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Water Quality Analysis of Ulhas River, Maharashtra, India

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Abstract — In the present study River Ulhas had been selected, as it is an important major river flowing in Mumbai Metropolitan Region. In the last few decades, river water quality is largely influenced by a good number of anthropological factors. The present study is done to understand river water quality by studying the physical and chemical parameters. Samples from ten different locations had been collected from the various sections of the river and tested in a laboratory, but only the first five samples, from starting of the source of river Ulhas have been considered in this present study. The derived results show that the water of the Ulhas River is getting polluted day by day with regard to physicochemical parameters. This issue needs to address by the various authorities to avoid further deterioration of the river water quality.

Keywords— **Water quality, Ulhas River, Water pollution, Water quality monitoring, Physico-chemical**

INTRODUCTION

Water is the basic requirement of all the living organisms on the earth. The presence of water is the reason, behind earth being the only planet to support life. For human survival, water is the basic requirement. Water played a very important role in the evolution of human settlements. Due to the increasing urbanization in the world, industrialization, modernization of agriculture, deforestation, these issues have been raised and these issues lead to spoiling the quality of river water day by day.

The secondary sector in India is growing rapidly since the 1990s. This is leading to a rapid rise in soil, water, air, and noise, pollution. Almost all industries carry out their polluted liquid wastes in nearby streams or creeks maybe with some treatment or without treatment. This liquid waste includes toxic chemicals, toxic heavy metals, pesticides, and many other chemicals. This disposal severely affected the excellence of water, whenever international standards were applied to this water [1,2]. The environmental situation is many ways far from acceptable in India, as many industries are not following the rules and regulations given by the Central Pollution Control Board (CPCB) and Pollution Control Boards of various States.

Mumbai is not just a metropolitan city in the state of Maharashtra, but it is also the financial capital of India. A large part of the Ulhas River basin falls in the MMR, which is experiencing rapid urbanization, industrialization, and infrastructure development. According to

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Singare, Sahu KC, Zingade (2012, 1983, 1980), the increasing numbers of industries are responding to an increase in the intensity of waste effluents into the Ulhas River. There is a need of carrying out a periodical assessment of the water quality of the rivers and then take appropriate measures to avoid water pollution. This thought inspired the researcher to carry out a systematic and detailed study of water quality analysis of the Ulhas River.

STUDY AREA

The Ulhas River is perennial in its lower course and seasonal in the upper hilly section of the Western Ghats. The Sahyadri range is along the eastern side of the western coastal plain, which is a very important physiographic division that affects climate too. The Ulhas River originates near the Rajmachi hills, which is a part of the Sahyadri range of the Western Ghats in the state of Maharashtra (Fig-1). The Ulhas basin extended between latitudes of 18^0 44' to 19^0 42' North and longitudes of 72^0 45' to 73^0 48' East. The basin stretched for about 112.49 kilometres till entering the sea near Vasai town. The Ulhas basin has an area of 4733.8 km^2 and gets 2934 mm annual rainfall mainly from south-west monsoon winds [3,4].

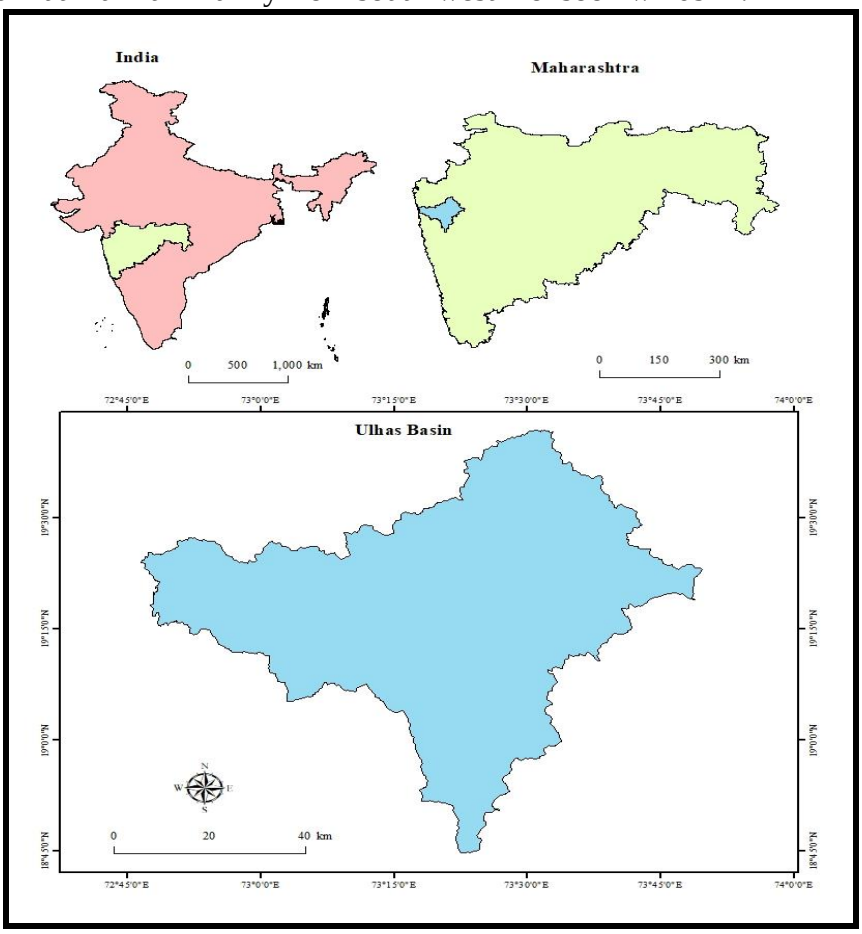

Fig-1: Study Area –Ulhas Basin

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In the lower course of the Ulhas River, Arabian Seawater enters the river channel during high tide and move up to the town of Kalyan. This section of the river channel is associated with characters such as tidal currents, low depth, mangrove type of vegetation, the gradient in salinity, daily changing temperature, etc. From Kalyan town in the Nouth-East direction, the estuarine part of the river begins to headword side of Ulhas River, and it meanders for 40 kms till joining to the Arabian Sea. The Ulhas River is shallow in the lower course due to having sediments from its catchment area [5]. The Ulhas River originates near Khandala in the Pune district and then passes through Karjat tehsils of the Raigad district. Then Ulhas flows through Badlapur, Ambarnath, Ulhas Nagar, Ambivli, Kalyan, and Dombivali areas and at the last meets the Arabian Sea near Vasai Fort. River Ulhas receives a few tributaries and they are Kamwadi, Pej, Chilar, Murbadi, Varna, Kalu, and Bhatsa. Most of the tributaries join the main river from the right bank side due to local topography. The upper part of the river basin is associated with rural land use such as hill slopes, forests, agricultural fields, grasslands and a small proportion of the built-up area. The lower part of the basin is associated with urban land use such as industries, slums, residential buildings etc. In this research paper, an investigation is carried to understand the impact of land use on the water quality of the river.

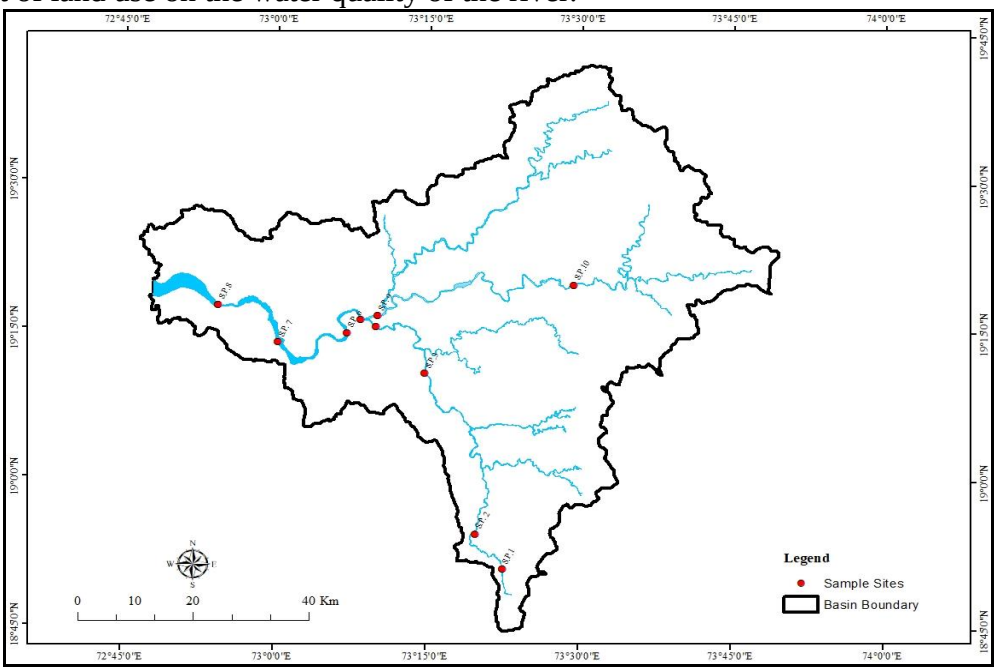

Fig-2: River Ulhas and its tributaries with water sampling sites (SP.1 to SP.5)

After passing the Ulhas Nagar, Ulhas River flows under the bridge which connects Ambivli and Shahad. The Bhatsa River and Kalu River has a confluence near Titwala town and then at a short distance, they join with River Ulhas. These two tributary rivers contribute to nearly 56 % catchment area from Ulhas River. From Kalyan toward the Arabian Sea, the river Ulhas flows just above sea level. This section of the river is associated with mudflats, mangroves and some rocky stretches. Fig -2 shows the river basin of the Ulhas along with its tributaries and spots from where water samples were collected for the study.

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METHODOLOGY:

This study is based on the primary data collected during the month of August 2020 at five locations across the river channel of Ulhas. The samples were collected from riverbanks and from the themed channel of the rivers. These samples were tested for 18 parameters. The colour, odour and temperature parameters were observed and noted by the researcher whereas other parameters were tested in the laboratory. The other parameters were potential of hydrogen (pH), turbidity, hardness, suspended solids (SS), dissolved oxygen (DO), lead (Pb), zinc (Zn), cadmium (Cd), arsenic (As), iron (Fe), nitrate, phosphates, biochemical oxygen demand (BOD), chemical oxygen demand (COD) and fluoride (F). The samples were tested in, "Pollution Control Cell" of Thane Municipal corporation, Thane. All these parameters were analysed by using various methods as per AWWA, APHA, and WPCF (1982). The data is tabulated and interpreted as following:

Table 1: Water sample collection places.

Sample sites	**Place**	**Address**	**Latitude**	**Longitude**
SP.1	Chochi	At the upstream of river Ulhas, near Village Chochi, Tehsil Karjat, Dist. Raigarh.	18°50'56.94"N	73°22'31.12"E
SP.2	Dahivali	At the upstream of river Ulhas, near village Dahivali, Tehsil-Karjat, Dist. Raigarh	18°54'30.16"N	73°19'48.34"E
SP.3	Manjarli Gaon	At the upstream of river Ulhas, near Manjarli Gaon, Badlapur, Dist. Thane.	19°10'42.76"N	73°14'42.64"E
SP.4	New Visarjan Ghat	Ulhas River at the upstream of river Ulhas, at New Visarjan Ghat, Tehsil- Ulhas Nagar, Dist. Thane	19°15'23.09"N	73°9'54.24"E
SP.5	Gandhari Bridge	At the Gandhari Bridge on the Ulhas River, Close to Aadharwadi, Tehsil- Kalyan, Dist. Thane.	19°16'5.96"N	73°8'26.15"E

RESULTS AND DISCUSSION:

TABLE 2: PHYSICOCHEMICAL PROPERTIES OF WATER AT VARIOUS LOCATIONS IN THE RAINY SEASON 2020

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		Sample sites in Ulhas basin						
Sr. No.	**Parameters and unit of measurement**	**SP.1**	**SP.2**	**SP.3**	**SP.4**	**SP.5**	**Average**	**Normal Range Requirement (Acceptable Limits) Indian water quality standards 10500 - 2012**
1	Colour -	Clear	Clear	Yellowish	Light Brown	Yellowish	-	-
2	Odour -	Odour free	Odour free	Unpleasant	Rotten eggs	Fishy	Unpleasant	-
3	Temperature ^{0}C	30.20^0	30.20^0	30.50^0	31.20^0	31.50^0	30.72^0	-
4	pH -	7.71	7.82	7.44	7.39	7.25	7.52	6.5 – 8.5
5	Turbidity -*NTU*	12	12	14	17	14	13.8	1 NTU
6	Hardness – *mg/L*	52	47	100	72	52	64.6	200
7	Suspended Solids *(SS) mg/L*	27	35	30	35	27	30.8	100
8	Dissolved Oxygen *(Do) mg/L*	7.54	7.46	5.31	7.06	6.66	6.80	6.5 – 8
9	Lead *(Pb) mg/L*	00 *(BDL)*	0.92	00 *(BDL)*	0.18	00 *(BDL)*	0.22	0.01
10	Zinc *(Zn) mg/L*	0.2	0.1	0.2	0.1	0.2	0.16	5
11	Cadmium *(Cd) mg/L*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	0.003
12	Arsenic *(As) mg/L*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	0.01
13	Iron *(Fe) mg/L*	00 *(BDL)*	0.96	00 *(BDL)*	0.26	0.12	0.26	0.3
14	Nitrate *(NO_3) mg/L*	00 *(BDL)*	00 *(BDL)*	5.1	00 *(BDL)*	1.9	1.4	45
15	Phosphates *(PO_4) mg/L*	0.23	0.26	0.33	0.23	0.22	0.25	0.1
16	Biochemical Oxygen Demand *(BOD) mg/L*	5	5	6	6	8	6	03 mg/l or less
17	Chemical Oxygen Demand *(COD) mg/L*	15.2	11.5	15.7	16.3	16.3	15	250
18	Fluoride *(F) mg/L*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	00 *(BDL)*	1.0

[BIS- Bureau of Indian Standards, (Bhavan et al. 2012)], [BDL: - beyond detection limit, *BDL* is considered as 00]

1. Colour: There is no suggested good or bad colour by the Bureau of Indian Standards. Only 2 water samples (SP1, SP2) were observed with clear or without any colour among the 5 samples.

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At sample stations SP3 and SP5, water was observed yellowish and at the sample station, SP4 was observed having a light brown colour. This is due to the monsoon rains.

2. Odour: BIS has not given any specifications about the odour of drinking water. During the sample collection, it was found that only 2 water samples SP1 and SP2 were odour free, and the remaining water samples SP3, SP4, and SP5 were having unpleasant, rotten eggs and fishy odours, respectively. This is mainly due to the impact of waste disposal from the urban areas.

***3. Temperature*:** The average water temperature is 30.72^0C observed in the Ulhas River. No wide fluctuations were observed in water temperature between all the sampling stations. There was no variation in water temperature due to the rainy season as there was very high rainfall on the day on which the water samples were collected.

4. Potential of hydrogen (pH): The standard range of water pH is from 6.5 to 8.5 according to the Indian water quality standards. pH 7 of water is Neutral. pH less than 7 is acidic and greater than **7 is alkaline**[6–11]. The pH of river water was found lowest during monsoon seasons due to heavy rainfall [12]. The average pH of all 5 locations is 7.52, which is indicating the good quality of water. All 5 water samples were within the desired standard limit.

5. Turbidity: The desired limit of water Turbidity is 5 NTU for "A" class quality water According to the Indian water quality Standard [13,14]. The acceptable limit of Turbidity is 1 Nephelometric Turbidity unit means 1- NTU, and the Permissible limit of Turbidity is between 1 to 5 NTU. The average Turbidity of water from all 5 stations of river Ulhas is 13.8 NTU. In all water samples' the turbidity is beyond the permissible limit. It is mainly due to the impact of the heavy monsoon.

6. Hardness: According to the 2002 water code, the desirable limit of Hardness is 200 mg/L, and it is permissible up to 600mg/L. Hardness is generally stated as the calcium carbonate in milligrams equal to each litre. When the concentration of calcium carbonate in water is less than 60 mg/L then it is considered soft water, when it is between 60 to 120 mg/L then it is considered moderately hard water when it is in between 120 to 180 mg/L it is identified as hard water and when found the concentration of calcium carbonate more than 180 milligrams it is considered too hard water [6]. The average hardness of all 5 samples is 64.6mg/L. It comes in the moderately hard category. It is observed that the hardness is within the desired limit, but it is a sudden increase in Badlapur (SP3) as compared with the other water monitoring points. It is due to the addition of effluent discharge from Badlapur MIDC and sewage water from the Badlapur residential area.

7. Suspended Solids: According to the Environment Protection Rules, 1986, the desired water quality limit is 100 mg/L for inland surface water. The average suspended solids found 30.8 mg/L in the river Ulhas. It is in the limit as per BIS. The values of suspended solids at water monitoring points SP1, SP2, SP3, SP4, and SP5 were 27, 35, 30, 35, 27 mg/L, respectively. The data indicate that the concentration of suspended solids in all monitoring points is within the desired limit.

8. Dissolved Oxygen (DO): The desirable and Permissible limit of Dissolved Oxygen is 6.5 to 8.0 mg/L. If the amount of DO present in water is low that responsible for organisms become stressed, suffocate, and die [2]. After analyzing the data found that the average level of DO is 6.80mg/L, which is within the permissible limit. Water monitoring point SP3 has a low amount

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of DO (5.31mg/L), which is very less than desirable and permissible limit. DO is found lowered at the water monitoring point Badlapur (SP3) due to the addition of a variety of industrial biodegradable pollutants which stimulate the growth of organisms and algal growth.

9. Lead (Pb): The desirable and permissible limit of Lead is 0.01mg/L. Presence of more amount of Lead effect neurological disorders, blood disorders, problems in hearing, hypertension, problems in kidney functions and mental problems. The average amount of Lead present in Ulhas River is 0.22, which is more than the desired and permissible limit. The data indicate that water monitoring points SP2 and SP4 have the more amount of Lead that is 0.92 and 0.18 mg/L, respectively.

10. Zinc (Zn): The desirable limit of Zinc is 5mg/L and the permissible limit is 15mg/L. The average amount of Zinc present in the river Ulhas is 0.16mg/L. It is observed that the amount of Zinc at all water monitoring points SP1, SP2, SP3, SP4, and SP5 was within desired limits.

11. Cadmium (Cd): The desirable and permissible limit of Cadmium is 0.003mg/l. Cadmium is beyond detection level (BDL) at all water monitoring points.

12. Arsenic (As): The permissible and desirable limit of Arsenic is 0.01mg/l. Arsenic is also beyond detection level (BDL) at all water monitoring points.

13. Iron (Fe): As per BIS (2012), the permissible and desirable limit of Iron is 0.3 mg/L. The average amount of Iron is found at 0.26 in the river Ulhas, which indicates that the amount of Iron is within the desirable and permissible limit. The iron was found beyond the detection level at water monitoring points SP1 and SP3. But at water monitoring point SP2 is detected 0.96 mg/L, which is beyond the desirable and permissible limit. Water monitoring points SP4 and SP5 has the amount of Iron is 0.26 and 0.12 mg/L, respectively.

14. Nitrate (NO_3): According to the BIS (2012), the permissible and desirable limit of Nitrate is 45 mg/L [15]. The average amount of Nitrate is 1.4mg/L in the river Ulhas. All water monitoring points are within the desired and permissible limit. The amount of Nitrate found at monitoring points SP1, SP2, and SP4 is beyond detection level. The amount of Nitrate found at the monitoring points SP3 and SP5 have 5.1 and 1.9, respectively. Nitrate helps to identify the contamination in water. It is also an essential nutrient for living things. Nitrates originate from the system of sewage disposal, inorganic fertilizers, and manures. A level of Nitrate above 5mg/L is considered harmful to aquatic animals. This situation is observed at monitoring point SP3 (5.1) due to effluent discharge from Badlapur MIDC and the residential area.

15. Phosphates (PO_4): The desirable and permissible limit of Phosphate is 0.1 mg/L. The average amount of Phosphates found was 0.25mg/L during the period of study in the river Ulhas. Water monitoring point SP1, SP2, SP3, SP4, SP5, has the amount of Phosphates is 0.23, 0.26, 0.33, 0.23 and 0.22 mg/L, respectively. The amount of Phosphate at all water monitoring points was beyond the desirable and permissible limit. Phosphate/Phosphorus are observed in the water due to the addition of urban and wastewater from industries that affected nutrients in soils like manure, inorganic fertilizer, or sludge of sewage. Land overflow increases the phosphorus/phosphates throughout the rainy seasons [16].

16. Biochemical Oxygen Demand (BOD): The Permissible and desirable limit of BOD is 30 mg/L. The average amount of Biochemical Oxygen Demand (BOD) is 6mg/L, which is within

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the desirable and permissible limit. The amount of Biochemical Oxygen Demands at all water monitoring points SP1, SP2, SP3, SP4, and SP5 have been observed 5, 5, 6, 6, and 8 mg/L, respectively. It indicates that the quality of water is good. More amount of BOD in water denotes water pollution. The amount of DO in water effects the BOD.

17. Chemical Oxygen Demand (COD): The desirable and Permissible limit of COD is 250 mg/L. The average amount of Chemical Oxygen Demand is found 15mg/L in the river Ulhas. The water monitoring points SP1, SP2, SP3, SP4, and SP5 have an amount of chemical oxygen demand is 15.2, 11.5, 15.7, 16.3, and 16.3, respectively. It is also observed from the data that the amount of Chemical Oxygen Demand at all water monitoring points was in the desirable and permitted limit.

18. Fluoride (F): The 1.0 mg/L is the desirable and permissible limit of Fluoride. The Fluoride was found beyond detection level at all monitoring points. In the study executes by Jadhav [1], fluoride was detected in the year 2013 at 3 sample points S2, S3, and S4 when concentration was 0.14, 0.08, and 0.10 mg/L respectively. But in this present study, after observation of data, we can conclude that the concentration of Fluoride is not detected because of COVID 19 Pandemic disease as this resulted in lockdown situations. All companies were shutting down from the mid of March 2020. This situation affected positively and with that monsoon also helped to flush out the polluted water into the Arabian Sea from the Ulhas River.

1.6. CONCLUSION

After analysis of the 18 water quality parameters it is clearly showed that the water of the Ulhas River is polluted to some extent in relation to physico-chemical parameters. The results also revealed that after having 3 months' complete lockdown due to Covid 19 pandemics from the end of March 2020 improved the quality of water.

All industries were shut down, transportation was completely stopped during this period of lockdown and rainfall supported to flush out the polluted water hence water quality is improved. The data on water quality creates a possibility for research on - water pollution, and health check. Outcomes from the present study necessitate continuous water quality monitoring of the river Ulhas. There must develop a system of continuous monitoring and maintaining the quality of water for saving the river.

Conflict of Interest

The Author(s) declare no conflict of interest.

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