

Physicochemical Fingerprinting And Water Quality Index (WQI) Profiling: Deciphering The Pollution Gradient of The RiverMula Ecosystem

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Abstract- We present a comprehensive study on the physicochemical properties of water samples from the Mula River in Pune, Maharashtra. Water samples are under investigations were collected from Khadkwasla Dam to Sangam Bridge during pre-monsoon (April-May 2018), monsoon (July-August 2018), and post-monsoon (October-November 2018) seasons. The samples' physicochemical properties, including pH, DO, BOD, COD, chloride, nitrate, sulphate, calcium, magnesium, and hardness, were compared to WHO standards. The Mula-Mutha River water in Pune has degraded in quality. The biological oxygen demand has increased to over 30 mg/l, exceeding the allowed limits for bathing. The Municipal Corporation is now supplying enough water for the planned population. More water leads to more sewage, which exceeds the capacity of treatment systems. As a result, more pollution is released into the Mula-Mutha rivers, which flush out Pune's waste. Physicochemical parameters for pre-monsoon, monsoon, and post-monsoon seasons are within WHO limits, with the exception of DO, BOD, COD, chloride, calcium, magnesium, and hardness.

Keywords: Physico-chemical parameters, Municipal Corporation, Mula-Mutha River

I. INTRODUCTION

Prior to 1960, Punwadi people relied heavily on the Mula-Mutha River for residential and agricultural reasons. Maintaining water quality requires accurate measurements. Good water quality leads to better health outcomes than poor water quality. Numerous studies have analysed the physicochemical and microbiological features of Mula Mutha river water to determine its quality (20). Regularly monitoring these indicators is a tough and time-consuming task, even with adequate people and laboratory facilities. Statistical correlation techniques can be used to compare physicochemical parameters. This study investigates 11 physicochemical parameters, including pH, DO, BOD, COD, chloride, nitrate, sulphate, calcium, magnesium, and overall hardness. The physicochemical properties of water samples were compared

to WHO's recommended standards [5]. The goal is to reduce the complexity and dimensionality of massive data sets. Reducing the dimensionality and complexity of a big data set is the goal. Significant correlation can be further confirmed by systematically calculating the correlation coefficient between physico-chemical parameters [2]. The word "water quality" refers to the appropriateness of water to support different operations or applications. There will be specific requirements for the physical, chemical, or biological properties of water for any given use. For instance, there may be restrictions on the pH and temperature ranges for water that supports invertebrate communities or limits on the concentrations of toxic substances for drinking water [3-4]. As a result, a variety of factors that restrict water consumption can be used to describe water quality. As a result, a variety of factors that restrict water consumption can be used to describe water quality. Every usage will have its own requirements and effects on water quality, even though many have certain common requirements for certain factors. Different users' requests for quantity and quality are not always compatible, and the actions of one user may limit the actions of another, either by requiring water of a quality that is outside the range that the other user requires or by degrading the quality while using the water [5-6]. The quantity and quality requirements of various users are frequently compromised in attempts to preserve or enhance a particular water quality. The idea that natural ecosystems should be taken into account when considering strategies for managing water quality is becoming more widely acknowledged. This is due to their inherent worth as well as the fact that they are sensitive markers of alterations or degradation in the general quality of the water, offering a valuable supplement to physical, chemical, and other data. 7-9. Numerous human and environmental factors have an impact on the quality of water. Geological, hydrological, and climatic factors are the most significant natural variables because they have an impact on the amount and quality of water that is accessible. When there is little water available and it is necessary to make the most of the scarce resource, their impact is often highest [10]. The government and international regulations usually establish the requirements for river water

quality and drinking water quality. This international body's primary goal is to maintain the highest and lowest levels of contaminants in water that will be used for different reasons. Even the river and the natural springs were thought to be safe for all intents and purposes, but things have changed as a result of increased industrialization. Therefore, before using the water for different purposes, it must be analyzed [11–12].

II. MATERIAL AND METHODS

In 2018, water samples were taken from Khadkwasla Dam to Sangam Bridge during the pre-monsoon (April–May), monsoon (July–August), and post-monsoon (October–November) phases. A digital pH meter was used to measure the pH during sampling. Standard procedures were used for the laboratory analysis of the samples. Total alkalinity was determined using the titrimetric method, while total dissolved solids and total suspended solids were determined using the gravimetric method (APHA, 1998). For chloride, Mohr's argentometric titration technique was employed [27]. The turbidimetric approach was used to estimate sulphate. In contrast, the EDTA titrimetric approach was used to determine Ca+2, Mg+2, and TH [13]. All of the chemicals utilized were of AR grade.

III. RESULTS AND DISCUSSION

**Observation Table No. 1:
Selected Sampling Stations**

Sr.No.	Name of the sampling station
1	Kharakwasla(Muthariver)
2	Vitthalwadi(Muthariver)
3	GarwareCauseway(Muthariver)
4	HolkarBridge(Mulariver)
5	WakadCauseway(Mulariver)
6	AundhCauseway(Mulariver)
7	BundGarden(Mula-Muthariver)

Observation Table 2: Sampling point variation in Pre-Monsoon Season(summer)

Parameters	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	WHO limit
pH	8.41	6.77	7.74	6.48	6.20	6.11	5.84	6.5to8.5
DO	2.32	0.7	0.8	0.7	0.8	0.8	0.6	7mg/l
BOD	9.53	32	33.4	54	54.2	57	63.5	--
COD	44.1	88.2	90.6	97.5	103.8	188.3	287.5	--
Chloride	49.4	119.3	152.7	268.3	264.5	267.7	279.7	250mg/l
Nitrate	12.4	27.1	28.7	28.2	37.3	42.3	43	50 mg/l
Sulphate	6.3	8.2	8.4	19.1	22	23.3	29.1	200mg/l
Calcium	14	18.3	21.7	36.3	427.	49.1	56	75 mg/l
Magnesium	5.3	7.5	9.3	13.7	12.6	26.4	31	30 mg/l
Hardness	33.12	88.9 1	113.3 2	86.23	189	321	304	300mg/l

**Observation Table No3:
Sampling point variation in Monsoon Season(summer)**

Parameters	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	WHO limit
pH	9. 52	8.2 5	7.7 3	6.6 7	7.3 4	6.32	5.6 8	6.5to 8.5
DO	2. 42	0.9 2	0.7 9	0.6 6	0.7 8	0.84	0.6 4	7mg/l
BOD	10 .0	46. 5	43. 4	48. 7	53. 3	56.6	69. 1	--
COD	46 .2	44. 1	63. 7	83. 4	12 3.7	136. 9	14 3.0	--
Chloride	29 .0	65. 4	21 7.3	231 .3	23 6.6	248. 2	25 9.0	250m g/l
Nitrate	13 .1	17. 1	18. 3	21. 2	19. 4	26.3	36. 0	50 mg/l
Sulphate	16 .0	21. 2	27. 6	29. 9	31. 8	37.6	46. 0	200m g/l
Calcium	21 .2	33. 1	39. 3	48. 2	47. 4	53.5	68. 0	75 mg/l
Magnesium	9. 0	14. 3	16. 2	15. 6	18. 3	24.4	28. 0	30 mg/l
Hardness	23 .1	123 .21	12 8.3	143 .23	16 3.4	198. 7	20 7	300m g/l

**Observation Table No4:
Sampling Point variation in Post Monsoon Season(winter)**

Parameters	S ₁	S ₂	S ₃	S ₄	S ₅	S ₆	S ₇	WHO limit
pH	9.90	8.64	7.97	6.83	6.67	6.12	5.67	6.5to8.5
DO	2.1	0.7	0.6	0.3	0.23	0.19	0.12	7mg/l
BOD	8.4	42.2	39.3	42.1	47.6	51.4	67.0	----
COD	40.1	58.4	67.5	89.2	127.8	187.3	201.0	----
Chloride	36.0	152.2	231.0	257.4	263.1	269.4	273.5	250mg/l
Nitrate	14.0	26.3	37.2	39.3	41.1	46.7	49.0	50 mg/l
Sulphate	19.2	20.3	24.6	29.7	34.9	46.4	57.9	200mg/l
Calcium	23.3	34.6	49.7	70.7	79.4	81.7	87.9	75 mg/l
Magnesium	11.5	17.6	16.1	19.3	24.8	28.3	29.7	30 mg/l
Hardness	30.17	104.44	107.68	127.04	135.86	149.2	167.34	300mg/l

Waters can be characterized using a wide range of water quality metrics. Nonetheless, a few characteristics are particularly significant and require regular attention. Additionally, alternative sets of criteria may be chosen based on the purpose of characterizing a body of water. The parameters that may be ascertained in the field are referred to as field-parameters since the water parameters can be ascertained both analytically, that is, in a laboratory, and in the field during the collection of the water sample. Water samples were taken from Sangam Bridge to Khadkwasla Dam in 2018 during the pre-monsoon (April–May), monsoon (July–August), and post-monsoon (October–November) phases. The logarithmic of the reciprocal of the concentration of H⁺ ions is the definition of pH. Water gets acidic and its pH falls as the quantity of hydrogen ions rises. The fields of medicine, biology, chemistry, agriculture, forestry, food science, environmental science, oceanography, civil engineering, chemical engineering, water treatment and purification plants, and many more depend on pH readings (14). Here, the pH ranges from 5.84 to 8.41 during the pre-monsoon season, indicating that the water is alkaline in the first sampling site, Kharakwasla, and acidic at the sample station, Bund Garden, indicating an increase in H⁺ ion concentration. However, during the monsoon, the pH ranges from 5.68 to 9.52, indicating alkalinity at the first sample station. This could be because water is collected from all sources. The post-monsoon pH ranges from 5.67 to 9.90, indicating that the water at the initial test point is alkaline. A relative indicator of how much oxygen is carried or dissolved in a body of water is called dissolved oxygen. The physical, chemical, and biological processes that are taking place in the body of water affect the amount of dissolved oxygen. The observed values in this case vary from 0.3 to 2.42 mg/L during the entire season. Living things need dissolved oxygen to sustain their biological functions [15–16]. It is also a significant factor in corrosion. The fact that wintertime heat is more conducive to increased photosynthesis is likely the reason for the greater DO concentrations in the winter [17]. Oxygen should be soluble in good water. 7.0 and 7.6 mg/L at 30°C and 35°C, respectively [18–19]. Aerobic biological processes require dissolved oxygen in water. The anaerobic breakdown of the contaminants causes the water to smell bad when there is not enough dissolved oxygen in the water.

The amount of oxygen needed for the biological oxidation of organic matter under aerobic circumstances at 20°C for five days is measured by BOD. In general, the degree of contamination in sewage, waste water, and industrial effluents is directly correlated with BOD [20–21]. The observed values in this case fall between 8.4 to 69.1 mg/L. Here, the Monsoon session at the Bund Garden sample station yielded a higher BOD result of 69.1 mg/L. Any type of

oxidizable contaminants found in sewage are measured by COD [22]. The amount of organic matter in the sewage sample that is both biologically oxidizable and biologically inert is measured by COD [23]. The observed values in this case range from 44.1 to 287.5 mg/L.

All natural waters include chlorides. Chlorides in freshwater sources range from 100 to 200 mg/L [24, 26]. The observed values in this case fall between 29.0 and 279.7 mg/L. Increased chlorine levels are a sign of using water for bathing, laundry, detergent use, etc. The sample's chloride content did not surpass the WHO's maximum allowable level of 500 mg/L for drinking water [28]. Compared to the presence of chloride, the taste of water is less affected by the presence of sulphate [25]. The ICMR recommends a recommended limit of 200–400 mg/L of sulfate in drinking water. The measured levels fall within the WHO limit for the remaining criteria, such as hardness, calcium, and magnesium [28].

IV. CONCLUSION

With the exception of a few sampling locations for two or three parameters, such as hardness and chlorides at the pre-monsoon stage, it is determined that the physico-chemical parameters of the Mula-Mutha River are within the WHO's allowed limit. COD and BOD after the rains. The presence of dissolved salts and carbonates from the surrounding soil, garbage from temples, additional home waste, industrial waste, and agricultural waste—mostly organic matter—as well as other solid waste entering the water are the main causes of pollution in the Mula-Mutha River.

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