REVIEW OF RESEARCH
ISSN: 2249-894X
IMPACT FACTOR : 5.7631(UIF)
UGC APPROVED JOURNAL NO. 48514
VOLUME - 8 | ISSUE - 9 | JUNE - 2019

ASSESSMENT OF PHYSICOCHEMICAL PARAMETERS OF SOPARA CREEK WATER BY PRINCIPAL COMPONENT ANALYSIS

Anushri Kini[1] and Supriya Deshpande[2]
[1]Viva College, Virar, Dist. Palghar
[2]M. D. College, Parel, Mumbai.

ABSTRACT:

Life on the earth is not possible without water and hence hydrological study is very important to understand relationship between trophic levels and food webs. A systematic study has been carried out to assess seasonal variations in physicochemical parameters of Sopara creek, Vasai, India. Physicochemical characters of water help in the determination of quality of water, health of aquatic ecosystem and pollution load. Water samples from three different stations were collected during pre-monsoon, monsoon and post- monsoon season. The physicochemical parameters were determined seasonally by the standard methods APHA. The present study reveals that Sopara creek is greatly polluted due to discharge of industrial effluents and domestic waste from eastern part of Vasai industrial area and Naigaon. Various physicochemical factors were assessed. Throughout the study period, the values of pH, temperature, and alkalinity were found to be within the permissible limit prescribed by WHO. But the values of other parameters viz. chloride, Biological Oxygen Demand, Chemical Oxygen Demand, turbidity and Total Dissolved Solids were above the permissible limit of WHO . Pearson correlation analysis was used to determine correlation among the physicochemical parameters. Principal component analysis is used to determine common pollution sources.

KEYWORDS: Physicochemical parameters, pollution, water samples, seasonal variation, Sopara Creek, waste.

INTRODUCTION

Water is the elixir of the life. Quality of water provides valuable information about health of that ecosystem and quality of water in turn depends on its physicochemical parameters. Major changes in the physicochemical factors can affect distribution, migration of aquatic life, nutrient concentration leading to loss of aquatic habitat and fishery diversity (Sharma & Singh, 2016). Seasonal changes in physicochemical parameters depend on physical and biological processes as well as are influenced by anthropogenic activities like dumping of industrial, domestic, agricultural waste directly into the water bodies without any treatment (Fakayode & Onianwa, 2002; Bhaware *et al*., 2013). In India all industries are under control of rules and regulations of Central Pollution Control Board. But guidelines given by CPCB are not followed by all the industries especially by medium and small

scale industries because of the high cost of waste treatment which increases the price of the product. Industrialization and urbanization are essential for the development, but also playing direct or indirect role in polluting the environment (Nasrullah *et al*., 2006). In India about 70% streams and rivers are polluted due to municipal sewage, industrial and agricultural wastes (Rostogi, 1987).

Estuaries are dynamic, complex ecosystems which provide habitat to many organisms. Many authors studied seasonal variations of estuarine water of Indian coast (Singare, 2010; Singare, *et al*., 2012; Mehata & Amin, 2008; Velsamy *et al*., 2013). West coast of India is highly disturbed as compared to east coast due to pollution, flooding, saltwater intrusion, industrialization etc.

The present study focuses on status of pollution of Sopara creek. Sopara Creek originates in Pelhar Lake at Vasai east and ultimately meets Arabian Sea at Bhaynder. Eastern part of Vasai has more developed industrial area with approximately 3500 large, medium and small scale industries. Huge amount of industrial effluents are poured directly into Sopara creek from many industries like textiles, tanneries dyeing units, plastic, rubber, automobile, pharmaceuticals, engineering, electrical etc. (Bendre, 2016). Ecological status of estuaries and creek can be monitored through different physicochemical parameters which help in its management (Tabatabaie, 2010, Mishra, 2007). Pollutants in aquatic environment cause disturbance in marine activities harm aquatic organisms and hazards to human health (FAO, 1990).

MATERIAL AND METHOD:

Three different stites of Sopara creek were selected to cover entire belt for assessment of its pollution. Site 1 is located at Naigaon (19.342911°, 72.823486°), site 2 at Navaghar (19.393345°, 72.862427°) and site 3 at Sativali (19.4069°, 72.865°).

Sample collection and preservation is very important step in the study of physicochemical parameters of water. Water samples were collected during pre-monsoon, monsoon and post-monsoon seasons (October 2017 to September 2018) from the selected stations, in triplicates from surface (maximum depth 20 cm) from each station. Clear acid-washed glass bottles were used for collection of water samples. The bottles were rinsed with sample water three times before sample collection. For rinsing water is collected from depth below 10cm (Sufani & Ishak, 2015). Samples were filtered through 0.45 micropore membrane filter and preserved at 4°C.

Following physicochemical parameters were studied: Temperature, turbidity, TS, TSS, TDS, pH, conductivity, Dissolve Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), alkalinity, silicates, chlorides, carbonates, bicarbonates, sulphate, salinity and hardness (APHA 1998).Water temperature was measured using mercury thermometer on the site. Elico pH meter was used to check pH of the water. For determination of TDS & TSS Whatman filter paper no 541 was used. Salinity was analyzed by Mohr-Kundsen AgNo3 titration method. Total hardness was estimated using complexmetric titration method. For dissolve oxygen water samples were collected in white and brown BOD bottles. DO was fixed immediately by adding 1ml of winklers A and 1ml of winklers B solutions in each BOD bottle. Turbidity was determining by using turbidometer.

Principal Components Analysis (PCA) was used to determine the environmental parameters that characterized the study area. The PCA was performed on the normalized environmental data. The PCA provides information on the most meaningful parameters and to summarize the statistical correlation among environmental variables with minimum loss of original information (Mahapatra, *et al*., 2012; Helena *et al.,* 2000). The Kaiser's criterion (Kaiser, 1960) was used to determine the total number of axis to be retained. Only eigenvalues ≥ 1is considered. Two-way ANOVA analysis was performed to find out the significance of spatial and temporal variation in the physicochemical variables. When the ANOVA results were significant, Tukey's HSD post hoc test was performed. To test the relationships between the various parameters, a Pearson's correlation analysis was performed (Pujar, *et al*., 2010).

The software package Statistical 8.0 was used for the analysis.

Table No. 1: Seasonal variation in physicochemical parameters:

	Site 1	Site 1	Site1	Site 2	Site 2	Site 2	Site3	Site3	Site 3
	Pre-Mon	Mon	Post- Mon	Pre-Mon	Mon	Post- Mon	Pre-Mon	Mon	Post- Mon
pH	7.667	7.3167	7.53	7.88	6.867	7.0433	7.707	6.37	7.33
Temperature	31.67	29.5	29.5	30.167	29.67	29.833	31	29.83333	30
Conductivity unit	16.28	3.67	12.2833	2.91	0.842	1.883	3.257	0.066	2.9437
Turbidity	31.67	204.333	59.697	26.0133	15.7	52.473	38.243	40.1	18.547
T.S. (mg/L)	15331.67	2966.67	17404.33	2285	800.33	4062	2672.33	582	3534.67
T.D.S. (mg/L)	15154	2466.67	16865.67	1809	558.667	3897	2217	439.66	3239.67
T.S.S. (mg/L)	177.67	500	538.667	479.33	241.67	260	455.33	142.333	295.33
DO (mg/L)	3.6	5.233	4.933	4.4	5.267	4.9	4.1	5.1	4.7
BOD (mg/L)	71.33	207.333	119.67	73.667	186	113	40.52	175.66	101
COD (mg/L)	187.67	291	224.67	110.84	293	209	180	259.66	236.33
Alkalinity (mg/L)	53	250	194.33	744	250	237.33	582.33	249.9267	324
Silicates (mg/L)	11.20	9.53	30	25.928	19.39	41.33	29.5987	16.19	38.67
Sulphate (mg/L)	182.21	110.66	130.197	41.689	23.85	137.33	56.165	57.6	130.67
Chloride (mg/L)	4657	1331.5	2271.517	582.087	198.937	305	536.123	256.317	317
Hardness (mg/L)	2533.67	502	938.33	585.04	259.33	379.04	605.333	244.436	331.33
Salinity (mg/L)	60.30	18.94	50.357	11.809	4.0533	10.54	10.92433	3.303	8.48
Carbonates (mg/L)	1.63	0.2133	6.263	2.367	0.1	2.1867	5.2	0.396	1.7
Bicarbonates(mg/L)	15.57	8.5	25.3167	18.167	9.6	20.3533	16.867	7.066	16.967

RESULTS AND DISCUSSION:

The result of Pearson's correlation between the various physicochemical variables measured in the study area is given in Table No. 2. pH showed a significant negative relation with DO, BOD and COD and positive with alkalinity. Temperature showed a strong negative relation with DO and positive with chloride and hardness. Conductivity Unit showed significant relation with several parameters. Conductivity Unit was strongly related to TS, TDS, sulphate, Chloride, hardness and salinity. TS and TDS also showed strong positive relation with sulphate, Chloride, hardness and salinity. A significant negative relation was obtained between alkalinity and, DO, BOD and COD. Bicarbonate was positively related to carbonate and sulphate. Sulphate showed positive relation with chloride and salinity. Since Conductivity Unit showed a strong positive relation with TS, TDS, sulphate, chloride, hardness and salinity, these parameters were not considered for PCA so as to deal with multicollinearity.

Table No. 2. Pearson's correlation between physicochemical parameters. Marked correlations are significant at p <0 .05*; p<0.01** and p<0.001***.

	pH	Temp	Con	Turb	TS	TDS	TSS	DO	BOD	COD	Alk	SiO4	SO4	Cl	Hard	Sal	CO3	HCO3
pH	1.00																	
Temp	0.44	1.00																
Con	0.52	0.58	1.00															
Turb	0.01	-0.36	-0.01	1.00														
TS	0.43	0.36	0.95***	-0.03	1.00													
TDS	0.41	0.37	0.95***	-0.04	0.99***	1.00												
TSS	0.63	-0.36	0.10	0.45	0.16	0.14	1.00											
DO	-0.67*	-0.94***	-0.59	0.37	-0.41	-0.42	0.07	1.00										
BOD	-0.71*	-0.65	-0.36	0.53	-0.30	-0.30	-0.14	0.85**	1.00									
COD	-0.70*	-0.51	-0.24	0.41	-0.18	-0.18	-0.25	0.72*	0.86**	1.00								
Alk	0.70*	0.63	0.14	-0.31	-0.06	-0.06	0.19	-0.76*	-0.73*	-0.85**	1.00							
SiO4	0.12	-0.23	-0.24	-0.43	-0.06	-0.06	0.13	0.03	-0.44	-0.31	-0.06	1.00						
SO4	0.24	0.39	0.71*	0.19	0.71*	0.72*	-0.11	-0.36	-0.21	-0.03	-0.20	0.09	1.00					
Cl	0.43	0.67*	0.96***	0.09	0.85**	0.85**	-0.05	-0.61	-0.25	-0.17	0.17	-0.45	0.69*	1.00				
Hard	0.48	0.83**	0.91***	-0.08	0.76*	0.77*	-0.15	-0.77*	-0.42	-0.33	0.34	-0.39	0.64	0.97***	1.00			
Sal	0.48	0.50	0.99***	0.08	0.96***	0.96***	0.13	-0.51	-0.28	-0.20	0.06	-0.27	0.71*	0.95***	0.88**	1.00		
CO3	0.56	0.04	0.41	-0.19	0.54	0.52	0.59	-0.33	-0.63	-0.47	0.18	0.47	0.15	0.17	0.16	0.40	1.00	
HCO3	0.59	0.08	0.46	-0.29	0.61	0.60	0.44	-0.33	-0.65	-0.57	0.15	0.68*	0.41	0.22	0.23	0.45	0.82**	1.00

PCA analysis on environmental parameters resulted in three components that explained 83% of the variability (Table No. 3). PC1 with 48% of the variability showed strong positive (>0.7) loadings for DO, BOD and COD whereas pH, temperature and alkalinity had highest negative loading on this axis. The second PC was influenced by temperature (positive loading) while silicates showed positive loading,

and accounts for 19% of the total variance in the physicochemical parameters in the area. Sulphate showed a strong positive loading on the third axis and accounted for 16% of the variability. PC1 showed a clear seasonal trend and separated the monsoon season (all three sites) from the other seasons. Site 1 Premonsoon season was characterized by high temperature, while post-monsoon (Site 1 and 2) was a period of increasing silicates. High loading of Site 1 during post-monsoon was due to the high sulphate concentration.

Table No. 3. Coefficients in the linear combinations of variables making up PC's.

	PC 1	PC 2	PC 3
Eigenvalue	5.76	2.24	1.95
% Variation	48	18.7	16
Cumulative % Variation	48	66.7	82.95
pH	**-0.81**	0.05	0.11
Temperature	**-0.70**	**0.61**	-0.06
Conductivity unit	-0.58	0.35	0.65
Turbidity	0.43	0.25	0.47
DO	**0.89**	-0.40	0.06
BOD	**0.96**	0.12	0.17
COD	**0.87**	0.08	0.32
Alkalinity	**-0.73**	0.29	-0.55
SiO_4	-0.29	**-0.87**	-0.04
SO_4	-0.34	0.17	**0.81**
CO_3	-0.63	-0.53	0.26
HCO_3	-0.69	-0.60	0.36

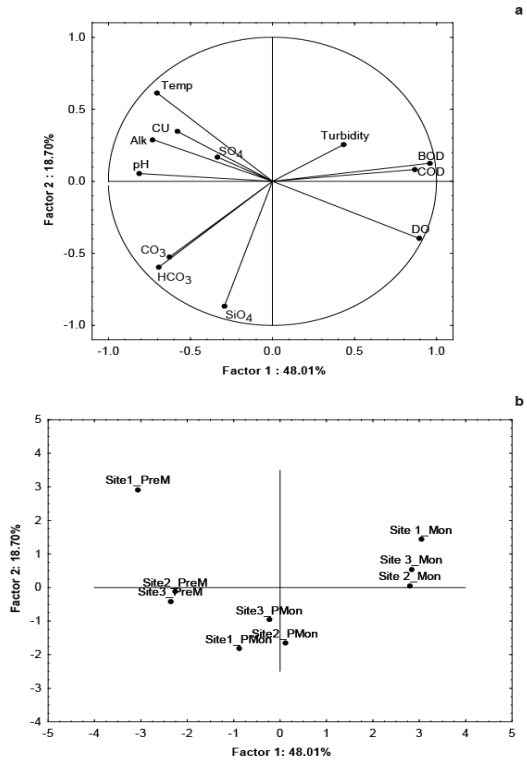

Fig: Principal component analysis of seasonal physicochemical parameters using for the study area. (a) loading of physicochemical parameters and (b) sites and season.

2 -Way ANOVA:

Table . 4. Results of 2-way ANOVA result and Tukey'sposthoc test. Only significantly high values are given

	Source	SS	Df	MS	F	P	Highest
pH	Site (St)	0.63	2	0.316	15.54	0.000	
	Season (S)	3.64	2	1.823	89.70	0.000	
	St*S	1.15	4	0.287	14.15	0.000	Site 2PreM
Temp	Site (St)	0.65	2	0.33	3.7	0.04	
	Season (S)	8.07	2	4.04	45.7	0.000	
	St*S	3.09	4	0.77	8.8	0.000	Site 1PreM
Con	Site (St)	457.46	2	228.73	2385.85	0.000	
	Season (S)	164.28	2	82.1427	856.81	0.000	
	St*S	107.61	4	26.9048	280.64	0.000	Site 1 PreM>PostM
Turb	Site (St)	20832.66	2	10416.33	788.55	0.00	
	Season (S)	18444.22	2	9222.11	698.14	0.00	
	St*S	46577.46	4	11644.36	881.51	0.00	Site 1 Mon
TS	Site (St)	550511862	2	275255931	3072.21	0.00	
	Season (S)	234263883	2	117131941	1307.34	0.00	
	St*S	161203294	4	40300824	449.81	0.00	Site 1 PostM>PreM
TDS	Site (St)	537995413	2	268997706	2481.84	0.00	
	Season (S)	230666061	2	115333031	1064.09	0.00	
	St*S	169675677	4	42418919	391.37	0.00	Site 1 PostM>PreM
TSS	Site (St)	55890	2	27945	3.58	0.04	
	Season (S)	32191	2	16095	2.06	0.15	
	St*S	455431	4	113858	14.61	0.000	Site1 PostM>Mon
DO	Site (St)	0.3800	2	0.1900	15.09	0.000	
	Season (S)	6.3356	2	3.1678	251.56	0.000	
	St*S	0.7644	4	0.1911	15.18	0.000	Mon Site 2>1>3
BOD	Site (St)	3440.2	2	1720.1	101.20	0.000	
	Season (S)	74794.2	2	37397.1	2200.20	0.000	
	St*S	714.5	4	178.6	10.51	0.000	Mon Site 2>1>3
COD	Site (St)	4308	2	2154	21.39	0.000	
	Season (S)	66724	2	33362	331.22	0.000	
	St*S	9661	4	2415	23.98	0.000	Mon Site 2>1>3
Alk	Site (St)	34056	2	17028	4.714	0.022	
	Season (S)	816299	2	408149	112.98	0.000	
	St*S	65209	4	16302	4.51	0.010	Site 2 PreM
SiO4	Site (St)	810.85	2	405.42	122.06	0.000	
	Season (S)	2183.09	2	1091.54	328.64	0.000	
	St*S	120.37	4	30.09	9.060	0.000	PostM site2>3
SO4	Site (St)	31866.5	2	15933.3	286.17	0.000	
	Season (S)	29898.1	2	14949.1	268.49	0.000	
	St*S	19994.6	4	4998.6	89.77	0.000	Site 1 PreM
Cl	Site (St)	34497922	2	17248961	686.830	0.000	
	Season (S)	8693281	2	4346641	173.07	0.000	
	St*S	9354870	4	2338717	93.12	0.000	Site 1 PreM>PostM
Hard	Site (St)	5122596	2	2561298	2202.81	0.00	
	Season (S)	4036456	2	2018228	1735.75	0.00	
	St*S	3202413	4	800603	688.55	0.00	Site1 PreM>PostM
Sal	Site (St)	7363.10	2	3681.55	2488.22	0.000	
	Season (S)	1753.99	2	876.99	592.72	0.000	
	St*S	1237.58	4	309.39	209.10	0.000	Site1 PreM>PostM
CO3	Site (St)	6.53	2	3.26	22.63	0.000	
	Season (S)	54.03	2	27.01	187.23	0.000	
	St*S	52.56	4	13.14	91.08	0.000	Site 1 PostM
HCO3	Site (St)	42.21	2	21.11	10.48	0.000	
	Season (S)	730.92	2	365.46	181.57	0.000	
	St*S	84.14	4	21.04	10.45	0.000	Site 1 PostM

Two-way ANOVA detected significant site, season and site plus season variability for all the parameters, except for TSS (Table 4). TSS did not show significant seasonal variability in the study area. Significant interaction effect (site plus season) indicates that measured physicochemical variables showed changes as per the sites in different seasons. Based on the two-way ANOVA and TUkey HSD post hoc test temperature, conductivity unit, turbidity, TS, TDS, TSS, sulphate, chloride, hardness, carbonate and bicarbonate showed significantly high values at Site 1 mostly during pre-monsoon and post-monsoon season. Turbidity showed significant variation at all the sites and season, and the Tukey's HSD post hoc test detected significantly high values at site 1 during monsoon. DO, BOD and COD showed significantly high values in all the three sites during the monsoon season. pH and alkalinity showed significantly high values at site 2 during the pre-monsoon season (Table 4).

CONCLUSION:

The study of Sopara Creek shows that, it is highly polluted due to the natural and anthropogenic activities such as industries, agricultural effluents, plastic pollution etc. Less water flow at site 2 and 3 is also one of the reason to increase level of pollutants in the water. Seasonal variation in physicochemical parameters of Sopara creek is mainly depend on seasonal tidal amplitude, fresh water influx, sea water intrusion resulting in continuous exchange of inorganic, organic compounds matter of animal and plant origin. Higher level of pollution is mainly due to discharge of untreated industrial municipal sewage waste directly into the creek. Lack of knowledge among the people about use of insecticides, pesticides and wastes after many rituals are also responsible for increase in pollution. Polluted water not only affects aquatic ecosystem but also affects human health. Based on results of research work it is concluded that, there is urgent need to undertake effective measures to prevent entry of pollutants for the conservation of aquatic ecosystem and its resources.

REFERENCES:

1. APHA. (20th Edition 1998). Standard methods for the examination of water and waste water. Washington: Edn, American Public Health Association.
2. Bendre, H. (2016). A study on sustainable water conservation and management: A need of the community residing At Vasai region of Palghar district. *IJARIIE-ISSN(O)-2395-4396* , Volume 2, Issue (1).
3. B.H. Mehata, C.S.Amin. (2008). A study on sea water pollution levels in Vasai region, Mumbai, India. *Jr. of Industrial Pollution Control* , 24 (1) pp 1-8.
4. Budhratna Bhaware, M. A. (2013). Seasonal variation in physico-chemical parameters and nutrients inwater of Bhatye estuary, Ratnagiri central West Coast of India. *International journal of Environmental sciences* , Volume 3, Number 5.
5. Fakayode, S. O. (2002). Heavy metals contamination of soil and bioaccumulation in Guinea grass (Panicum maximum) around Ikeja Industrial Estate, Lagos, Nigeria.Environ. Geolog. *Environ. Geolog.* , 43: 145-150.
6. FAO; Food and agricultural organisation (1990) African fisheries and environment. food and agricultural organisation of the united nations. Reginal offfice for Africa, Accra. RAFR/19/02. 26pp.
7. Helena, B., Pardo, R., Vega, M., Barrado, E., & Ferna ndez, J. M. (2002). Temporal evolution of groundwater composition in an alluvial aquifer (Pisuerga sRiver, Spain) by principal component analysis. *Water Res.,* , 34(3), 807-816.
8. Kaiser, H. F. (1958). The varimax criterion for analytic rotation in factor analysis. *Psychometrika.* , 23, 187-200.
9. Mahapatra SS, M. S. (2012). Prediction of water quality using principal component analysis. *Water quality, Exposure and health.* , 4(2), 93-104.
10. Mishra, V., 2007. Hydrological study of Ulhas River estuary. *Journal of Aquatic Biology*, 22 (1):97-104

11. Nasrullah R. N., H. B. (2006). Pollution load in industrial effluent and ground water of Gadoon Amazai Industrial Estate (GAIE) Sswabi, nwfp. J. of Agri. Biol. Sci,. *Journal of Agriculture and Biological Science.* , 1(3): 18-24.
12. Pravin Singare, R. S. (2010). Soil pollution along Kalwa Bridge at Thane Creek of Maharashra, India. *Journal of environmental protection* , 1, 121-128.
13. Pravin U. Singare, Manisha P. Trivedi, Ravindra M. 2012. Sediment Heavy Metal Contaminants in Vasai Creek Of Mumbai: Pollution Impacts American Journal of Chemistry p-ISSN: 2165-8749 ; 2(3): 171-180 e-ISSN: 2165-8781
14. Pujar Prasad M., H. H. (2010). Real-time water quality monitoring through Internet of Things and ANOVA-based analysis: a case study on river Krishna. *Applied Water Sciences.* , 10.22.
15. Rastogi Veer Bala and Jayaraj, (1987). *Animal ecology and distribution of animals* . Kadar Nath, Rama Nath, Meerut.
16. Tabatabaie. T. Amiri (2010). The impact on industrial pollution on macrobenthic fauna communities. *African Journal of Environmental Science and Technology* , Vol. 4(9), pp. 547-557.
17. Tirthesh Kumar Sharma, R. S. (September 2016). Seasonal variation in physicochemical parameters of water of Pani ki Dharmasala, Jhansi, India. *International journal of Innovative Research in Science, engineering and technology.* , Volume 5, Issue 9.
18. Velsamy,G. N.Manoharan and S. Ganesan, 2013, Analysis of physicochemical variations in sea water samples Uppanar Estury, Cuddalore, Tamilnadu, India. International journal of Research in Biological sciences; 3(2):80-83.
19. Zarith Sufani and Mohd Ishak. (Dec. 2015). Determination of heavy metal accumulation in fish species in Galas river, Kelantan and Beranang mining Pool, Selangor. *www.researchgate.net/publication/284114077* .
20. WHO (2004), Guidelines for drinking water. (3rd Edn.) Geneva.