E-ISSN: 2706-8927
P-ISSN: 2706-8919
www.allstudyjournal.com
IJAAS 2024; 6(5): 144-146
Received: 06-04-2024
Accepted: 10-05-2024

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Physicochemical assessment of water quality in the Hiran River at the confluence of Umrethi reservoir, Gir-Somnath

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DOI: https://www.doi.org/10.33545/27068919.2024.v6.i5b.1701

Abstract
A water quality assessment was conducted on the Hiran River across the 2022 - 2023 pre-monsoon, post-monsoon, and winter seasons to determine the effects of human activity and sewage disposal. The methodology involved testing a comprehensive suite of physico-chemical parameters including pH, Electrical Conductivity (EC), alkalinity, total hardness, key ions (calcium, magnesium, potassium, fluoride, chloride), nutrient loads (nitrate, nitrite, phosphate), and pollution indicators (Dissolved Oxygen, BOD, COD, salinity) at sites spanning the river from its source through rural, urban, and underdeveloped zones. The observed deterioration in water quality was chiefly linked to anthropogenic sources, such as unauthorized sewage and industrial runoff, a lack of proper site protection, and general urban runoff. The overall conclusion is that the Hiran River water is moderately polluted, though parameter ranges generally remained within acceptable limits.

Keywords: Physicochemical parameters, water quality, hiran river, Umrethi reservoir, seasonal variation, pollution indicators, anthropogenic impact

Introductions
The Hiran River, a vital waterway in Gujarat, Western India, originates near the Sasa hills within the Gir Forest. Indian rivers have historically served as lifelines, and the Hiran, with its total catchment area of 518 km2, is no exception. Its main tributaries, including the Sraswati River and Ambakhoi Stream, contribute to the river system, which ultimately drains into the Arabian Sea near the Somnath temple. The river flows for a maximum length of 40 km, supporting a rich wildlife ecosystem and several human settlements. Major infrastructural projects, such as the Kamleshwar Dam (also known as Hiran-1) and the Umrethi Dam, are built along its course. Flowing from the western side of the Gir Forest, the Hiran River remains a crucial, year-round water source for the region's ecology and biodiversity.

River water offers multiple essential services, including providing drinking water for countless rural and urban communities and livestock, supporting fish culture, recharging groundwater, and aiding in flood control (Shanmugam *et al*., 2006) [20]. Globally, surface sources like rivers, dams, lakes, and canals meet one-third of the world's drinking water requirements (Jannalagada *et al*., 2001) [8]. Consequently, many researchers, particularly in India, have routinely studied the physicochemical and biological characteristics of these water bodies, including rivers and reservoirs, across different locations and time periods (Mathew, *et al*., 1999) [13].

Materials and Methods
Originating in the central Gir Forest at the Sasa hills (21∘20′ N, 70∘88′ E), the Hiran River flows 40 km across a 518 km2 catchment area, merging with the Arabian Sea (20∘89′ N, 70∘40′ E). This vital system, completed near Talala by tributaries like the Sraswati River and Ambakhoi Stream, is a primary, year-round water source for the western forest's biodiversity and surrounding human settlements. The river's flow is regulated by major infrastructure, including the Kamleshwar Dam (Hiran-1) and the Umrethi Dam (Hiran-2).

Three sampling points are selected from the river water samples near Umrethi reservoir confluence. Fieldwork was conducted seasonally, encompassing the pre-monsoon, post-

monsoon, and winter periods throughout the year from three sampling points are selected from the river water samples near Umrethi reservoir confluence. Water samples were collected in triplicate from three stations near Umarethi along the Hiran River, with laboratory analysis initiated immediately upon sample collection. Standard protocols were followed for both sampling and analysis. The physicochemical characteristics were determined using specific established methods: Temperature was measured with a temperature probe; pH and EC via the Electrometric method; Turbidity using the tube method; and Dissolved Oxygen (DO) by the Winkler's method. Parameters including Alkalinity, Total Hardness, Chloride, Salinity, Calcium, Magnesium, COD, BOD, Oil and Grease, and Fluoride were analyzed using titrimetric methods. Finally, Nitrate, Nitrite, Nitrogen, Phosphorus, Potassium, and Phosphate were measured with standard methods (APHA 14th edition).

Results and discussion

Data sampling period from September 2022 to August 2023 the recorded observation is tabulated with mean and standard deviation in table 1 and 2.

Table 1: Physico- chemical parameters from Hiran River at Umrethi.

Parameter	P	K	Ca	Mg	COD	BOD
Premonsoon	0.61	3.21	58.22	68.23	18.30	5.41
Monsoon	0.74	3.79	51.21	68.65	14.21	4.25
Postmonsoon	0.95	4.12	75.26	42.21	4.50	4.80
Mean Value	0.76	3.70	61.56	59.69	12.33	4.80
Standard Deviation	0.17	0.46	12.36	15.14	7.08	0.60

Table 2: Physico- chemical parameters from Hiran River at Umrethi.

Parameter	pH	EC	Alkalinity	Total hardness	DO	Nitrate	Nitrite
Premonsoon	8.3	0.49	59.42	120	4.21	0.43	0.35
Monsoon	8.0	0.51	62.51	128.20	4.61	0.59	0.42
Postmonsoon	8.49	0.42	66.53	152.10	5.23	0.42	0.43
Mean Value	8.26	0.47	62.82	133.43	4.68	0.48	0.40
Standard Deviation	0.25	0.05	3.57	16.68	0.51	0.10	0.04

pH: The pH plays a significant role in productivity of the water body. Hiran river was found to be alkaline in nature and a wide range of pH observed during the study period with values ranging from 8.0 to 8.49. Higher average values of pH was found during summer season, may be due to increased photosynthetic activity and bacterial decomposition of organic matter. Kanan and Job (1979) [10], Jadhav and Deshmukh (2006) [7], Jindal and Gusain (2007) [9], Mishra *et al*. (2008) [14], Sinha and Biswas (2011) [24] and Saxena & Saxena (2012) [15] have found similar results in different water bodies.

Dissolved Oxygen: DO observed at Hiran river was in the range 4.21 to 5.23 during the study period. Dissolved oxygen in water body is result of wind action, vertical circulation of water body as well as photosynthesis of plant matter. Minimum mean value of 4.21 was reported for DO from Hiran during summer might be due to increased rate of decomposition of organic matter, and rise in temperature while maximum mean values of 5.23 was observed during monsoon due vertical circulation brought about by wind action and fluviatile condition of river during monsoon. Similar results were obtained by Sahu *et al.* (2000) [18], Naz and Turkmen (2005) [17] and Singh and Singh (2011) [23].

Conductivity: The conductivity of water depends upon ions present in water. The electrical conductivity of station ranged between 0.42 to 0.51. Higher value of conductivity can be harmful to soil structure and can cause salinity hazard on the water body Low values of electrical conductivity of monsoon in the present investigation corresponds dilution of water during rainy season which causes decrease in electrical conductance due to addition of rain water in the river whereas higher value of electrical conductivity in summer may be attributed to decrease in the water level, higher temperature and high rate of evaporation and resultant increase in decomposition rate of organic matter at the site. Natural waters usually have EC values of 20 to 1500 *µmhos cm*-1 (Boyd, 1978). However, the standard limit set by WHO is 250 *µmhos*/cm. Similar observation was made by Das (2000) [3], Sulabha and Prakasam (2006) [21]. Krishnamurthy *et al.* (2010) [11], Sharma *et. al*. (2011) [22].

The total alkalinity is the sum total of carbonates and bicarbonates, a measure of capacity of water to neutralize strong acid. Total alkalinity is important parameter determining the productivity of the water body. Water with alkalinities of more than 50 ppm are most productive of fish, whereas waters with alkalinity of less than 10 ppm rarely produce large crops, The present investigation revealed the narrow range of values from 59 to 66 mg/l. The maximum permissible limit of alkalinity is 66 mg/l for drinking water (WHO). Mean values of alkalinities 62 mg/l were observed during the present study. Similar observations were made by Nair and Rajendra (2000) [16], Bade *et al*. (2009) [2], Verma *et al*. (2012) [26] and Meenakshi Saxena (2012) [15].

Total Hardness of water body is mainly governed by the content of calcium and magnesium salts. The observed total hardness values ranged between 120 to 152 mg/l indicates the Hiran river is moderately hard. Higher mean values of hardness was observed during post monsson. Similar behavior of total hardness was recorded by Khan *et al*. (1986) [12], Khadade and Mule (2003), Shyam Sunder and Khatri (2015) The calcium and magnesium concentration in the present study observed from 61 and 59 mg/l. respectively.

Nitrate: Organic pollution in the water body can be judged by Nitrate-Nitrogen. The nitrates are an important source of nitrogen for phytoplankton. Nitrate represents the highest oxidized form of nitrogen. The values of nitrate ranged between 0.35 to 0.43 mg/l in the current study.

Phosphates are essential nutrients for plant growth in water body (Jhingran, 1982) [6] but in higher concentration causes eutrophication. Through the natural process of weathering, the rocks gradually release the phosphorus as phosphate ions which are soluble in water. In the present investigation

the maximum values of 0.75 mg/l. Phosphates were found during more concentration post monsoon. This is in agreement with the Khan and Parveen (2012) [12].

Biochemical oxygen demand is important parameter in estimating the pollution status of sewage and domestic waste. It indicates the presence of biodegradable organic matter quantitatively, which consumes dissolved oxygen from the water. The higher values of BOD produce obnoxious smell and unhealthy environment. In the present study the BOD values ranged from 4.2 to 5.41 mg/l. Desirable limit for BOD is 4.0 mg/l and permissible limit is 6.0 mg/l according to Indian standards. Present study reveals the Hiran site with moderately higher polluted water. Higher BOD values were observed during the summer months due to elevated microbial activity at higher temperature. Similar results were observed by Sachidanandamurthy and Yajurvedi (2004) [19] Devaraju *et al*. (2005) [14], Garg *et al* (2009) [5].

Conclusion

This investigation reveals that water quality of Hiran river experiences seasonal fluctuations of physico-chemical parameters. The data of present study clearly reflect that the water of Hiran river site is moderately polluted

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