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Water Quality Analysis of Mula-Mutha River

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Abstract: ***Urbanization is one of the great prospects for development of a developing country like India. With this increasing rate of urbanization, various problems arise and one of the major problems that India faces in the current scenario is the provision of clean drinking water due to the flow of migrants to the cities. The control of water pollution of rivers requires large efforts, and water quality is an important issue in the field of water resources planning and management and requires data collection, laboratory analysis, and data interpretation. Consistent monitoring of river water quality and establishment of long-term management helps for protection of valuable water resource. In general, for a comprehensive surface and groundwater quality assessment, physical, chemical and biological water quality parameters are required. The spatial changes in different water quality parameters for Feb 2020 along the river reach have been studied; both onsite result and laboratory results have been compared.***

Keywords: Mula-Mutha River, Water quality, Analysis, Comparison.

I. INTRODUCTION

The Mula-Mutha is a river in India, in the city of Pune molded by the union of the Mula and Mutha rivers, which later convenes the Bhima River, greeting the Krishna River further and finally evacuates into the Bay of Bengal. Parts of the river are among the 351 most highly polluted stretches listed by the Central Pollution Control Board and thus one of the most contaminated rivers in India. The study has been incorporated for a reach of about 27 Km of the Mutha River starting from the Khadakwasla Dam at the upstream with the total reservoir capacity of 341 million cubic meters which later joins the river Mula. The Mundhwa weir is the end point of our study area. The control of water pollution of rivers requires large efforts, and water quality is an important issue in the field of water resources planning and management and requires data collection, laboratory analysis, and data interpretation. Consistent monitoring of river water quality and establishment of long term management helps for protection of valuable water resource.[1]

II. MATERIALS AND METHOD

The cross sections of the river geometry (provided by CWPRS) were taken at every 30 meters of distance for a reach of 27 Km of river Mutha. The upstream end noted at Khadakwasla Dam with river station no 27000 meters to the downstream end at Mundhwa weir with river station no 0 meters. The flow was presumed to be steady throughout the reach length.

The cross sections data and the discharge data with its corresponding water levels were provided by Central water and Power Research Station, Pune. The water samples for its quality test were taken at seven different locations using the portable Water Quality meter which displayed the Water Temperature, DO, pH, TDS, Conductivity, Salinity, Turbidity and Depth.[1]

A. Guidelines for Sample Collection

1) Samples are collected at the downstream of the point source pollution
2) Sampling in stagnant water or at a place where reverse flow occurs is avoided.
3) The samples are collected just below the water surface avoiding the influence of surface boundary effects also avoiding going too close to the channel bed.

Site visits across Mula-Mutha river was organized during 25 Feb to 29 Feb by CWPRS team. Gorhe, Khadakwasla, Vitthalwadi, Dattawadi, Bund Garden, Kharadi, Mundhwa, Khamgaon, Pargaon and Daund were various locations for sample collection.

Samples were collected following the guidelines given by CWPRS officials. Instrument Sonde was used onsite which gave data like latitude, longitude, salinity, DO, alkalinity, TDS and temperature. 5 liter can and glass bottles were used for sample collection for determination of various physico-chemical parameter like DO, BOD, pH, electrical conductivity, cation (Ca^{+2} and Mg^{+2}), anions (Co_3^{-2}, HCO_3^{-}, SO_3^{-2}, Cl^{-}) and silica. [2]Biological samples are collected in 1liter plastic cans and microbiological samples were collected in sterilized bottles.

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III. TEST ON SAMPLE

A. Tests for Dissolved Oxygen

Water samples for each site were taken in three borosil bottles of 300ml each. One of the bottles were fixed at the site by adding Alkali Iodide Azide Solution and Magnus Sulphate which traps all the oxygen present in the water sample in the form of precipitate. The 2nd bottle is covered with aluminum foil and the 3rd bottle is kept in normal conditions for 24 hours after which they are fixed. Then titration is done with Sodium Thiosulfate ($Na_2S_2O_3$) in the burette and 200ml of water sample in the conical flask along with few drops of Sulfuric acid (H_2SO_4) for dissolving the precipitate and starch as indicator.[2]

B. Tests for Biochemical Oxygen Demand

Water samples for each site were taken in two BOD bottles of 300ml each for initial and final tests. Nutrients namely Calcium Chloride ($CaCl_2$), Iron (III) Chloride ($FeCl_3$), Phosphate Buffer and Magnesium Sulphate ($MgSo_4.7H_2O$) were added in both the bottles after which the initial bottles were fixed while the final bottles were kept in the BOD incubator for 5 days. The BOD bottles were taken out from the incubator after 5 days and then DO was fixed by adding Alkali Iodide Azide Solution and Magnus Sulphate. Later titration was carried out same as for DO.

C. pH

pH is a scale used to indicate the acidity or basicity of a water-based solution. The pH scale is logarithmic and is inversely associated to the concentration of hydrogen ions in any solution. pH value ranges from 1 to 14 and a value below 7 shows an acidic character while 7 and above show a basic character at 25°C. It can be measured through a glass electrode, a pH meter or a colour changing indicator like methyl orange\phenolphthalein. The range 6.5 to 8 is preferred for the existence of the freshwater aquatic organisms.pH of the water samples was further tested in the laboratory using four methods namely, pH paper, by a universal indicator, by digital meter and by a portable meter. [3]

D. Turbidity

Turbidity in fluid is due to the occurrence of a large number of particles invisible to naked eye but comparable to smoke in air. It is a visual characteristic of any fluid, here specifically water. More the number of suspended solids in the water sample higher the turbidity. Higher turbidity in water also raises the temperature of water, lowers the DO, prevents light from entering into the water body and reaching the aquatic life reducing the photosynthesis in plants and harming the fishes.

It is generally measured in terms of NTU (Nephelometric Turbidity units).Standards of 20, 40, 100 and 400 NTU are prepared from a previous sample of 4000 NTU.

Turbidity was measured using digital as well as portable meters in the laboratory. In the digital meter, the distilled water was set to zero and calibrated by setting 100 NTU to 100 by the calibrating knob which was further used to record values for the 20, 40, 100 and 400 NTU standard samples. Then the water samples are tested in the digital meter.

E. Conductivity

Conductivity is the measure of proficiency of water to conduct electrical flow though it which is in direct relation with the ion concentration present in the water. Dissolved salts and inorganic materials such as alkalis, sulfides, chlorides and other carbonate compounds are the main sources for these conductive ions in the water. Conductivity of water rises with the increase of ion concentration, still keeping it electrically neutral as the positive and negative ions remain equal. Conductivity is usually expressed as micro or milli Siemens per centimeter (µS/cm or mS/cm). For freshwater the SI unit is micro Siemens per centimeter. The samples are tested using digital as well as portable meters giving the electrical conductivity in µs/cm.[3]

F. Salinity

Salinity is a degree of the aggregate of dissolved salts existing in the water sample. It is the result of a natural process of weathering of rocks or deposition of salt for years by wind and rain in the area. Water used from the rivers in the industrial work with a high amount of salinity may cause corrosion in the machineries, poor health of the aquatic life, and less production of crops when used for irrigation purposes.

Salinity is mostly measured based on application and reporting procedure. As for the standard unit parts per thousand or grams/kilograms (ppt or g/kg) is used. For the freshwater sources it is measured in mg/l.

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G. Total Dissolved Solids

Total dissolved solid is the combination of all the ions smaller than 2 microns (0.0002 cm) including the salinity concentrations. TDS is the same as salinity for the freshwater but includes organic solutes like urea and hydrocarbon along with the salt ions in the polluted areas or the wastewater. It affects the taste of water indicating hardness or high alkalinity present in the water. It is usually put across in terms of mg/l. A high concentration of TDS can cause the cells of aquatic animals to shrink causing them to float or sink beyond their ranges. Same happens with a low concentration of TDS except that the cells swell up which is also harmful.[7]

H. Calcium and Magnesium

The hardness of water sample was tested by determining the amount of calcium and magnesium present in it. First the total hardness was tested using 50 ml of sample and 2ml of (NH_4OH+NH_4Cl) along with eriochrome black T (a complexometric indicator) and titrated with standard solution of EDTA (ethylenediamine tetra acetic acid) till a change of colour from wine red to blue is noticed and the reading was noted. Then the hardness due to calcium was recorded by taking 50 ml of the sample along with 2 ml of 10% KOH and Murexide indicator which was again titrated with the standard EDTA solution until the colour changes from pink to purple and noted. Calcium hardness was then detracted from the total hardness giving the results for magnesium hardness in the sample.[3]

I. Nitrate Nitrogen (NO_3-N)

Nitrate gets into the water and is easily mixed as a result surface runoff from the nitrate containing fertilizers. It also gets formed due to the oxidation of other configurations of nitrogen like nitrite ammonia and organic nitrogen such as amino acids. It is conveyed in terms of mg\l or parts per million. Water with a less amount of dissolved oxygen in it reduces the rate of conversion of ammonium to nitrite and nitrate which is more harmful for aquatic life. 50ml of the sample was taken and evaporated to aridness on hot plate after which 1ml of 1-2-4 phenol disulphonic acid and 10ml of 10% KOH solution was added giving the amount of NO_3-N present.[6]

J. Silica

In wells and surface water, silica content ranges from about 1-100 parts per million.it is present in the form of Quartz which is present in almost all of the earth's minerals. 50 ml of the filtered sample was taken into which 1ml 1:1 of HCL and 2ml of ammonium molybdate was added and kept for 5 minutes. Then 2 ml of oxalic acid was added and absorbance was documented at 410 nm. It is expressed in terms of mg/l.

IV. STUDY AREA

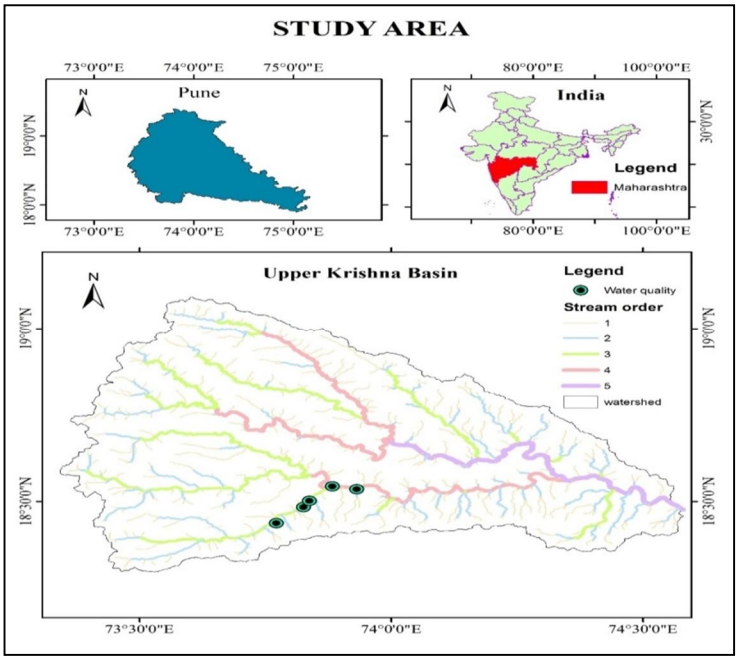

Figure .1.shows the study area

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	Khadakwasla	Vitthalwadi	Dattawadi	Bund Garden	Kharadi	Mundhwa(US)	Mundhwa(DS)
Air Temp	26.4	28.2	30	25.9	26.2	29.3	29.2
Water Quality Parameter							
Water Temp (◦C)	24.5	26.98	25.93	24.4	25.76	25.9	25.5
Conductivity	54.1	564	328	595	606	627	622
DO	7.9	0.11	1.95	0.08	1.69	0.8	4.71
pH	7.76	7.13	7.16	7.09	7.16	7.14	7.25
Turbidity	19.5	377.98	200-600	172	188.94	160.94	149.65
Salinity (ppm)	0.02	0.26	0.15	0.29	0.29	0.3	0.3
TSS	0	0	0	0	0	0	0
TDS	35.4	352.7	212.7	390.95	388.16	400.68	399.5
Depth (m)	0.05	0.4	0.04	0.108	0.085	0.058	0.057

Table.1. Onsite Data Collected Using SONDE instrument

Table.2. Results of Laboratory test

Sampling Station		Khadk wasla	Vittalwadi	Dattawadi	Bundgarden	Kharadi	Mundhwa (u/s)	Mundhwa (d/s)
Physical	pH	7.64	7.05	7.39	7.18	6.91	7.15	7.67
	E.C.	58	578	465	621	630	582	632
	N.T.U.	2.6	10.6	0.87	12.5	12.4	11.6	4.2
Physico-Chemical	D.O.	7.52	0.078	2.27	0.15	1.72	0.94	2.9
	B.O.D.	8.94	21.18	64.92	52.14	49.62	70.02	55.14
Nutrients	NO_3^-	0.123	6.975	6.245	8.99	9.41	8.57	7.195
	PO_4^{3-}	0.333	15.47	13.77	24.46	26.47	25.34	27.86
Cations	Ca^{+2}	22.092	115.24	112.383	117.145	125.717	116.193	117.145
	Mg^{+2}	4.154	32.894	15.581	23.661	28.885	37.511	47.825
	Na^+	20.1	25.1	10.8	12.1	36.3	35.5	18.2
	K^+		4.6	5.2	3.8	12.1	10.8	
Anions	CO_3^{2-}	NIL	NIL	NIL	NIL	NIL	NIL	NIL
	HCO_3^-	97.01	450.42	346.48	346.48	485.07	485.07	415.77
	SO_3^{2-}	5.52	30.6	20.9	36.2	34.1	37.3	37.1
	Cl^-	27.99	67.97	51.98	75.97	75.97	81.97	79.97
Others	Silica	-	1.255	4.66	0.63	1.91	1.91	4.05

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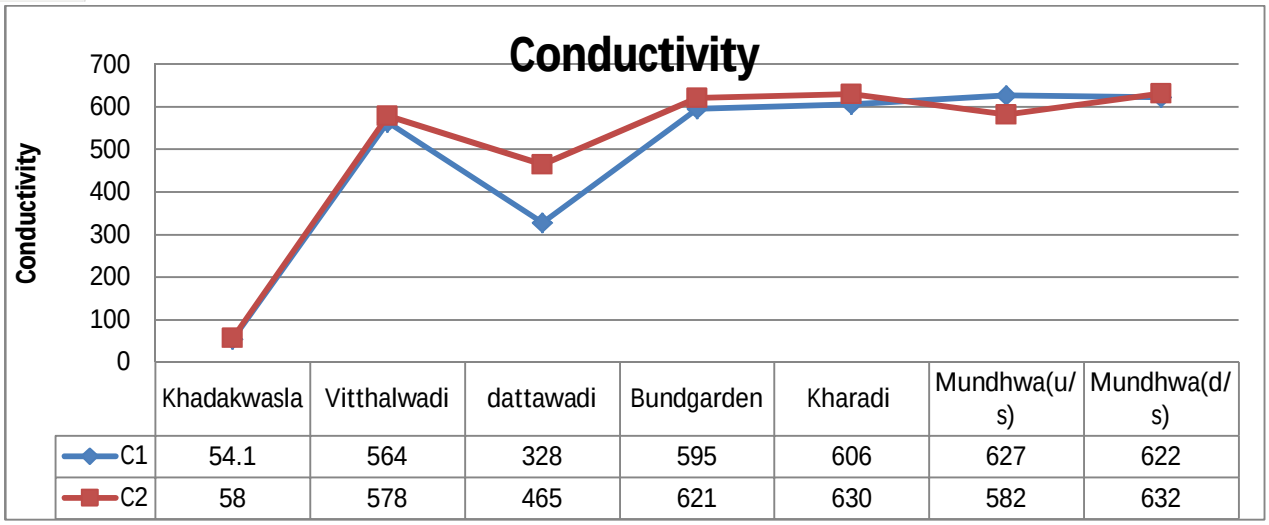
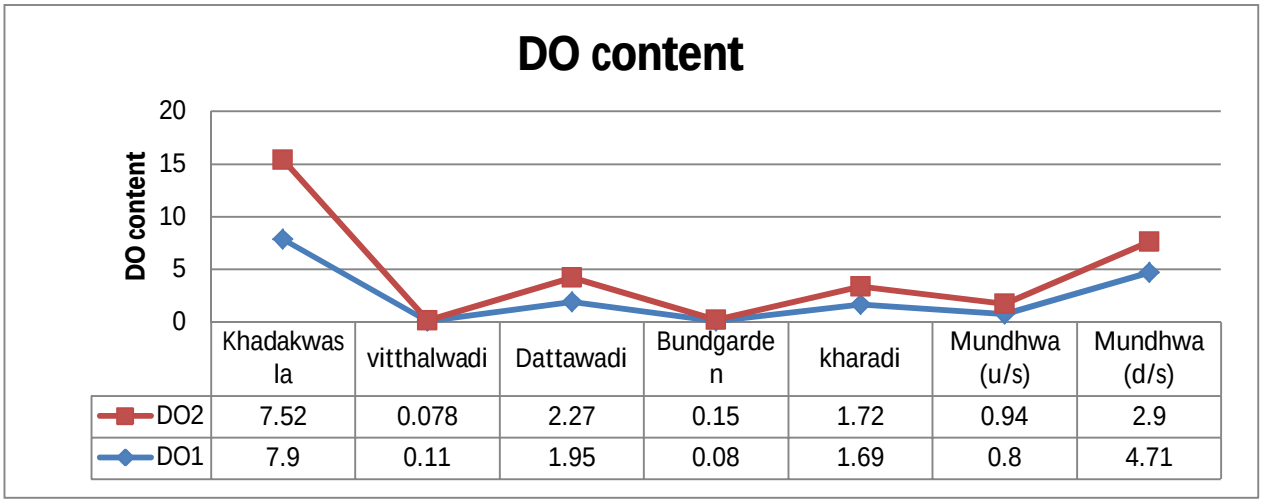


	Khadakwasla	Vitthalwadi	dattawadi	Bundgarden	Kharadi	Mundhwa(u/s)	Mundhwa(d/s)
C1	54.1	564	328	595	606	627	622
C2	58	578	465	621	630	582	632

Graph.1. Conductivity

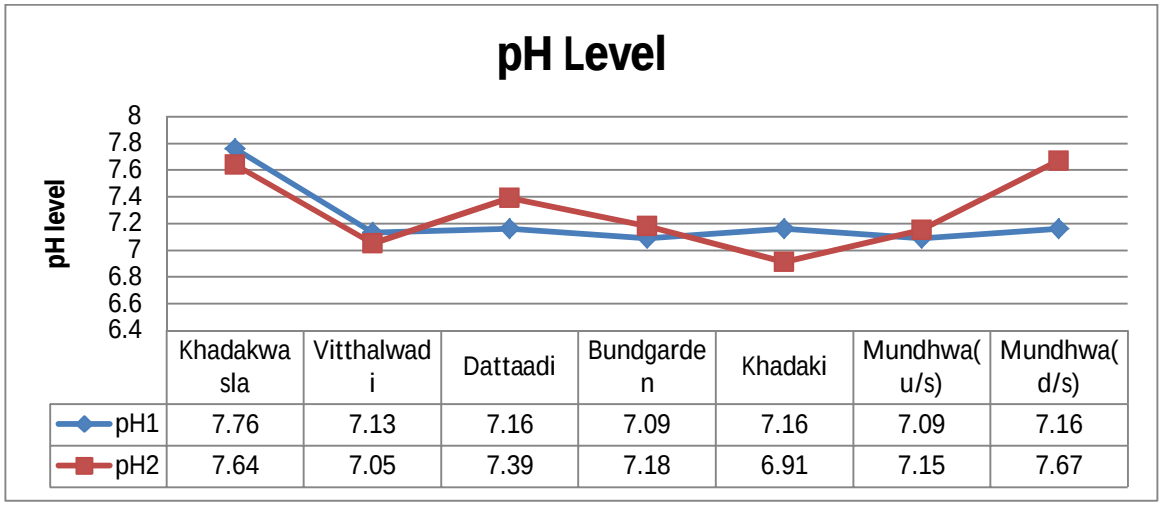
1) C1 represent Onsite data and C2 represent Laboratory data.



	Khadakwasla	vitthalwadi	Dattawadi	Bundgarden	kharadi	Mundhwa (u/s)	Mundhwa (d/s)
DO2	7.52	0.078	2.27	0.15	1.72	0.94	2.9
DO1	7.9	0.11	1.95	0.08	1.69	0.8	4.71

Graph.2. DO content

2) DO1 represent Onsite data and DO2 represent Laboratory data.



	Khadakwasla	Vitthalwadi	Dattaadi	Bundgarden	Khadaki	Mundhwa(u/s)	Mundhwa(d/s)
pH1	7.76	7.13	7.16	7.09	7.16	7.09	7.16
pH2	7.64	7.05	7.39	7.18	6.91	7.15	7.67

Graph.3. pH level

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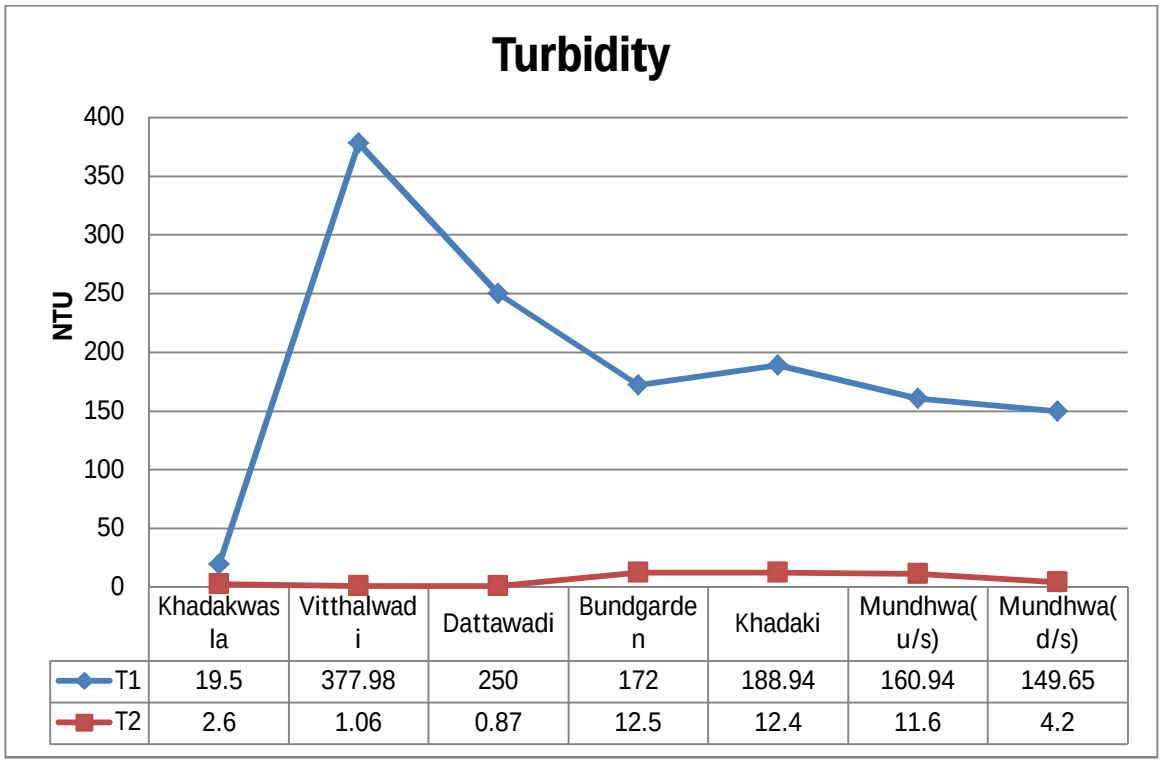
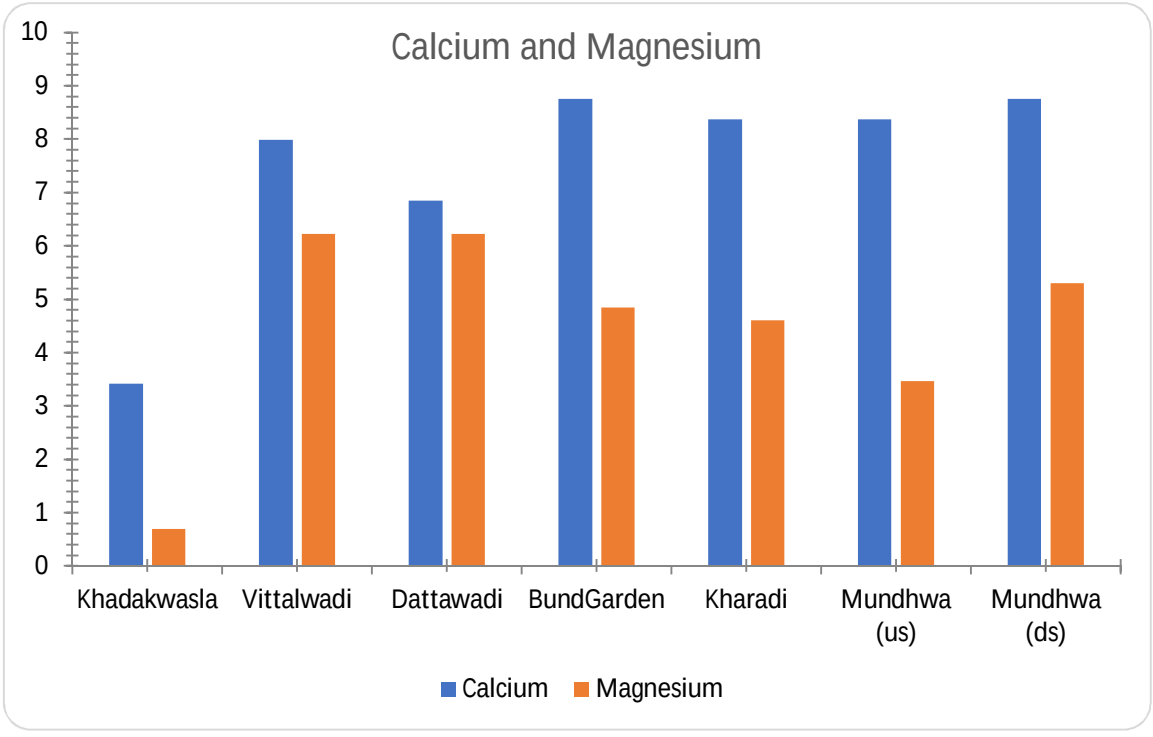
3) pH1 represent Onsite and pH2 represent Laboratory data.



	Khadakwasla	Vitthalwadi	Dattawadi	Bundgarden	Khadaki	Mundhwa(u/s)	Mundhwa(d/s)
T1	19.5	377.98	250	172	188.94	160.94	149.65
T2	2.6	1.06	0.87	12.5	12.4	11.6	4.2

Graph.4. Turbidity

4) T1 represent Onsite and T2 represent Laboratory data.



Graph.5. Calcium and Magnesium of Different Sampling Location

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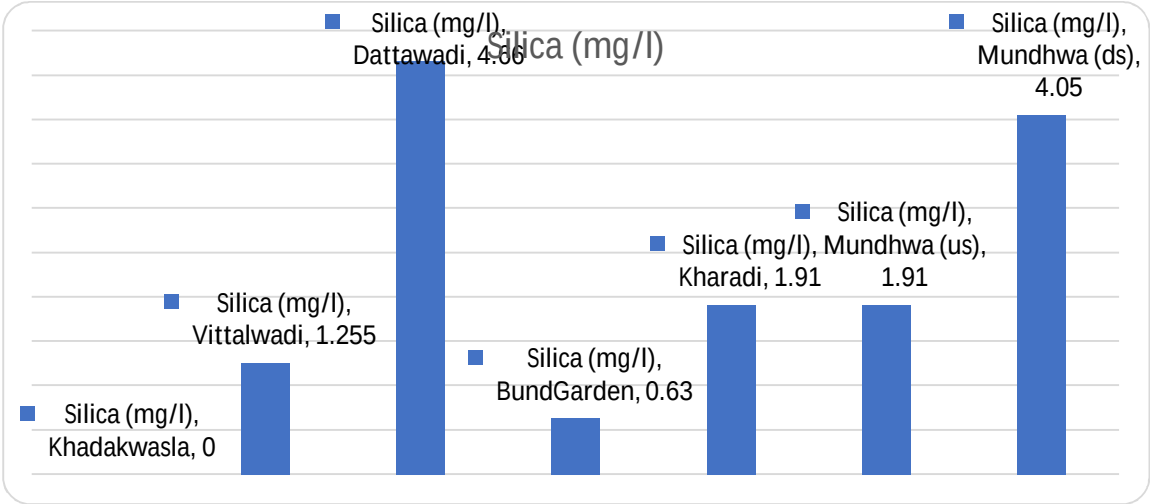

Graph.6. Graphical Representation of Silica for Different Sampling Stations

V. RESULT AND DISCUSSION

The result of the present study is depicted in Table 1&2 and Graph 1-6.Temperature is the important factor for determining rate of chemical process in the aquatic ecosystem. It also influences population fluctuation in the water body. Temperature observed is in range of 24◦C to 27◦C. The electrical conductivity is a measure of mineral contents present in water. Rang varies from 50NTU - 650NTU. Both tests show little variation in the values. Dissolved oxygen plays a very crucial role for the survival of aquatic organism. Shows 0.5mg/l to 8mg/l range and seems to be low for the aquatic life for survival.

Potential of hydrogen (pH) is negative logarithm of the hydrogen ion concentration and shows the intensity of acidity or alkalinity of water. Here observation shows that the water is more basic as all values are above 7.

The turbidity reflects the transparency in water and it is caused by presence of substances in water. Large difference in lab and onsite value is observed. Hardness of water is determined by knowing the amount of calcium of magnesium. Graph 5 shows the presence of Ca and Mg in the sample. Sodium silicate adds silicate anions, together with sodium and hydroxyl ions to water and is found in all natural water here presence range is 0-5 and is harmless.

VI. FUTURE SCOPE

Seasonal variation study can be carried out using same approach of above study.

Software can be used for model development for water quality analysis.

Water quality of different location for different season can be studied.

VII. ACKNOWLEDGEMENT

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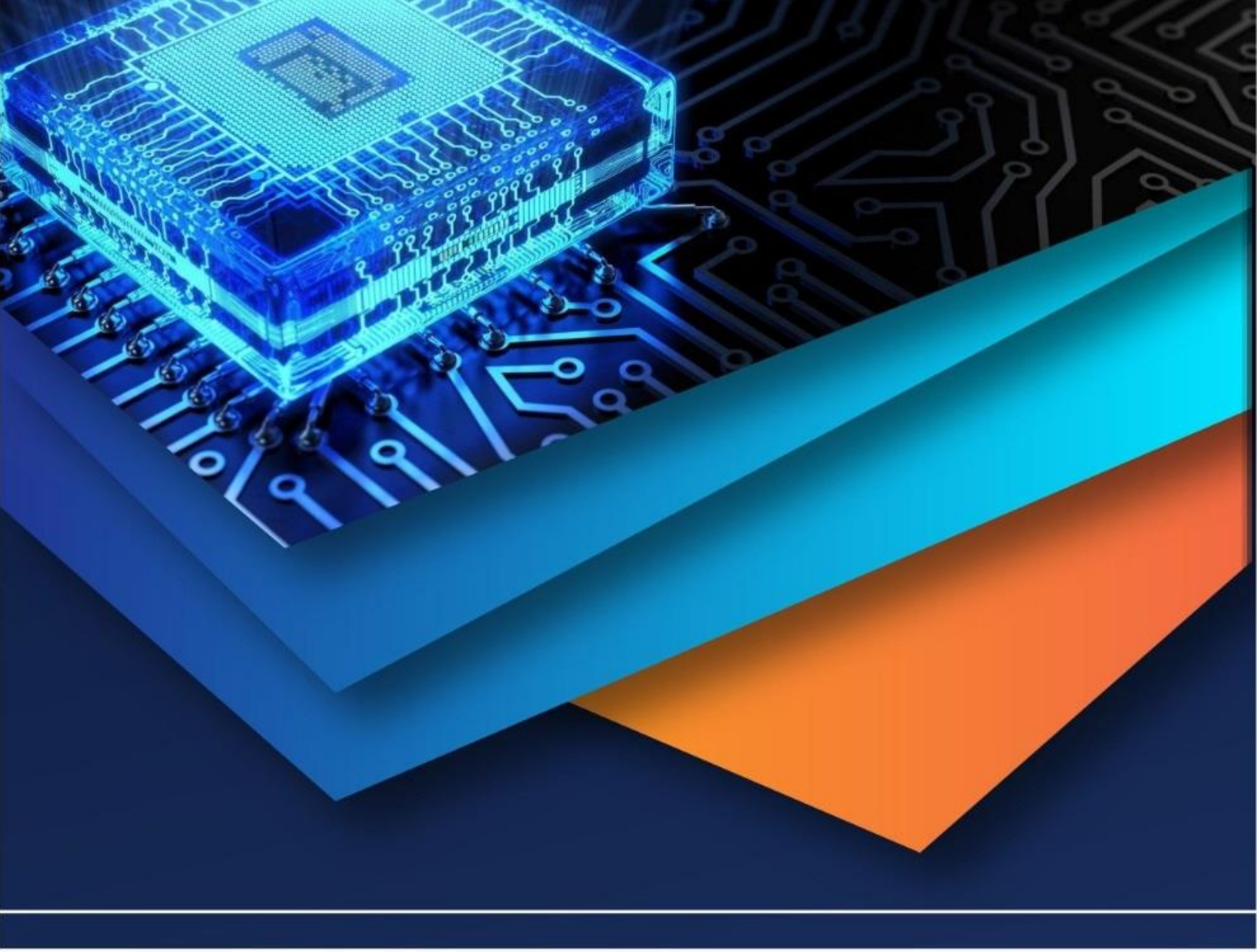

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