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Correlation Study for Assessment of Water Quality and Its Parameters of Par River Valsad, Gujarat, India

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ABSTRACT:

In the present work water samples are collected from eight different location of Par river in Valsad city from August 2014 to January 2014 on monthly basis for assessment of water quality for monsoon and post monsoon season carried out. The water sample analyzed for eleven Physico-chemical parameters namely Temperature, pH, electrical conductivity (EC), Turbidity, Total dissolve solids (TDS), Dissolve oxygen (DO), Biochemical oxygen demand (BOD), chemical oxygen demand (COD), chloride, Total hardness, Sulphate Pearson's correlation coefficient (r) value is determined using correlation matrix to identify the highly correlated and interrelated water quality parameters. To test the significance of the pair of parameters p-value is carried out and in order to test the joint effects of several independent variables, without frequent or repeated monitoring of water quality in a location. The result indicate that The mean values of all the measured physico-chemical parameters of Par river water are within the highest desirable limit set by WHO. Therefore water found to be potable after some primary treatment. The correlation study and correlation coefficient values can help in selecting a few parameters which could be frequently measured to determine the status of water quality regularly. This will help the regulatory bodies to issue a warning on deteriorating water quality and taking steps to implement control measures for the water body.

Keywords: water quality parameters, Pearson correlation, p-value, Par River, Monsoon, Post-Monsoon.

I. INTRODUCTION

Water is known as blue gold, one of the most priceless gifts of Nature is also regarded as the life line on Earth, because evolution of life and development of human civilization could not have been possible without water. Rivers have always been the most important fresh water resources, along the banks of which our ancient civilizations have flourished and still most of the developmental activities are dependent upon them. River water finds multiple uses in every sector of development like agriculture, industry, transportation, aquaculture, public water supply etc [16].

River pollution in India has now reached to a point of crisis. Surface waters are most vulnerable to pollution due to their easy accessibility for disposal of wastewaters. In India the river systems are getting polluted day by day. In many parts of the world the polluted water from river is used for drinking, domestic purpose as well as irrigation without assessing its suitability. Therefore Management and protection strategies have to be developed for each water basin individually [25].

During the journey Par River passes though agriculture area, residence area, nearby villages and also from the industry Atul at the Valsad city of Gujarat. Atul industry is fertilizer, pharmaceutical, chemical manufacturing product company. Par River is the ultimate final disposal body for discharge of the treated wastewater of the effluent treatment plant. At the bank of the river other villages also discharges there domestic effluent in the same. As well as nearby area of the estuary there also fishing activity carried out by people. It is a cumbersome task to regularly monitor all the parameters even if adequate manpower and laboratory facilities are available. Therefore, in recent years an easier and simpler approach based on statistical correlation, has been developed using mathematical relationship for comparison of physico-chemical parameters.

Extensive research has been carried out on statistical analysis to assess the surface water quality. Naseema et.al [15] have assess the water quality parameter of Ganga River, Kanpur, India using Pearson's correlation coefficient (r) value which determined using correlation matrix to identify the highly correlated and interrelated water quality parameters. Navneet kumar find an approach to river water quality management though correlation study between various water quality parameters of Gagan river at Mordabad,India [16]. Megha Agrawal et.al [12] have study correlation analysis of water quality of Kosi River at Rampur,India. In the present study an attempt has, been made to assess water quality of Par river in Valsad district, Gujarat in India.

II. MATERIAL AND METHOD

A. Description of Study Area

The Par River is one of the important west flowing rivers in the region, north of Mumbai and south of the Tapi River. The catchment area of the river Par comprises of the hill ranges of the Nasik district of Maharashtra and Valsad district of Gujarat and slopes westward towards the Arabian Sea. The river rises in the Sahyadri hill ranges at an elevation of about 1100 m above mean sea level in Nasik district of Maharashtra state and traverses a distance of 131 Km before draining into the Arabian Sea. In the present study assessment of the par river at Valsad city is selected to analyze. Water samples collect from eight locations along Par River at the Valsad city area starting from nearby area of the national highway no.8 Bridge to the estuary of river at Arabian sea as shown in Fig. 3.1. The study area has been selected for collection of samples on the bases of certain characteristic features. The samples were collected for a period of three months from august 2014 to January 2014 for monsoon and post monsoon season from eight sites reasonably representing the water quality of the river system. The selected sampling sites and observed pollution sources at each site are as follows:

- Nearby N.H.8 (S1) - It receives moderate amount of domestic pollution.
- Pumping station (S2) – Free from any discharges.
- Pumping station of Atul industry (S3) - . Free from any discharges.
- At Atul industry (S4) - It receives considerable amount of domestic waste and also agriculture runoff from nearby area.
- At 2km away from Atul industry (S5) - It receives huge amount of ETP treated effluent discharge .
- At Haria village (S6) - It is polluted due to huge discharge of untreated domestic sewage waste.
- At 2km away from estuary (S7) - It is polluted due to the agricultural runoff.
- At estuary - It is polluted due to fishing, sand digging and occasional bathing activity.

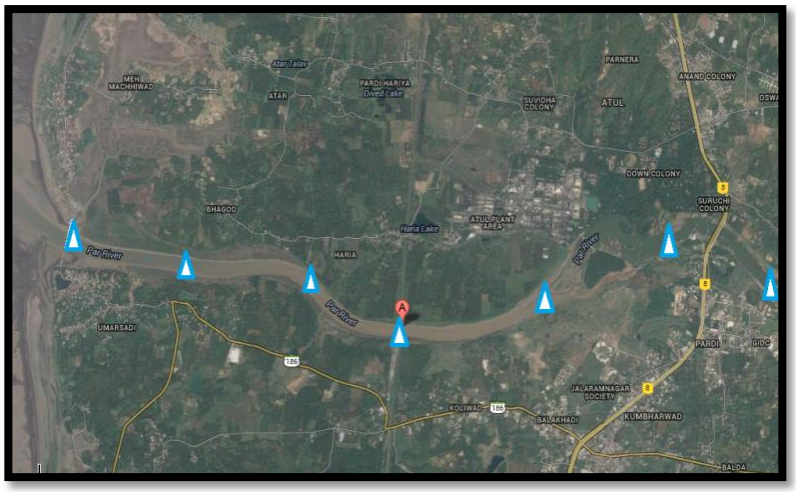

Figure 1 Sampling Stations along the Stretch of Par River

[Source: Google Map]

B. Sampling and Analysis

The present study deals with few physical and chemical parameters of the water to check the present status of water quality for the monsoon season at the monthly interval for three Months. Samples were collected from surface at the depth of 4-5 cm at the middle of the river flow. After collection of samples, these bottles were labeled and possible efforts were made to transport them to the laboratory as earlier as possible.

The water sample analysed for eleven Physico-chemical parameters namely Temperature, pH, electrical conductivity (EC), Turbidity, Total dissolve solids (TDS), Dissolve oxygen (DO), Biochemical oxygen demand (BOD), chemical oxygen demand (COD), chloride, Total hardness, Sulphate in the laboratory as per the standard procedures of APHA. Standard methods used for this analysis of the parameter are shown in Table no.:3.2. National River water quality standards and Bureau of Indian Standards (BIS) for river water quality has been considered for comparison of surface water quality of Par River.

III. STATISTICAL ANALYSIS

Statistical analysis was carried out using statistical package for social sciences (SPSSVersion17). The physico-chemical parameters for all the study sites were analyzed by calculating Pearson's correlation coefficient (r) value. In order to calculate correlation coefficients, correlation matrix was constructed by calculating the coefficients of different pairs of parameters and correlation for significance was further tested by applying p valve [15]. The variations are significant if

p<0.05, p<0.01, and non-significant if p>0.05. The significance is considered at the level of 0.01 and 0.05 (2- tailed analysis).

IV. RESULTS AND DISCUSSION

The statistical result with respect to range, mean, minimum, maximum, SD and SE values for surface water quality with WHO & BIS standards parameters are summarized in **Table 1**. The statistical results for various physicochemical parameters were depicted in **table 2**and **3** for surface water with correlation matrix for Monsoon and Post-Most season respectively.

A. Temperature

In an established system the water temperature controls the rate of all chemical reactions, and affects fish growth, reproduction and immunity. Drastic temperature changes can be fatal to fish. In the present study temperature was recorded minimum during the post monsoon 18.3ºc as compare to monsoon. The variation is mainly related with the atmosphere temperature and weather conditions. Higher temperature during June was due to greater heating.The Water temperature (Temp) not showed significant correlation with other water quality parameter.

Table.1 Descriptive Statistics of Water Quality Parameter of Par River (N=24)

WQP (unit)	Minimum	Maximum	Mean	Std. Error	Std. Deviation	WHO	BIS
TEMP (ºC)	18.30	22.50	20.2941	.49531	2.04220	-	-
PH	6.20	8.60	7.5118	.19114	.78810	7 -8.5	6.5-8.5
EC (µs/cm)	.23	.91	.4298	.05123	.21123	-	-
TDS (mg/l)	227.00	2506.70	585.8059	176.61462	728.20072	500	500
TURB (NTU)	8.30	240.00	56.8471	16.03067	66.09613	200	-
DO (mg/l)	2.30	6.70	4.8529	.36794	1.51704	6	6
BOD (mg/l)	3.30	9.30	5.2235	.47601	1.96263	6	30
COD (mg/l)	9.20	43.10	18.6529	2.61363	10.77625	10	10
TH (mg/l)	172.00	480.70	232.0765	21.74408	89.65315	200	300
CHLORIDE (mg/l)	10.80	48.10	21.9765	2.54706	10.50182	200	250
SULPHATE (mg/l)	13.20	43.60	26.6000	2.33607	9.63185	250	200

B. pH

pH is most important in determining the corrosive nature of water. Lower the pH value higher is the corrosive nature of water. pH was positively correlated with electrical conductance. In the study the pH value of surface water ranged from 6.2 to 8.6, indicating that the nature of water is slightly basic to strong basic. Variation in pH showed that different characteristics waste merged to the river at the different location.

The pH showed positive correlation with correlation with DO (r = 0.720, p< 0.01) in Monsoon.

The pH showed negative correlation with EC(r = -0.806, p<0.01), TH(r = -0.746, p<0.01), COD(r = -0.722, p<0.01) in Monsoon.

C. Turbidity

Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms. Turbidity reflects the transparency in water [26]. . In the study turbidity value recorded maximum 240NTU in monsoon at the estuary location and minimum recorded at the pumping station. Maximum turbidity showed in the monsoon season due to runoff merged to the river.

Turbidity showed positive correlation with EC(r=0.953, p<0.01), TDS(r=0.904, p<0.01), TH(r = 0.915, p<0.01), Cl^-(r = 0.926, p<0.01), SO_4^{-3} (r = 0.857, p<0.01) and COD(r = 0.947, p<0.01) in Monsoon and with EC(r = 0.944, p<0.01), TH(r = 904., p<0.01), COD(r = 0.922, p<0.01) in Post-Monsoon.

Turbidity showed negative correlation with DO (r = -0.718, p< 0.01) in Monsoon and in Post Monsoon DO (r = -0.760, p< 0.01).

D. Electrical conductivity (EC)

Conductivity is a measure of the ability of an aqueous solution to carry an electric current. It can serve as an indicator of other water quality problems. If conductivity increases, it indicates that there is source of dissolved ions in the vicinity. Increasing levels of conductivity and cations are the products of decomposition and

mineralization of organic materials [26]. In the study EC measure maximum 0.91(µs/cm)in the Monsoon and minimum 0.23(µs/cm) in post monsoon. EC showed the maximum correlation with the other parameter.

EC showed the positive correlation with turbidity, TDS(r=0.851, p<0.01), TH(r=0.870, p<0.01), Cl^- (r=0.896, p<0.01), SO_4^{-3} (r=0.871, p<0.01),BOD(r=0.809, p<0.01) and COD(r=0.904, p<0.01) in Monsoon season and TDS(r=0.879, p<0.01), TH(r=0.903, p<0.01), Cl^- (r=0.916, p<0.912), SO_4^{-3} (r=0.912, p<0.01) and COD(r=0.969, p<0.01) in Post-Monsoon. EC showed negative correlation with DO (r = -0.756, p< 0.01) in Monsoon and (r = -0.877, p< 0.01) in Post-monsoon.

E. Total dissolved solids (TDS)

In water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles. At high flows, the TDS values tend to be diluted by surface runoff and for most rivers there are an inverse correlation between discharge rate and TDS. Waters with high total dissolved solids (TDS) are unpalatable and potentially unhealthy [19]. In the study TDS recorded maximum 2506 mg/l at estuary and minimum 227 mg/l at the pumping station in post monsoon.

TDS shows the positive correlation with TH,EC, COD,BOD, Cl^- positive correlation shows with Cl^- (r= 0.980, p<0.01), BOD (r= 0.949, p<0.01) and COD (r= 0.977,p<0.01). TDS showed negative correlation with DO (r = -0.594, p< 0.01) in Post-monsoon.

F. Dissolve Oxygen (DO)

DO is one of the most important parameter. Its correlation with water body gives direct and indirect information e.g. bacterial activity, photosynthesis, availability of nutrients, stratification etc. Dissolved oxygen decreased due to increase in temperature and also due to increased microbial activity. DO value recorded maximum during the monsoon season. DO showed the Maximum correlation with BOD and COD

DO shows the negative correlation with Turbidity (r = -0.718, p< 0.01) EC(r = -0.756, p< 0.01) TH (r = -0.711, p< 0.01), BOD (r = -0.830, p< 0.01), COD (r= -0.825,p<0.01) and SO_4^{-3}(r = -0.740, p< 0.01) in the monsoon season.

G. Biochemical Oxygen Demand (BOD)

BOD is a measure of organic material contamination in water, specified in mg/L. BOD is the amount of dissolved oxygen required for the biochemical decomposition of organic compounds and the oxidation of certain inorganic materials.

BOD shows the positive correlation with Turbidity(r =0.852, p< 0.01), EC (r =0.809, p< 0.01), TDS(r =0.949, p< 0.01), TH (r = 0.754, p< 0.01), Cl^- (r = 0.946, p< 0.01) in Monsoon. BOD showed negative correlation with DO (r = -0.830, p< 0.01) in Post-monsoon.

H. Chemical Oxygen Demand(COD)

COD is another measure of organic material contamination in water specified in mg/L. COD is the amount of dissolved oxygen required to cause chemical oxidation of the organic material in water. Both BOD and COD are key indicators of the environmental health of a surface water supply. COD value maximum recorded at the industrial discharge point in Post-monsoon. COD value represents the presence of organic matter in the river basin which indicates the polluting level of the stream.

COD showed the positive correlation with pH (r =0.722, p< 0.01), Turbidity (r =0.947, p< 0.01), EC (r =0.977, p< 0.01), TDS (r =0.920, p< 0.01), TH (r =0.847, p< 0.01) and Cl^- (r= 0.948 , p< 0.01) in the Monsoon and in Post Monsoon Turbidity (r =0.922, p< 0.01), EC (r =0.969, p< 0.01) and Cl^- (r= 0.945 , p< 0.01). COD showed negative correlation with DO (r = -0.549, p< 0.01) in Monsoon and in Post-Monsoon season with DO (r = -0.825, p< 0.01).

I. Total hardness

Hardness of water is an important consideration in determining the suitability of water for domestic and industrial uses. Hardness is caused by multivalent metallic cations and with certain anions present in the water to form scale. The principal hardness-causing cations are the divalent calcium, magnesium, strontium, ferrous iron and magnesium ions [26]. Total Hardness showed Maximum at the domestic discharge site and further al site downstream to the sea.

TH showed the positive correlation with Turbidity(r =0.915, p< 0.01) in Monsoon and in Post monsoon Turbidity (r =0.904, p< 0.01), EC (r =0.903, p< 0.01).TH showed negative correlation with DO (r= -0.838., p< 0.01) in post-Monsoon and in Monsoon. DO (r= -0.711., p< 0.01).

J. Chloride

Chlorides occur naturally in all types of waters. High concentration of chlorides is considered to be the indicators of pollution due to organic wastes of animal or industrial origin. Chlorides are troublesome in irrigation water and

also harmful to aquatic life [26]. Presence of chloride showed Maximum after the discharge of industry effluent and from domestic discharge. Maximum value recorded after the Monsoon season.

Chloride showed the positive correlation with BOD (r =0.946, p< 0.01), COD (r =0.948, p< 0.01), Turbidity(r =0.926, p< 0.01) in Monsoon and in Post- Monsoon with EC (r =0.916, p< 0.01) and TDS (r =0.920, p< 0.01). Chloride showed negative correlation with DO (r= -0.659, p< 0.01) in Monsoon and in Post-monsoon with DO (r= -0.754, p< 0.01).

K. Sulphate

The Sulphate content of natural waters is an important consideration in determining their suitability for public and industrial supplies [26]. All the natural water contains sulphate ion. Maximum sulphate is recorded during the Monsoon season at the site where agriculture runoff merged to the river from nearby area.

Sulphate showed the positive correlation with EC (r =0.857, p< 0.01), TDS(r =0721, p< 0.01) and TH (r = 0.879, p< 0.01) in monsoon and with EC (r =0.912, p< 0.01), in Post Monsoon.

Sulphate showed negative correlation with DO (r= -0.740, p< 0.01) in Monsoon.

Table.2 Pearson Correlations coefficient of Par River water quality parameter (Monsoon season)

WQP	TEMP	PH	TURB	EC	TDS	TH	Cl^-	SO_4^{-3}	DO	BOD	COD
TEMP	1										
PH	-.285	1									
TURB	-.376	**-.806****	1								
EC	-.276	**-.746****	**.953****	1							
TDS	-.397	.668**	**.904****	**.851****	1						
TH	-.349	**-.783****	**.915****	**.870****	**.816****	1					
Cl^-	-.389	**-.704****	**.926****	**.896****	**.920****	**.813****	1				
SO_4^{-3}	-.317	**.741****	**.853****	**.857****	**.721****	**.879****	**.731****	1			
DO	.153	.720**	**-.718****	**-.756****	-.426*	**-.711****	**-.659****	**-.740****	1		
BOD	-.388	-.625**	**.852****	**.809****	**.949****	**.754****	**.946****	.614**	-.470*	1	
COD	-.467*	**-.722****	**.947****	**.904****	**.977****	**.847****	**.948****	**.791****	**-.549****	**.936****	1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3. Pearson Correlations coefficient of Par River water quality parameter (Post-Monsoon season)

WQP	TEMP	PH	TURB	EC	TDS	TH	Cl^-	SO_4^{-3}	DO	BOD	COD
TEMP	1										
PH	-.052	1									
TURB	-.168	.619**	1								
EC	-.144	.572**	**.944****	1							
TDS	-.141	.549**	**.875****	**.879****	1						
TH	-.127	.631**	**.904****	**.903****	**.750****	1					
Cl^-	-.148	.479*	**.870****	**.916****	**.920****	**.798****	1				
SO_4^{-3}	-.082	.519**	**.808****	**.912****	**.725****	**.818****	**.780****	1			
DO	.169	-.485*	**-.760****	**-.877****	**-.594****	**-.838****	**-.754****	-.862**	1		
BOD	-.067	.240	.408*	.555**	.132	.594**	.394	.650**	**-.830****	1	
COD	-.147	.420*	**.922****	**.969****	**.888****	**.852****	**.954****	**.850****	**-.825****	.489*	1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

V. CONCLUSION

The results of present investigation conclude that from correlation analysis, the negative relationship DO with other parameters reveals the high organic pollution with anthropogenic activities in the river basin. Thus it can be concluded that the water of the river Par at sampling site with lower value of DO represents serious threat to the ecosystem due to anthropogenic pollution. In both case Monsoon and Post-Monsoon EC showed the maximum correlation with the other parameter. The correlation study and correlation coefficient values can help in selecting a few parameters which could be frequently measured to determine the status of water quality regularly. This will help the regulatory bodies to issue a warning on deteriorating water quality and taking steps to implement control measures so that proper treatment of effluent could be done to minimize contaminants in Par river water.

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