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Water Quality Index Analysis of Pamba River and Mannar Panchayat

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ABSTRACT: The Pamba river, a vital water source in Kerala passing through the districts of Alappuzha, Pathanamthitta and Kottayam, has been facing significant pollution challenges, particularly in the stretch between Nedumudi to Mannar. This study aims to assess the water quality of this section using the Water Quality Index (WQI), a comprehensive tool that integrates various water quality parameters into a single value. The analysis focuses on key indicators such as pH value, Total Dissolved Oxygen (TDS), Turbidity, Total alkalinity, Total hardness, Electrical conductivity, Acidity, Calcium, Sulphate, Fluoride, Iron and Nitrates, which reflect the extent of pollution and the river's overall health. Samples collected from various locations along the river's course are analyzed to understand the water quality.

KEYWORDS: Water quality index, Index calculation, Water pollution, Environmental monitoring

I. INTRODUCTION

The Pamba River, Kerala's third-longest river, is a vital source of drinking water for Pathanamthitta and Alappuzha districts. However, the river's health is under threat due to illegal construction projects along its banks. The unauthorised structures, which include even two- storey buildings with restrooms, lodging and dining facilities, pose significant environmental risks. During the monsoon season, the structures obstruct floodwater flow, leading to riverbank erosion and destruction. Mannar Panchayat, a coastal region in Kerala which is situated near Pamba river, is facing significant environmental challenges due to pollution in its water bodies. The area's water environment is under threat from various sources, including industrial effluents, agricultural runoff, domestic waste, and natural factors. This pollution not only affects the aquatic ecosystem but also poses serious health risks to the local population, who rely on these water sources for drinking, fishing, and other livelihood activities. The objective of this study is to investigate the water quality in Pamba river and Mannar Panchayath.

II. LITERATURE SURVEY

Thomas et al (2020) conducted a water quality analysis, indicating high levels of biochemical oxygen demand (BOD), chemical oxygen demand (COD), and fecal coliforms, particularly due to domestic sewage. Galal Uddin et al (2021) discusses about various Water Quality Index models used for various studies. According to them, in order to find the Water Quality Index, the water quality parameters of interest are selected. The water quality data are read next and for each water quality parameter the concentrations are converted to a single-value dimensionless sub-index. Weighting factor for each water quality parameter is determined in the next step. Water quality index is calculated as a single value by an aggregation function using the sub-indices and weighting factors

III. METHODOLOGY

The methodology consists of referring literature review, field data collection, data analysis, interpretation,, reporting and dissemination. Literature Review: An examination of existing studies, and practices related to the topic was conducted to establish a strong theoretical foundation and identify knowledge gaps. Stakeholder Engagement: Key stakeholders, including, will be involved through interviews, surveys, and workshops to gather insights, identify priorities, and ensure the relevance of the research. Field Data Collection: A combination of quantitative and qualitative data collection techniques will be employed, such as Surveys, Interviews Observations, Document Analysis. The sampling collection method for water quality analysis follows standard procedures as per BIS (Bureau of Indian

Standards) IS 3025, Standard Methods, and ISO 5667 guidelines. Water samples along along Paamba river at locations, Nedumudi, Veeyapuram, Cheruthana, Thakazhi, and Mannar are collected. Water samples from in Mannar Panchayat are also used to assess the water quality in the Panchayat area. Various parameters of water quality are tested in laboratories and Water Quality Index for various locations are estimated. WQI values are compared with the standard values and water quality levels are decided.

IV. DATA COLLECTION AND ANALYSIS

Water samples were collected from different locations viz. Cheruthana, Thakazhi, Nedumudi, Mannar and Veeyapuram along Pamba River. Different locations of water sample collection along Pamba river are shown in Photo 1 to Photo 4. Water samples from households in Mannar Panchayat was also collected to assess the water quality in Mannar Panchayat area.



Photo 1` Nedumudi

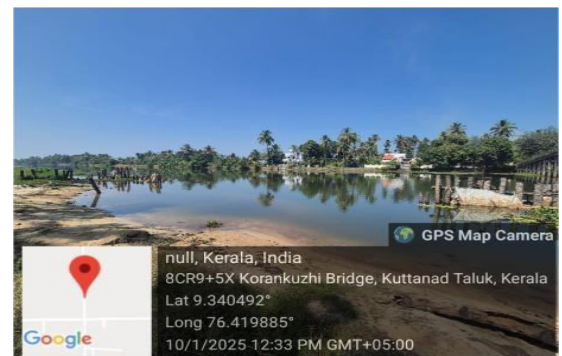


Photo 2 Cheruthana

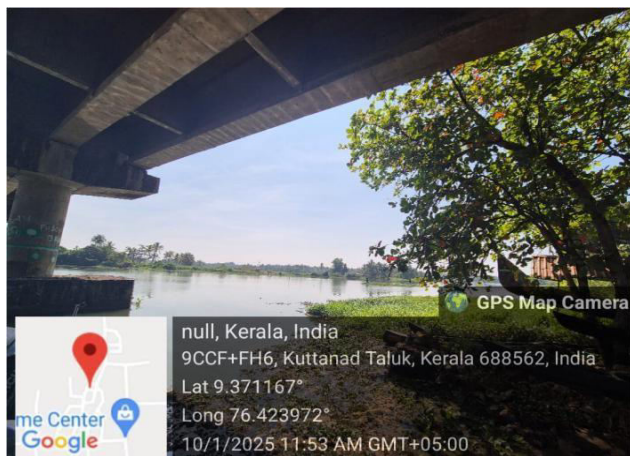


Photo 3 Nedumudi



Photo 4 Mannar



Fig 5.5 Bar chart for total hardness of water samples from different places

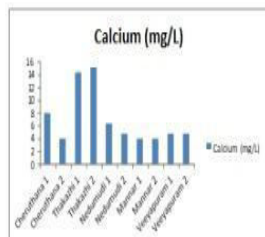


Fig 5.6 Bar chart for calcium in water samples from different places

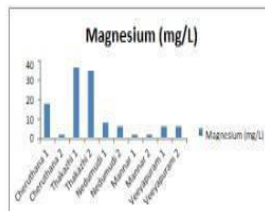


Fig 5.7 Bar chart for magnesium in water samples from different places

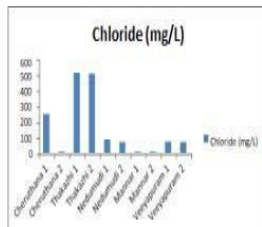


Fig 5.8 Bar chart for chloride in water samples from different places

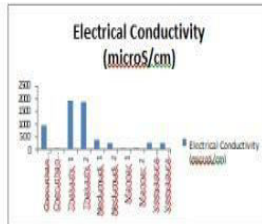


Fig 5.9 Bar chart for electrical conductivity of water samples from different places

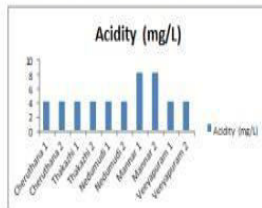


Fig 5.10 Bar chart for acidity in water samples from different places

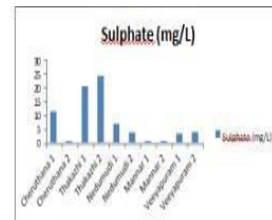


Fig 5.11 Bar chart for sulphate in water samples from different places

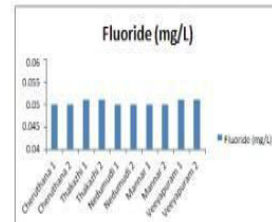


Fig 5.12 Bar chart for fluoride in water samples from different places

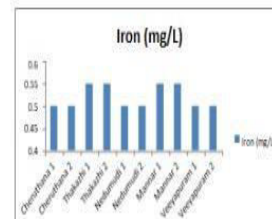


Fig 5.13 Bar chart for iron in water samples from different places

Figure 1 Water quality parameters in sampling locations

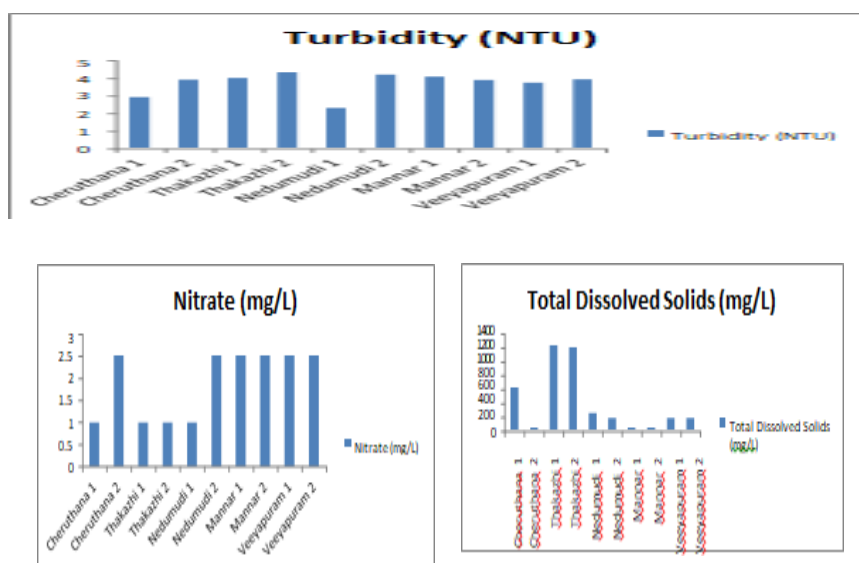


Figure 2 Water quality parameters in sampling locations

Steps involved in estimation of WQI are given here

Water Quality Index (WQI) is as follows: $WQI = \frac{\sum W_n \cdot Q_n}{\sum W_n}$

$$W_n = K / S_n$$

Where W_n is the Weightage of each parameter, K is the Proportionality constant and S_n is the Standard value of each parameter.

K is calculated using the equation given below:

$$K =$$

$$\frac{\sum_{i=1}^n \frac{1}{S_n}}{\sum_{i=1}^n \frac{1}{S_n} + \sum_{i=1}^n \frac{1}{V_i}} \quad 1$$

Sum of reciprocal of standard value of each parameters

$$Q_n = 100 \times \frac{(S_n - V_i)}{(S_n - V_i)}$$

$$(S_n - V_i)$$

where Q_n is the Quality rating of each parameter, V_n is the Observed value of each parameter and V_i is the Ideal value of each parameter.

$V_i = 0$, for all parameters except pH, $V_i = 7$ for pH

Table 1 Water Quality Assessment in terms

Water Quality Index	Water Quality
0-25	Excellent Quality
25-50	Good Quality
50-75	Poor Quality
75-100	Very Poor Quality

WQI values for different locations along Pamba river are estimated in Table 2 to Table 6. Values obtained from these analysis are compared with the water quality standard and a decision of water quality is made on the particular location.

Table 2 Water Quality Index -Cheruthana

Parameter	Std Value (S_n)	Observed Value (V_n)	W_n	Q_n	$WQI = \frac{W_n * Q_n}{\sum W_n}$
Turbidity	5	3.88	0.082	77.6	.62
pH	7.5	7.51	0.05	100	5
Total Dissolved Solids	500	26.47	0.0008	5.29	0.004
Total Hardness	200	16	0.002	8	0.016
Calcium	75	4.01	0.005	5.35	0.026
Magnesium	30	1.46	0.013	4.86	0.06
Sulphate	200	0.5	0.002	0.5	0.001
Fluoride	1	0.05	0.41	10	4.14
Iron	1	0.5	0.41	50	20.7
Nitrate	45	2.5	0.09	5.55	0.04
					Total WQI= 30.6

Table 3 Water Quality Index -Thakazhi

Parameter	Std Value (S _n)	Observed Value (V _n)	W _n	Q _n	WQI= $W_n * Q_n / \sum W_n$
Turbidity	5	3.97	0.082	79.4	0.63
pH	7.5	6.77	0.05	90.26	4.96
Total Dissolved Solids	500	1228	0.0008	100	0.08
Total Hardness	200	184	0.002	92	0.18
Calcium	75	14.43	0.005	19.24	0.09
Magnesium	30	35.96	0.013	100	1.55
Sulphate	200	20.6	0.002	10.3	0.02
Fluoride	1	0.051	0.41	10	4.14
Iron	1	0.55	0.41	70	28.98
Nitrate	45	1	0.09	4.44	0.03
					Total WQI= 40.66

Table 4 Water Quality Index - Nedumudi

Parameter	Std Value(S _n)	Observed Value (V _n)	W _n	Q _n	WQI= $W_n * Q_n / \sum W_n$
Turbidity	5	2.26	0.082	45.2	0.36
pH	7.5	7.25	0.05	50	2.75
Total Dissolved Solids	500	243.1	0.0008	48.62	0.03
Total Hardness	200	48	0.002	24	0.048
Calcium	75	64.1	0.005	8.5	0.042
Magnesium	30	7.78	0.013	25.9	0.33
Sulphate	200	6.87	0.002	3.43	0.006
Fluoride	1	0.05	0.41	10	4.14
Iron	1	0.5	0.41	50	20.7
Nitrate	45	1	0.09	4.44	0.039
					Total WQI=28.44

Table 5 Water Quality Index -Mannar

Parameter	Std Value(S_n)	Observed Value (V_n)	W_n	Q_n	$WQI = \frac{W_n * Q_n}{\sum W_n}$
Turbidity	5	4.05	0.082	81	6.7
pH	7.5	7.43	0.05	86	4.73
Total Dissolved Solids	500	26.8	0.0008	5.36	0.004
Total Hardness	200	16	0.002	8	0.016
Calcium	75	4.01	0.005	5.35	0.026
Magnesium	30	1.46	0.013	4.8	0.063
Sulphate	200	0.5	0.002	0.5	0.001
Fluoride	1	0.05	0.41	10	4.14
Iron	1	0.55	0.41	60	24.84
Nitrate	45	2.5	0.09	5.56	0.05
					Total WQI= 40.57

Table 6 Water Quality Index -Veeyapuram

Parameter	Std Value(S_n)	Observed Value (V_n)	W_n	Q_n	$WQI = \frac{W_n * Q_n}{\sum W_n}$
Turbidity	5	3.72	0.082	74.4	5.95
pH	7.5	7.25	0.05	50	2.75
Total Dissolved Solids	500	168.2	0.0008	33.64	0.026
Total Hardness	200	36	0.002	18	0.036
Calcium	75	4.81	0.005	6.41	0.032
Magnesium	30	5.83	0.013	19.4	0.253
Sulphate	200	3.26	0.002	1.6	0.003
Fluoride	1	0.051	0.41	10	4.14
Iron	1	0.5	0.41	50	20.7
Nitrate	45	2.5	0.09	5.5	0.04
					Total WQI =33.93

All locations under study along the Pamba river has good quality water , in the range of 25 to 50, with WQI ranging from 28.44 to 40.66

Table 7 WQI of household Samples

Sample	Parameter	Std value (S _n)	Observed value (V _n)	W _n	Q _n	WQI= $W_n * Q_n / \sum W_n$	Total WQI
S1	Turbidity	5	5.47	0.082	100	8.2	28.21
	TDS	500	85.77	0.008	8.6	0.008	
	Cl	250	7.88	0.004	3.2	0.01	
	F	1	0.39	0.8	26	20	
S2	Turbidity	5	0.4	0.82	8	6.56	11.13
	TDS	500	180.7	0.008	18.1	0.14	
	Cl	250	24.64	0.004	9.9	0.039	
	F	1	0.08	0.8	5.3	4.1	
S3	Turbidity	5	0.4	0.82	8	6.56	16.24
	TDS	500	104.5	0.008	10.5	0.084	
	Cl	250	17.74	0.004	7.1	0.02	
	F	1	0.18	0.8	12	9.6	
S4	Turbidity	5	17.28	0.082	100	8.2	12.62
	TDS	500	312.6	0.008	31.3	0.25	
	Cl	250	47.3	0.004	18.9	0.07	
S5	F	1	0.08	0.8	5.3	4.1	10.96
	Turbidity	5	0.4	0.82	8	6.56	
	TDS	500	180.6	0.008	18.1	0.14	
	Cl	250	26.64	0.004	10.7	.04	
	F	1	0.08	0.8	5.3	4.24	

The water quality of households ranges from 0-25, except in one location, which is of excellent quality.

V. CONCLUSION

Water quality parameters at different locations in Pamba river and in households of Mannar Panchayat are collected and analysed for Water Quality Index. Water Quality Indices estimated at five locations in Pamba river indicate that the water is of good quality, Water quality parameters such as pH value, total alkalinity, total hardness, calcium, sulphate, fluoride, iron, nitrate are within the permissible limits.

Water Quality Indices estimated for households at Mannar show that the water is of excellent quality. It was detected that the parameters such as total dissolved solids, chloride, fluoride are within the permissible limits and turbidity exceeds the permissible limit. Comparing the samples taken from Pamba river stations and households at Mannar, it is concluded that the water from Pamba River contains total dissolved solids content in higher levels than the water from the household at Mannar.

Results of the study gives an assessment of water quality in Mannar Panchayat and Pamba river near to the Mannar Panchayat. This assessment will help the planning authorities and public in large to understand the water quality of the area and make proactive measures in safe guarding the environment.

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