transaction, *Institute of Indian Geographers*, Vol. 40, No. 1, pp. 33-43.
7. Singh, A and Sharma, V.N., 2018, Deteriorating Scenario of Lakes: A Case Study of Ramgarh Lake , India , *National Geographical Journal of India*, Vol. 64 No.1-2, pp. 128-143.
8. Tiwari, F., 2013, Limnological Studies of Ramgarh Lake in eastern Uttar Pradesh, India, *African Journal of Basic & Applied Sciences*, and ISSN: 2079-2034, DOI:10.5829/idosi.ajbas.2013.5.3.7397, pp.145-148.
9. Mündel, T., King, J., Collacott, E., & Jones, D. A. (2006). Drink temperature influences fluid intake and endurance capacity in men during exercise in a hot, dry environment. Experimental physiology, 91(5), 925-933.
10. Sandick, B. L., Engell, D. B., & Maller, O. (1984). Perception of drinking water temperature and effects for humans after exercise. Physiology & behavior, 32(5), 851-855.
11. Wimer, G. S., Lamb, D. R., Sherman, W. M., & Swanson, S. C. (1997). Temperature of ingested water and thermoregulation during moderate-intensity exercise. Canadian Journal of Applied Physiology, 22(5), 479-493.
12. Brunstrom, J. M. (2002). Effects of mouth dryness on drinking behavior and beverage acceptability. Physiology & behavior, 76(3), 423-429.
13. Eccles, R., Du-Plessis, L., Dommels, Y., & Wilkinson, J. E. (2013). Cold pleasure. Why we like ice drinks, ice-lollies and ice cream. Appetite, 71, 357-360.
14. LaFata, D., Carlson-Phillips, A., Sims, S. T., & Russell, E. M. (2012). The effect of a cold beverage during an exercise session combining both strength and energy systems development training on core temperature and markers of performance. Journal of the International Society of Sports Nutrition, 9(1), 44.

15. Gorakhpur Environmental Action Group, 2009, *Saving a Dying Lake: The Case of Ramgarh Tal in Gorakhpur, Uttar Pradesh*, Institute for Social and Environmental Transition, Rock feller foundation, pp. 1-20.
16. Lavery, H.J., 1975, Water conservation and water fowl in northeastern Australia, inedited by Stanley, N.F. and Alpers, M.P., *Man-Made Lakes and Human Health*, Academic Press London, New York, San Francisco, A Subsidiary of Harcourt Brace Jovanovich, Publishers, pp. 277-292.