

Water Quality Analysis of River PAMBA using WQI Method and GIS Mapping

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Abstract : River Pamba is the third longest river in the South Indian state of Kerala. One of the most famous pilgrim centre in South India , Sabarimala dedicated to Lord Ayyappa is located in the banks of Pamba. During pilgrimage season, pilgrims use river water for various sanitary purposes and the water gets contaminated. This paper deals with the water quality analysis of River Pamba in three stages – before, during and after pilgrimage season and assess the water quality using Water Quality Index method and GIS mapping. The parameters analysed are pH, Turbidity, Conductivity, Chloride, Total Alkalinity, Total Acidity, Total Hardness, Total Dissolved Solids, Coliforms and E-coli.

Keywords- pH, Turbidity, Conductivity, Chloride, Total alkalinity, Total acidity, Total Hardness, TDS, Coliforms, E-coli, pilgrim season, GIS mapping, River Pamba, Water Quality Index,

I. INTRODUCTION

River Pamba is one of the major source of drinking water in Pathanamthitta and Alappuzha District of Kerala. Around thirty lakh people depend on this river and its tributaries for their different needs. The pilgrim season at Sabarimala starts from November to January every year. During this period, the water gets polluted more due to the sanitary activities done by pilgrims. So the water quality analysis should be done to check the extent of pollution.



Fig 1. River Pamba

II. OBJECTIVES

- To assess the water quality of River Pamba at different wards of Perunad panchayath.
- To analyse the water quality before, during and after pilgrimage season using WQI method and GIS mapping.
- To check whether the water quality is within the standards, and hence suitable or not for domestic and other purposes.

II. SCOPE

The water samples were collected and analysed- before , during and after pilgrimage season. Later on the next years, this information will be useful for taking pollution preventive measures before pilgrimage season starts. This method can be extended to the areas where Pamba river flows and affected by the pilgrim season . This methods helps to determine the polluted areas.

III. METHODOLOGY

- Samples were collected from 14 wards of Perunad Grama panchayath. The selected wards are Mukkan(S1),Perunad(S2),Madathummoozhy (S3) Puthukkada(S4),Arayanjilimon(S5),Thulappally (S6), Naranamthodu (S7), Sabarimala(S8), Manakkayam (S9), Kannanumon (S10), Nedumon (S11), Mampara (S12), Kakkad(S13), Madamon (S14).
- The water was tested for pH, Turbidity, Conductivity, Chloride, Total Alkalinity, Total Acidity, Total Hardness, Total Dissolved Solids, Coliforms and E-coli.

TABLE 1 DESIRABLE LIMITS OF PARAMETERS

Parameters	Remarks
pH	6.5 – 8
Turbidity	1 NTU
Alkalinity	200 mg/L
Acidity	150mg/L
TDS	500mg/L
Total Hardness	200mg/L
Chloride	250mg/L
Coliforms	Zero
E-coli	Zero

- After finding the values of these parameters, Water Quality Index of each point is calculated. The calculation of WQI is done using Weighted Arithmetic Mean Method.

WQI is calculated by the following equation:

$$WQI = \frac{\sum_{n=1}^n q_n w_n}{\sum_{n=1}^n w_n} \quad (1)$$

- $W_n = k/s_n$ (2)
 W_n = unit weight for nth parameter
 S_n = standard permissible value for nth parameter

k = proportionality constant.

- $qn=100 (vn-vi) / (vs-vi)$ (3)
vs = Standard value, vn = observed value, vi = ideal value

In most cases vi=0 except in certain parameters like pH

- $q\text{ pH} = 100 (v\text{ pH} - 7.0) / (8.5 - 1.0)$ (4)

TABLE 1 SUITABILITY OF WQI FOR HUMAN CONSUMPTION

Range	Remark
0-25	Excellent
26-50	Good
51-75	Bad
76-100	Very bad
100 & above	Unfit

➤ GIS Mapping is done using Arc GIS.

IV. RESULTS AND DISCUSSIONS

A. Test Results

The test results of water samples collected from different wards of Perunad grama panchayath before pilgrimage season are shown in TABLE 3.

TABLE 3 TEST RESULTS BEFORE PILGRIM SEASON

Site	pH	Turbidity	EC	TDS	Total Acidity	Total Alkalinity	Total Hardness	Chloride	Coliform	E-coli
S1	5.94	1.1	74	34	10	20	20	8	1100	20
S2	6.5	1.4	65	21	11	22	16	6	540	17
S3	6.06	8	37	20	16	24	16	4	1100	29
S4	5.45	6.1	52	36	14	19	22	12	960	24
S5	6.1	1.7	44	41	10	20	18	10	890	13
S6	6.45	2.5	40	50	12	22	14	6	1090	19
S7	5.59	6	64	27	11	23	19	12	460	10
S8	5.57	1.3	55	30	10	20	24	6	400	15
S9	6.12	7.8	32	51	14	24	15	7	750	21
S10	6.3	5	47	43	12	18	20	4	680	18
S11	5.81	4.1	51	32	14	21	22	10	980	24
S12	5.75	1.3	74	47	10	18	18	5	460	28
S13	5.63	1.1	76	28	10	22	26	8	870	16
S14	6.21	5	69	31	10	19	24	4	800	15

Remarks

- Low pH in all wards (less than 6.5) except Perunad, which showed a value of 6.5.
- Turbidity is within the desirable limits in all wards, but for drinking purpose, it is not safe (should be less than 1NTU).
- TDS, total hardness, chloride, alkalinity, acidity is within the desirable limit.
- E-coli and Coliforms are present

The test results of water samples collected from different wards of Perunad grama panchayath during pilgrimage season are shown in the TABLE 4

TABLE 4 TEST RESULTS DURING PILGRIM SEASON

Site	pH	Turbidity	EC	TDS	Total Acidity	Total Alkalinity	Total Hardness	Chloride	Coliform	E-coli
S1	7.1	6.1	80	40.4	9.3	20.5	28	12	1500	41
S2	7.6	7.2	68	34	10	23.1	25	10	950	30
S3	6.9	10.4	41	29	11.5	25.4	26	9.3	1320	48
S4	7.54	9.8	63	45	10.3	21	29	14.6	1200	40
S5	7.4	7.3	49	48	9.1	20.6	24	13.3	1100	32
S6	7.45	8.7	51	55	11.1	22.4	21	8.09	1400	39
S7	6.6	9.9	68	39	10.5	25.6	25	15.2	960	28
S8	7.3	12.1	63	41	9.6	25	34	12.1	1650	41
S9	7.9	11.3	45	60	13	26	20	19.2	900	42
S10	7.74	8.2	50	49	11.5	19.4	21	10	1250	40
S11	6.9	7.7	68.6	41	12.4	23	26	13.2	1400	42
S12	6.89	6.1	79	52	8.6	20.1	20	14.2	1080	44
S13	7.09	5.4	81	32	9.2	24	30	13.6	1350	36
S14	7.81	9.5	72	44	9.4	20	29	9.4	1150	29

Remarks

- pH, TDS, Total acidity, Total alkalinity, Total hardness, Chloride is within the limit.
- The value of turbidity is high compared to the values in before pilgrimage season.
- E-coli and coliform are present and have greater value compared to before pilgrimage season.

The test results of water samples collected from different wards of Perunad grama panchayath after pilgrimage season are shown in the table 5.

TABLE 5 TEST RESULTS AFTER PILGRIM SEASON

Site	pH	Turbidity	EC	TDS	Total Acidity	Total Alkalinit	Total Hardness	Chloride	Coliform	E-coli
S1	7	6	82	41	9.5	21	26	11.5	1520	50
S2	7.3	6.8	69	36	10.6	25	23	9	990	35
S3	6.7	9.6	43	31	12	26	25	9.1	1400	50
S4	7.4	8.9	64	47	10.5	21.5	25	13.2	1290	45
S5	7.1	7.1	51	61	9.6	21	21	12	1200	38
S6	7.2	8.4	52	57	11.9	23.6	20	7	1490	42
S7	6.3	9	70	43	10.8	25.9	22	14	1010	31
S8	7.25	11.9	65	46	10.1	26	29	12	1800	49
S9	7.5	10.6	46	61	13.5	27	19	18.9	990	48
S10	7.6	7.8	54	50	12	20.5	19	9.5	1300	43
S11	6.6	7.3	69	42	13.1	24.2	24	13	1450	44
S12	6.8	6	81	55	8.9	21.1	18	13.9	1100	49
S13	7	5.1	82	34	9.8	25.4	26	13.3	1400	40
S14	7.6	9	73	45	9.9	21.3	24	9	1250	35

Remarks:

- Ph, Total acidity, Total alkalinity, EC, TDS, Chloride is within the limit.
- Turbidity is above the limit and there is a slight decrease in the value compared to during pilgrimage season.
- E-coli and coliform content increased.

B. Water Quality Index

➤ Calculation of W_n

TABLE 6 CALCULATED VALUES OF W_n

Sl.no	Parameter	S _n	1/S _n	W _n =k/S _n
1	pH	8.5	0.117	0.216
2	Turbidity	5	0.2	0.368
3	EC	400	0.0025	0.004
4	TDS	500	0.002	0.0036
5	Total Acidity	150	0.00667	0.0122
6	Total Alkalinity	200	0.005	0.00921
7	Total Hardness	200	0.005	0.00921
8	Chloride	250	0.004	0.007368
9	Coliform	10	0.1	0.1842
10	E-coli	10	0.1	0.1842
	TOTAL		0.542	1

The value of $k = 1 / \sum(\frac{1}{S_i}) = 1.845$

TABLE 7 CALCULATION OF WQI

Sl.no	Station	WQI		
		Before pilgrim	During pilgrim	After pilgrim
1	Mukkam	2086.78	2885.291	2936.499
2	Perunad	1043.76	1867.21	1942.766
3	Madathumoozhy	2152.39	2598.24	2746.218
4	Puthukkada	1880.13	2364.43	2530.718
5	Arayanjilimon	1689.14	2145.02	2334.37
6	Thulapally	2069.44	2721.54	2886.988
7	Naranamthodu	930.59	1898.96	1994.177
8	Sabarimala	794.97	3208.66	3497.35
9	Manakkad	1490.63	1831.748	1997.596
10	Kannanumon	1332.94	2447.57	2540.015
11	Nedumon	1897.08	2714.73	2811.755
12	Mampara	926.82	2117.27	2163.82
13	Kakkad	1660.24	2594.20	2690.346
14	Madamon	1549.76	2253.729	2442.15
	Average WQI	1689.81	2403.49	2536.76

Since the Water Quality Index of Pamba river was in the range of 1000 – 3000 which is above 100 in all the 3 seasons(before , during and after pilgrim season), the water is unfit for human consumption. High value of WQI may be due to the large amount of coliform present in the river water.

C. GIS Mapping

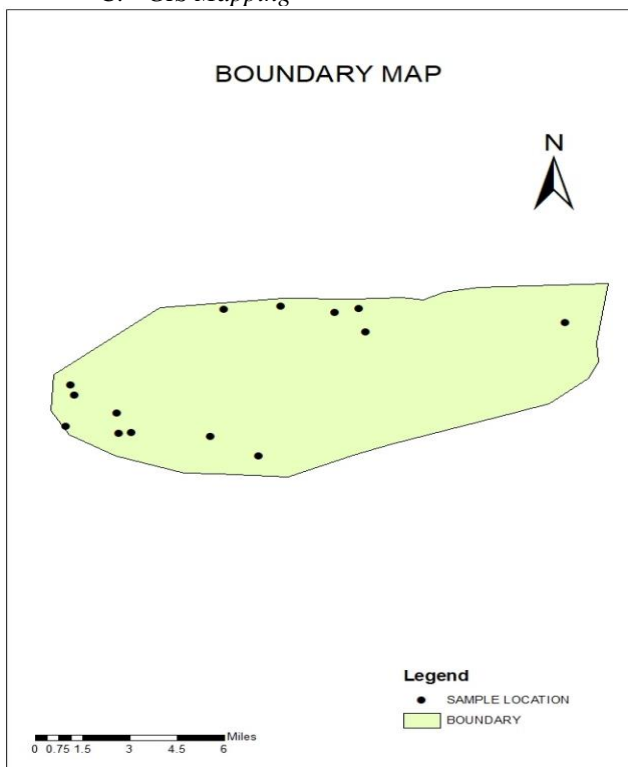


Fig. 2. Boundary map

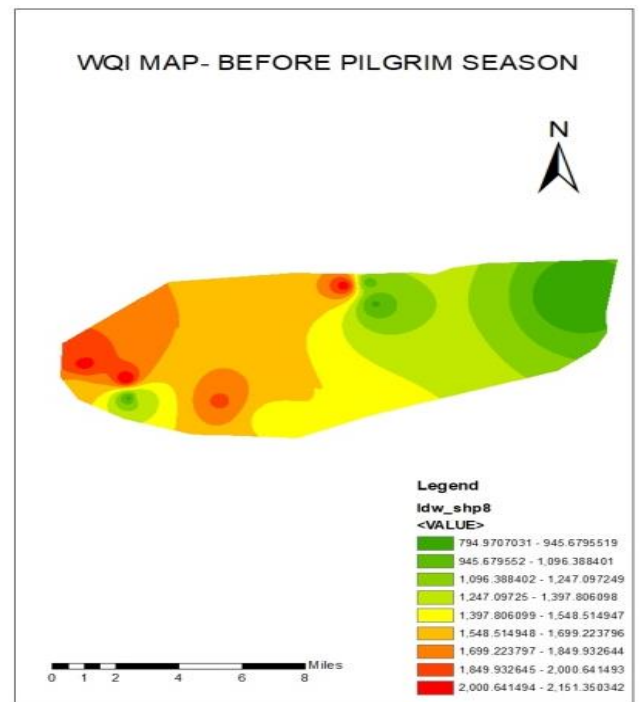


Fig 3. Map before pilgrim season

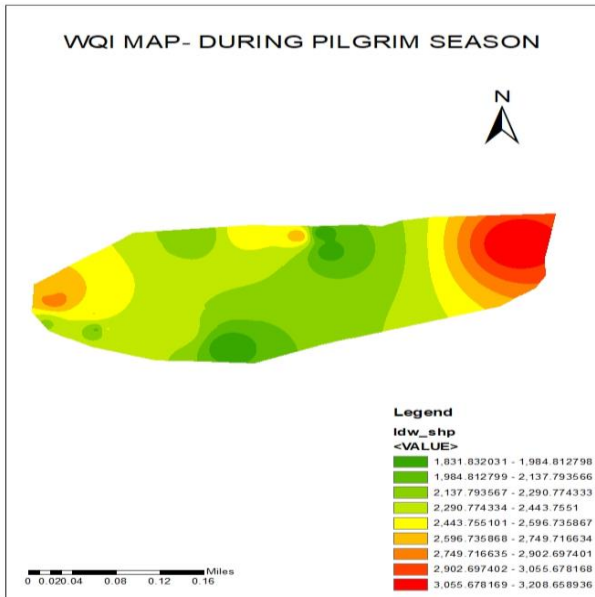


Fig 4. Map during pilgrim season

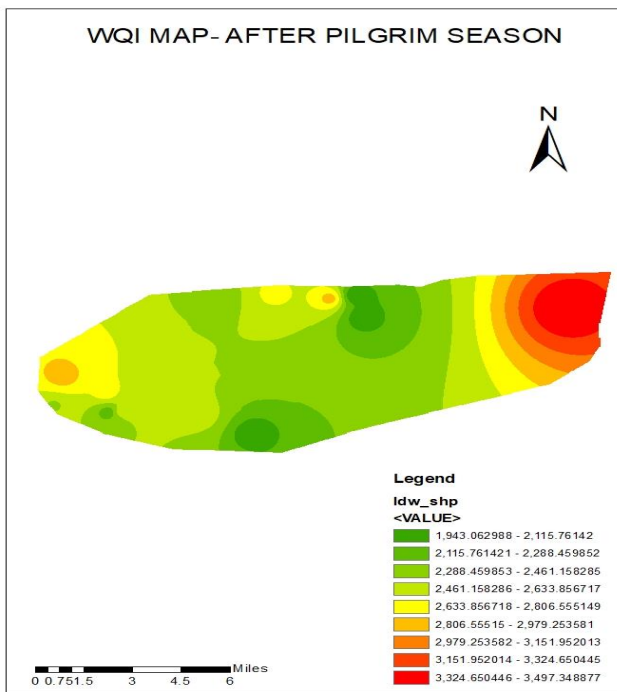


Fig 5. Map after pilgrim season

The GIS map is obtained using IDW Interpolation method. The map is plotted with X axis as longitude, Y axis as latitude and Z axis as WQI. In fig 3,4 and 5, the shades of different colours shows intensity of WQI within the selected boundary. The green colour shows areas with comparatively less WQI and red colour shows areas with high WQI.

V. CONCLUSION

In Pamba River, all physic-chemical and biological parameters were fluctuated in the three seasons and in different stations. Raised values of certain parameters like turbidity, total coliform, e-coli clearly indicated pollution of Pamba River. From the test results, it is clear that certain parameters crossed the permissible limit. The high

amount of coliform count may be due to the human excreta during pilgrim season. Low discharge of river water during and after pilgrim season is also a factor the increased amount of coliforms. The increased turbidity observed during pilgrim season may be due to the input of organic matter and sewage effluents into the river. The high value of WQI in all places is due to the high value of coliform content.

Remedies to reduce the level of pollution:

- Proper collection and management system for different types of waste generated during pilgrim season.
- Proper latrine facilities should be provided at places where pilgrims used to take rest, bathing etc.
- Also, a certain level of water should be maintained by releasing water from storage dams.
- Turbidity can be reduced by stopping the usage of soaps while pilgrims take bath in the river water.
- Powdered roots and shoots of *Vetiveria Zizanioides* (phytoremediation using plants) can be used for removing bacteria and pollutants.

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