IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Evaluation of water quality of *Ulhas* River to unravel the causes.

[1]Mukherjee Bholanath, [2]Kulkarni Mrudula, [3]Rajput Darshana, [4]Agashe Seema

[1]Associate Professor, [2,3]Research Student, [4]Assistant Professor
[1]Department of Chemistry, [2,3,4]Department of Biotechnology
[1,2,3,4]K.V. Pendharkar College (Autonomous), Dombivli, India

Abstract: The present work evaluates the quality of water of the *Ulhas* River for a period of three years, on a monthly basis and make a genuine attempt to unravel the various possibilities for the present state of pollution level in the river water. The natural water bodies are treasures to be preserved for future generations. Regular and prolong monitoring of various parameters of water bodies should be carried out by independent bodies. *Ulhas* River, in the western part of Maharashtra State, India, provides potable water to the extent of 60% to the population along its path. Unfortunately, industrialization with utter disregard for the environment, in addition to lopsided population growth has vitiated the pristine nature of the river. These factors necessitated the monitoring of the water quality of the river. The Physico-chemical properties of the river water monitored were viz. pH, temperature, conductance, TSS, TDS, DO, BOD, COD, acidity, alkalinity, total hardness of water and studying the statistical correlation within these parameters by applying Karl Pearson's Coefficient of Correlation. The drastic variations observed in the levels of the selected parameters, in comparison to the accepted levels raise severe questions on the awareness level among the population in general. The high levels of COD, BOD, DO are indicators of the grave state of the river. The concept of '*the polluter pays*' needs to be implemented in its 'letter and spirit', in addition to massive awareness among the masses to restore some of the lost glory of the river.

***Index Terms* - *Ulhas* River, *Karl Pearson's Coefficient of Correlation*, COD, BOD, TDS, TSS, the polluter pays**

I. Introduction

Water is said to be the universal solvent. The water bodies form an important part of ecosystem (Ripl *et. al.* 2003), thus needs to be conserved and well maintained (Wanjui, 2013). The effluent from different industries is disposed-off in the rivers, to creeks which is eventually discharged into the sea. When untreated effluent is discharged into water bodies pollution of water occurs, harming marine life and severely altering bio-geo-chemical systems. This phenomenon was exemplified in the book titled 'Silent Spring' by Rachel Carson way back in 1950s (Rachel, 1962). Hence, it is necessary to study pollution level in water bodies and the bio-geo-chemical pathways. Considering the importance of quality check of the river water, such a study was undertaken spanning for 3 years. The river water quality was checked at three different sites – the origin, the mid-course and the mouth to study the effect of anthropogenic activities on the pollution level in the course of river. This paper discusses about the quality of water at the mouth of the river.

Water analysis refers to the study of the various characteristics of water viz. physical, chemical, biological and radiological features. The measure of water quality is relative to the requirements of biotic species, human needs, and purposes (Midhun et al. 2016). The results of such analysis are compared with standard values to relate to the health of the ecosystem and the potability of water. The selection of tests varies with the intended use or discharge location.

Temperature affects the chemical and biological characteristics of surface water (Deshmukh, 2013). Thermal pollution lowers Dissolved Oxygen (DO) and increases Biochemical Oxygen Demand (BOD) of hydrophytes (Kale, 2016). Its repercussions are observed in the photosynthesis of hydrophytes, metabolic rates of aquatic beings and their sensitivity to pollution, parasites, and diseases (Bhateria and Jain, 2016).

Changes in pH of the aquatic ecosystem affects its living beings (Maoxiao *et. al.* 2018). pH below optimal level makes fish susceptible to fungal infections and disturbs their reproduction (Przeslawski *et. al.* 2008). Lower pH enhances solubility of heavy metals like Al, Pb, Cu and Cd, which is fatal for marine lives. While pH above optimal levels damages gills and skin of aquatic animals causing an irreversible damage (Zhang *et. al.* 2018).

The Chemical Oxygen demand (COD) of a water sample is normally in the range of 1.3 to 1.5 times the BOD. If COD is more than twice the BOD, it indicates a significant portion of organic matter in the sample is not biodegradable by ordinary organisms (Woodard, 2001). As per 'The Environment Protection Rules, 29 of 1986' (of India) (Singare and Dhabarde, 2017) and BIS, for Inland surface waters, the maximum limit for COD is 250 mg/L. The BOD indicates the presence of putrescible organic pollutants in water. Higher BOD levels cause rapid depletion of DO, leading to less availability of oxygen for the propagation of marine life (Kozisek, 2005). Natural water sources have dissolved minerals and gases, some of which are undesirable for domestic and industrial use (Jaishankar *et. al.* 2014). Most of the common ions which interfere with different processes are Ca^{+2}, Mg^{+2}, Fe^{+3}, Cr^{+3}, As^{+3} and

F^-, to name a few (Deshmukh, 2013). Total Dissolved Substance (TDS) and Total Suspended Substances (TSS) present in the effluent are also of high concern (Gupta and Paul, 2013). The conductance of water is an indirect measurement of TDS (Jadhav and Singare, 2015). High TDS affects the density of water, DO, osmoregulation in organisms and its utility (IGIDR Report, 2005).

During 2009-10, Dombivli was declared as Critically Polluted Area (CPA) based on the concept of Comprehensive Environmental Pollution Index (CEPI). Accordingly, a temporary moratorium was imposed on the initiating new projects and expanding the existing ones. It was reversed by the Ministry of Environment and Forest (MoEF) on February 15, 2011 (MMR Report, 2015).

Reti-bunder (latitude-19.247287 and longitude-73.117547) in Dombivli was selected as the sampling site because of its perennial accessibility and to proficiently study the effect of high tide and low tide on water quality. The Suburban region of Mumbai from Kopar to Mumbra is observed to have a lot of black sedimentation. This is due to the colloidal form of sewage discharge that gets sedimented on meeting with sea water. As this sampling site is near to the mouth of the river, during high tide lots of material gets washed into it. This augments the number of sea plankton which in turn increases the microbial load, thus elevating the BOD levels. During low tide, sewage water rushes in causing a rise in COD as the effluents get discharged into the water body.

The study undertaken, aims at analyzing Physico-chemical properties viz. pH, temperature, conductance, TSS, TDS, DO, BOD, COD, acidity, alkalinity, and total hardness of water. Carrying out a comparative study of the population growth with respect to pollution levels of the river near Dombivli is very much desirable to understand the effect of growth of population and its destructive effect on nature.

The statistical correlation within these parameters were studied by applying Karl Pearson's Coefficient of Correlation.

Karl Pearson's Coefficient of Correlation is a mathematical method used to calculate the degree and direction of the relationship between linear related variables. The 'Coefficient of Correlation' is denoted by "r". If the relation between two variables A and B is to be ascertained, then the following formula is used:

$$r = \frac{\sum(A-\bar{A})(Y-\bar{Y})}{\sqrt{\sum(A-\bar{A})^2}\sqrt{(Y-\bar{Y})^2}} \quad (Where, \quad \bar{A} = mean\ of\ A\ variable\ \&\ \bar{B} = mean\ of\ B\ variable)$$

i. The value of the Coefficient of Correlation (r) lies between ±1. Viz.:
   r = +1, perfect positive correlation
   r = -1, perfect negative correlation
   r = 0, no correlation
ii. The coefficient of correlation does not depend on the origin and scale. By origin, it means subtracting any non-zero constant from the given value of A and B the value of "r" remains unchanged. By scale it means, there is no effect on the value of "r" if the value of A and B is divided or multiplied by any constant.
iii. The Coefficient of Correlation is a geometric mean of two regression coefficient. It is represented as: $r = \sqrt{c_{ab} + c_{ba}}$
iv. The coefficient of correlation is 'zero' when the variables A and B are independent but the converse is not true.

STUDY AREA

The industrial zone in Kalyan-Dombivli (latitude 19.204 N, longitude 73.118 E) covers an area of 347.88 ha to the south of *Ulhas* River and is about 45 km away from Mumbai. The industrial belt has numerous small to medium scale heavily polluting pharmaceutical industries, engineering, agrochemical, textile, dye manufacturing and fine chemical industries generating about 14 million liters of industrial effluents per day. Some of the industries have built common Effluent Treatment Plants (ETP) that discard the treated effluents into the river, in spite, the *Ulhas* River water is of major concern to the water quality and the life it sustains (Singare and Dhabarde 2017).

Ulhas River from the point of origin (Rajmachi hills) has a length of 122 km and flows north turning left where it is joined by River Salpe. The river passes through many villages on its path and finally flows into the Vasai Creek (Gadhia *et. al.* 2012). The *Ulhas* basin lies within the North latitudes of 18° 44' to 19° 42' and East longitudes of 72°45' to 73°48' lies the *Ulhas* basin. The tropical climatic condition in the study area experiences average temperature of 27.108°C and average precipitation of 550.2 mm. It is noteworthy that approximately 60% of the total water supplied to this region is met through *Ulhas* River (MMR Report, 2015).

There is a difference of 1100-1200 mm of precipitation between the driest and wettest months. The variation in annual temperature is around 8°-9°C (https://en.climate-data.org).

II. MATERIALS AND METHODS

The samples were analyzed by well-known methods described in several practical handbooks and BIS. The presence of different radicals in the water samples were qualitatively analyzed as per Vogel's handbook. The various methods used to study the different parameters are tabulated in table number 1.

Table No.1: The list of various methods used to study the different parameters.

Sr. No.	Parameters Studied	Method used
01	Sampling method	Grab method
02	Acidity	Acid Base Titration
03	Alkalinity	Acid Base Titration
04	Biological Oxygen Demand	Wrinkler's method
05	Chemical Oxygen Demand	Closed Reflux method
06	Conductance	Conductometric method
07	pH	On site - pH meter
08	Temperature	On site – Thermometer
09	Total Dissolved Solids	Gravimetric method
10	Total Suspended Solids	Gravimetric method
11	Total Hardness	Complexometric Titration

Chemicals and reagents of Analytical grade manufactured by Merck Limited and Loba Chemie Pvt. Ltd without any further purification was used. Standard procedures of BIS were referred to carry out water analysis and values were compared with the standards given by BIS. All the parameters were analyzed on a monthly basis for the period January 2016 – December 2018.

Sampling, Collection & Preservation:
Sampling was done using the grab sampling technique on a monthly basis for a period of thirty- six months. These samples were collected in the cleaned polyethylene cans. The cans were filled up with water sample and were sealed airtight.

III. RESULTS & DISCUSSION

The findings of the different experimental analysis carried out are presented in table 2.

Table No.2: The table show the results of different experimental analysis carried out.

Year		Temperature (°C)	pH	Conductance (μS/cm)	BOD (ppm of O_2)	COD (ppm of O_2)	Acidity (ppm of $CaCO_3$)	Alkalinity (ppm of $CaCO_3$)	TDS (mg/L)	TSS (mg/L)
2016	Jan	28	7.3	178125	1.7	0.2	15.9	155.0	1286.7	23.75
	Feb	28	7.3	173250	3.4	0.1	23.0	108.4	9909.8	27.5
	Mar	32	7.3	184200	4.4	5.2	30.0	110.6	18533.0	40.0
	Apr	30	7.3	203925	0.2	8.0	95.8	575.0	22120.0	120.0
	May	32	7.3	161850	4.2	5.4	8.9	151.8	24000.0	11000
	Jun	33	7.6	250000	2.4	0.3	34.0	300.3	21210.0	50.0
	Jul	27	7.4	6800	0.5	35.2	1.7	29.8	320.0	80.0
	Aug	29	7.2	1400	4.3	7.6	8.5	97.0	146.7	105.0
	Sep	29	7.0	14400	0.3	29.6	18.8	81.0	706.7	130.0
	Oct	29	7.3	453700	0.1	44.8	2.7	83.0	426.7	400.0
	Nov	29	7.5	893000	0.2	60.0	36.0	85.0	1573.3	30.0
	Dec	29	7.5	201000	0.1	0.2	30.8	161.5	1000.0	20.0
2017	Jan	29	6.8	199800	1.6	0.3	30.0	184.0	10273.3	30.0
	Feb	29	7.4	187200	2.4	8.5	16.0	105.9	12659.9	35.0
	Mar	30	7.9	174600	3.2	4.4	120.0	120.7	15046.5	40.0
	Apr	34	7.8	226000	1.7	0.2	21.2	425.0	18226.0	200.0
	May	34	7.5	125000	5.4	14.1	6.8	819.0	19120.0	250.0
	Jun	28	8.0	183600	5.0	3.8	190.0	142.2	19586.7	380.0
	Jul	26	7.4	3900	2.2	3.7	1.9	40.0	413.0	310.0
	Aug	27	8.0	2700	1.1	8.8	1.6	36.0	253.3	620.0
	Sep	28	7.6	43000	3.0	2.8	2.0	36.7	147.0	210.0
	Oct	30	7.5	360000	0.2	10.8	2.0	38.0	7013.3	300.0
	Nov	29	7.8	780000	0.2	29.6	1.8	86.4	13186.7	420.0
	Dec	29	7.9	106200	4.9	16.7	2.0	110.0	7360.0	600.0
2018	Jan	29	7.8	156450	3.5	6.5	1.9	126.0	9605.9	30.0
	Feb	29	7.9	159300	4.4	4.6	1.6	116.2	11.7	20.0
	Mar	30	8.5	165000	1.9	6.0	210.0	115.5	11560.0	40.0
	Apr	34	7.8	181850	3.5	4.0	58.5	125.3	20173.0	325.0
	May	34	7.1	198700	5.0	1.9	11.0	135.0	23640.0	610.0
	Jun	28	6.5	117200	3.4	15.2	2.2	211.7	11026.6	760.0
	Jul	26.2	7.4	12460	0.9	0.2	1.6	19.6	80.0	640.0
	Aug	28	7.1	1200	2.4	36.3	1.6	41.8	200.0	430.0
	Sep	30	6.6	44400	4.0	26.0	8.7	90.0	140.0	2240.0
	Oct	30	6.9	406850	3.0	0.2	3.4	81.9	13600.0	500.0
	Nov	28	6.6	899000	1.6	0.5	1.9	83.7	24800.0	405.0
	Dec	29	7.7	153600	2.5	8.5	2.1	135.8	19200.0	310.0

The results of Total Hardness (ppm of $CaCO_3$) of the samples analyzed for the year 2018 are tabulated in table No.3.

Table No. 3: The Total Hardness (ppm of $CaCO_3$) of the samples.

Jan	1975	Apr	589.0	Jul	38.08	Oct	1888
Feb	1817.2	May	102.8	Aug	12.00	Nov	2240
Mar	1569.9	Jun	1489.6	Sep	902.0	Dec	2052

Temperature: The Temperature of the samples were measured on-site. The minimum temperature recorded was 26°C while the maximum was 34°C. The rise and fall in temperature were observed due to seasonal change which is a common phenomenon. Due to continuous and heavy rainfall during the months of July-August, the temperature was significantly low [Refer Fig.1].

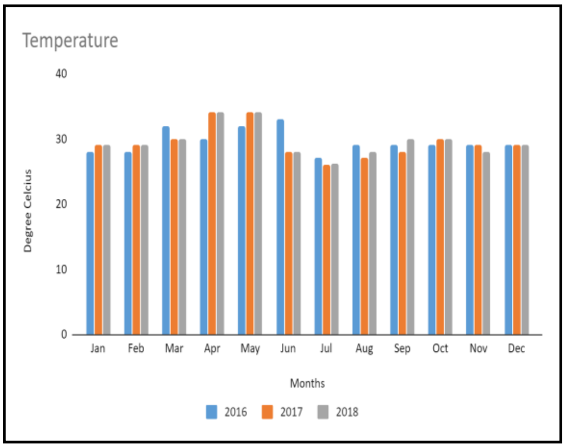


Figure 1

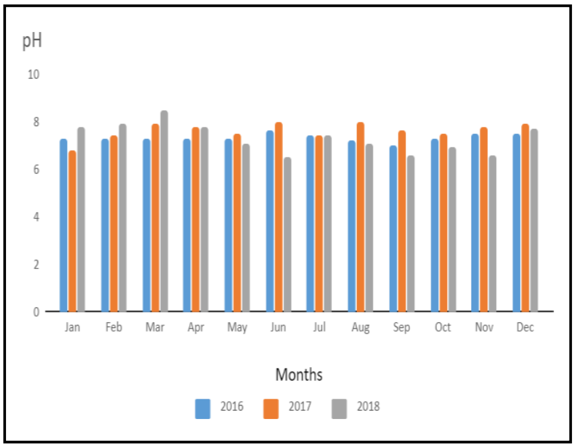


Figure 2

Figs.1&2: Figure 1 describes variations in temperature while figure 2 describes the variations in the pH of the water body for the year 2016-18.

pH: The pH of the water was measured on-site using an on-site pH meter. The pH observed expected variations due to the seasonal changes. The minimum pH noted was 6.5 while the maximum as 8.5. The average sea-water pH is about 8.2. The mixing of river water at this point with estuarine water in addition to changes occurring during the rainy season gives an expected pH range of water between 7.0 and 8.0 [Refer Fig. 2].

Conductance: The highest conductivity of water was recorded as 8.99 x 105 µSiemens/cm for November 2018. This aberration is possibly due to the time of collection of sample coinciding with the high tide on that date. The lowest conductance observed is 1.2 x 103 µSiemens/cm in August 2018. Due to heavy rainfall during the monsoon period of July-August, the mixing of rainwater causes very low conductance. The presence of Cl^-, PO_4^{-3}, and NO_3^- in sewage water is responsible for high conductance values observed [Refer Fig.3].

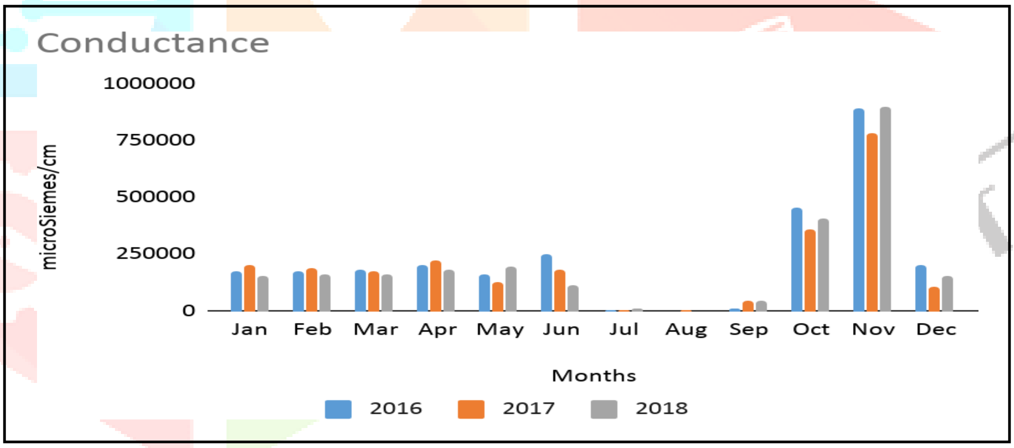
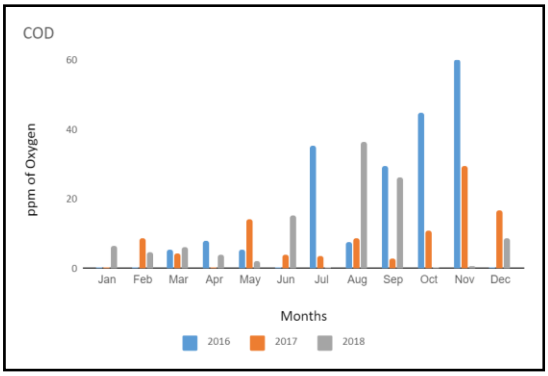


Figure 3

Fig. 3: Summary of specific conductance of the samples of three years.

COD: The highest COD value recorded was 60 ppm of Oxygen in November 2016 while lowest as 0.1 ppm of Oxygen in February 2016. Low COD levels during the pre-monsoon and post-monsoon months as compared to significantly high levels during monsoon months is a general trend observed. The high COD levels during monsoons are due to the run-off from the surrounding areas containing silicate, phosphate, and nitrate ions conforms to the findings of Gadhia *et. al.* (Gadhia *et. al.* 2012). Excess evaporation of the water body due to high temperatures in May 2017 causes saturation of pollutants brought by sewage water, in addition, due to scarcity of water during summer months the household sewage volume decreases by 60-70% but the saturation remains same, resulting in a peak in COD levels observed for this month. In 2018, monsoon commenced by July, hence the effect of summer heat is observed in June as well [Refer Fig.4].



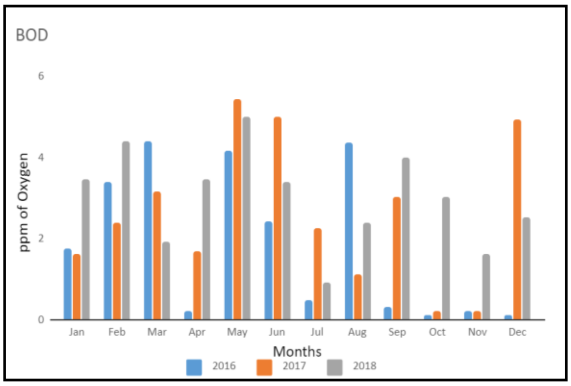


Figure 4 **Figure 5**

Figs. 4&5: Figure 4 represents the variation in the COD level while figure 5 represents the variation in BOD level.

BOD: The lowest BOD value recorded is 0.1 ppm of oxygen in September and October 2016. Whereas 5.4 ppm of oxygen was observed as the highest value in May 2017. The BOD values were found comparatively higher in monsoon than pre-monsoon and post-monsoon periods. High organic waste load during rainy season increases BOD levels (Gadhia *et. al*. 2012). An overall increase in BOD levels in 2018 is likely a result of steady influx of population. March 2016 has high BOD in comparison with March 2017 and 2018. The temperature in March 2016 was higher than 2017 and 2018. Warm water has a high BOD level than cold water. As the water temperature and rate of photosynthesis is directly related, hydrophytes grow faster and die faster. The dead plants on reaching the bottom of the water body are decomposed by bacteria. This decomposition process elevates BOD levels (Jensen *et. al.* 2005) [Refer Fig.5].

For the months of January, February, May and June 2016, BOD values observed were higher than COD. Similar observations were made for the months of January, April and June 2017 and for the month of May 2018. One of the drawbacks of COD is its inability to oxidize Ammonia/Ammonium ions. Unlike COD, BOD is capable of oxidizing Ammonium ions to Nitrate. This is important in the case of wastewater having a very high concentration of ammonium ions. Ammonium ion oxidation in the receiving environment requires dissolved oxygen. As the water is contaminated by household sewage along with industrial effluent, high amounts of Ammonia/Ammonium ions are introduced into the wastewater.

DO: gives direct and indirect information of water body like bacterial activity, photosynthesis, availability of nutrients, stratification etc. (Vikal, 2009). DO is inversely proportional to temperature and BOD (Morrissette and Mavinic, 1978) (Moss 1972). During summer, high temperatures reduce solubility of gases in water, increasing oxygen demand (Patil *et. al*. 2012) [Refer Fig.6].

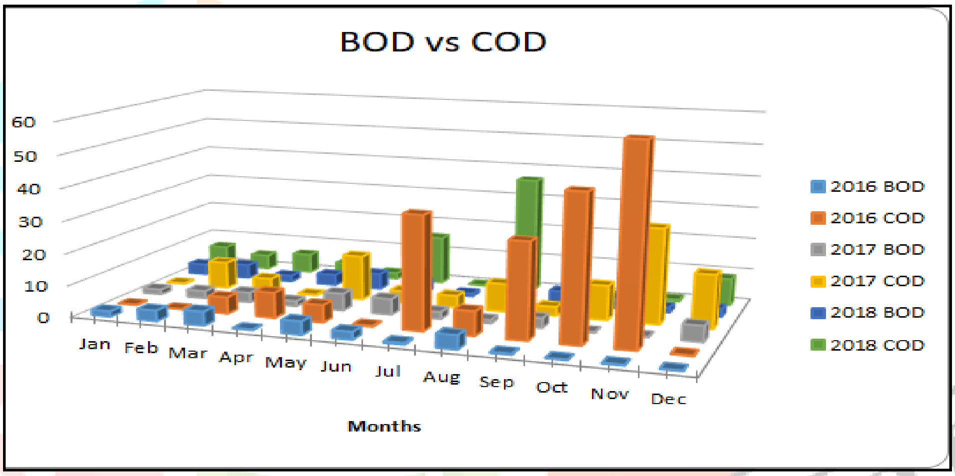
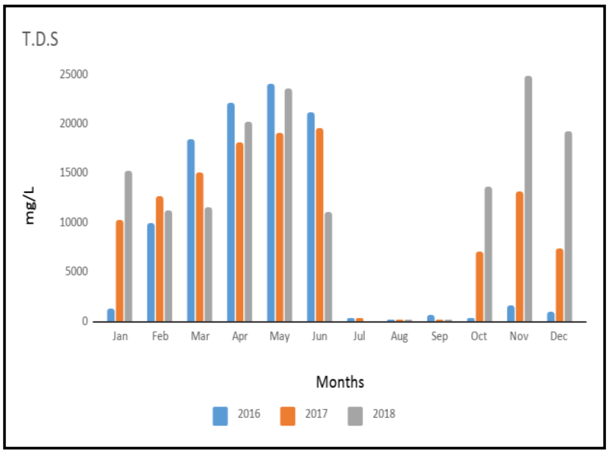


Figure 6

Fig. 6: Indicates a comparison between BOD and COD levels during the project period.

TDS: The highest amount of TDS was found to be 24800 mg/L recorded in November 2018 and the lowest was 11.72 mg/L in February 2018. It is observed that during the monsoon months, the TDS values drop due to dilution of the river water by rainstorm. The post-monsoon months show an increase in TDS values as the water flow is slowed down after heavy rains resulting accumulation of particles brought along by the water. During the pre-monsoon months, a rise in temperature causes saturation of these salts, hence rising TDS in water. This is a general trend observed for a span of 36 months. Water is classified based on the concentration of TDS as, desirable for drinking (up to 500 mg/L), permissible for drinking (up to 1,000 mg/L), useful for irrigation (up to 2,000 mg/L), not useful for drinking and irrigation (above 3,000 mg/L) (Jadhav and Singare 2015). The TDS shows a positive correlation with Alkalinity (r = +0.47), Conductance (r = +0.28), Total Hardness (r = +0.28) and TSS (r = +0.24). The correlation between TDS and Alkalinity implies that the dissolved solids are alkaline in nature. (Refer Table. 4) [Refer Fig.7].



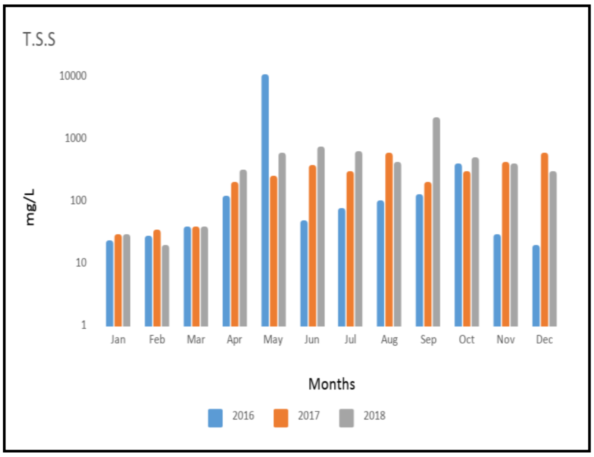


Figure 7 **Figure 8**

Figs. 7&8: Figure 7 indicates the TDS level and figure 8 indicates TSS level

TSS: The maximum TSS value recorded was 11000 mg/L in May 2016. For the monsoon period, TSS values are high as the sedimented waste/soil particles get stirred up. Also, runoff contributes in raising TSS levels in water body. The post-monsoon period shows a decrease in TSS values which is a result of variation in temperature. As the temperature rises during the pre-monsoon period, the currents in water body, overturn (Wilhelm and Adrien 2008) it is surfacing the settled particles, and ultimately increasing TSS levels. For the month of May 2016, the temperature recorded was higher as compared to 2017 and 2018. Hence, producing maximum TSS value. High TSS reduces sunlight penetration in the water body significantly. This affects the rate of photosynthesis producing less amount of oxygen in the water body which in turn increases the BOD of water bodies. This direct relationship between TSS and BOD is observed during summer season, and the r = +0.22 suggests a weak positive correlation between the TSS and BOD values for summer months. The TSS shows a weak positive correlation with Conductance (r = +0.06), TDS (r = +0.24) Alkalinity (r = +0.04) and Total Hardness (r = +0.3). (Refer Table. 4 Refer Fig.8].

Acidity: The maximum acidity recorded was 210 ppm of $CaCO_3$ in March 2018. The minimum recorded was 1.4 ppm of $CaCO_3$ in August 2018. During monsoon months, the water is less acidic as compared to post-monsoon months and pre-monsoon months and the reason being dilution of water by rains. During pre-monsoon months, the acidity increases as the temperature and pH are inversely related. A rise of 0.25°C in temperature, the pH level decreases by 0.45. Hence, as the hotter it gets, the more acidic water will be. In 2016, acidity is more as compared to 2017 and 2018 due to high average temperature, in addition to scanty rainfall. As the amount of oxygen required by aquatic life to for various processes was high, the amount of CO_2 produced too was high, raising the acidity of water. On the same lines, the peak of Acidity in June 2018 can be explained [Refer Fig.9].

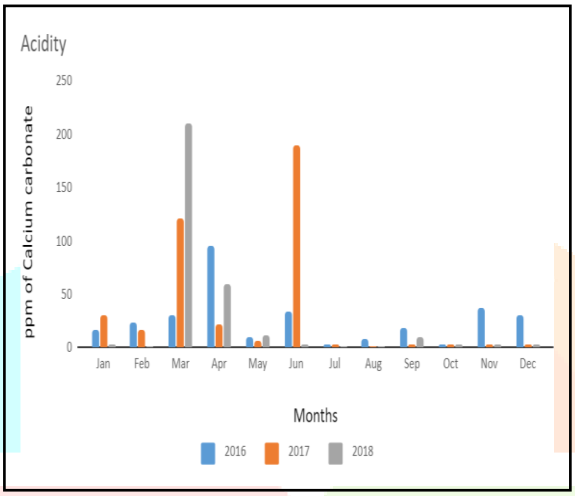


Figure 9

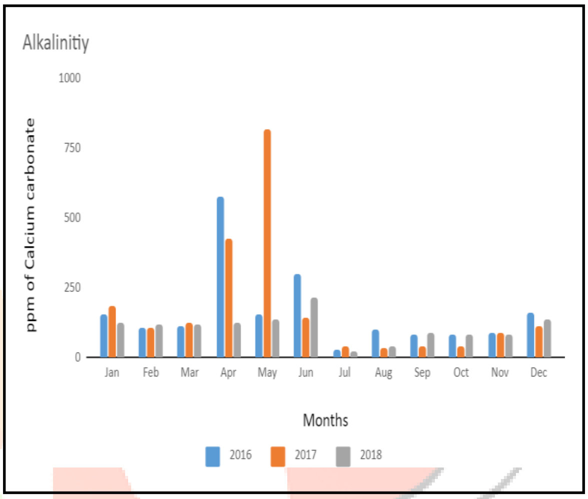


Figure 10

Figs. 9 & 10: Figure 9 indicates the Acidity level while figure 10 indicate the alkalinity level.

Alkalinity: The highest Alkalinity recorded was 819 ppm of $CaCO_3$ in May 2017 and the lowest was 19.6 ppm of $CaCO_3$ in July 2018. As the river water is expected to be alkaline in nature, on studying the graph, a similar observation can be noted. During the rainy season, dilutions cause a decrease in alkalinity, a normal phenomenon. The effluents from industries contain cleansing agents, detergents and other contaminants which raise the pH of the water. Thus, increasing the alkalinity of water. High temperatures leading to massive evaporation rate is possibly a contributing factor for the highest recorded alkalinity. The inverse relationship between pH and alkalinity, high alkalinity is observed in April 2016 as compared to April 2017 and April 2018. The weak positive correlation of Alkalinity with Conductance (r= +0.03), TSS (r= +0.04), TDS (r = +0.47) and Total Hardness (r = +0.39) is observed. The strong basic/strong alkaline compounds produce high conductance. The TDS that are responsible for increasing the Alkalinity levels are not strong basic/strong alkaline in nature to highly affect the conductance values. (Refer Table. 4)[Refer Fig.10].

Total Hardness: The highest Total Hardness was 2240 ppm of $CaCO_3$ in November 2018 while 12 ppm of $CaCO_3$ in August 2018 as a minimum. During monsoon months, Total hardness is low as compared to pre-monsoon and post-monsoon months due to dilution by heavy downpours. In June 2018, a heavy discharge of effluent containing $CaCO_3$, $MgCO_3$ and other basic salts might have led to an increase in Total Hardness of water during monsoon months. Throughout the year, due to effluent discharge, total hardness was observed to be very high. The Total Hardness is positively correlated with Conductance (r = +0.55), TDS (r = +0.28) and Alkalinity (r = +0.39) and TSS (r = +0.3). As the Total Hardness is the total hardness contributed by compounds carbonate ions (causing Alkalinity) and non-carbonate ions (chlorides, sulphates, nitrates), the Total Hardness has a higher coefficient of correlation with Conductance than with Alkalinity (Refer Table. 4) [Refer Fig.11].

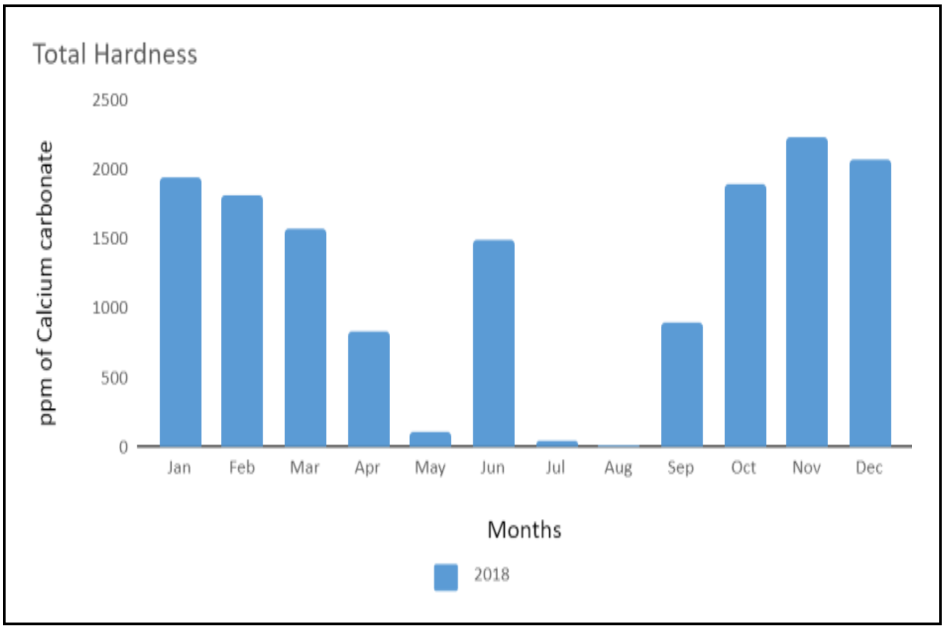


Fig. 11.: Total Hardness of water for the year 2018.

Table 4.: Karl Pearson's coefficient of Correlation within various Parameters

Karl Pearson's coefficient of correlation:					
Physico- chemical Parameters	Conductance	TDS	TSS	Alkalinity	Total Hardness
Conductance	1.0	0.28	0.06	0.03	0.55
TDS	0.28	1.0	0.24	0.47	0.28
TSS	0.06	0.24	1.0	0.04	0.3
Alkalinity	0.03	0.47	0.04	1.0	0.39
Total Hardness	0.55	0.28	0.3	0.39	1.0

IV. CONCLUSION

The present work meticulously evaluates the quality of water of the *Ulhas* River and make a genuine attempt to unravel the various possibilities for the present state of pollution level in the river water, also an effort to establish a statistical relationship within the physico-chemical parameters studied through the application of Karl Pearson's coefficient of Correlation. The study stretches over a period of three years on a monthly basis. The deterioration of the quality of water of the *Ulhas* River can be summarized by comparing the observed values of different parameters to those specified by different well-known standards and guidelines.

Table 5.: Represent a comparison of values as specified by different standards and observed values.

Sr. No.	Parameter	Technique used	WHO standard	Indian Standard	EPA guidelines	Observed
1.	Temperature	Thermometer	-	-	-	34°C
2.	pH	pH meter	6.5 – 9.5	6.5 – 9.5	6.5 – 9.5	8.5
3.	Conductance	Conductivity meter	-	-	2500 μS/cm	899000 μS/cm
4.	B. O. D.	Incubation followed by titration	6 ppm	4 ppm	5 ppm	5.4 ppm
5.	C. O. D.	Closed Reflux method	10 ppm	-	40 ppm	60 ppm
6.	Acidity	Acid–Base titration	-	-	-	210 ppm
7.	Alkalinity	Acid–Base titration	-	200 ppm	-	819 ppm
8.	T. D. S	Gravimetric method	-	500 mg/L	-	24800 mg/L
9.	T. S. S	Gravimetric method	-	-	-	11000 mg/L
10.	Total Hardness	Complexometric Titration	200 ppm	200 ppm	< 200 ppm	224 ppm

The natural water bodies are treasures to be preserved for future generations. Regular monitoring of such water bodies should be a welcome initiative in this direction. *Ulhas* River, in the western part of Maharashtra State, India, provides potable water to the extent of 60% to the population along its path. Unfortunately, industrialization with scanty regard for the ecosystem, in addition to lopsided population growth has vitiated the pristine nature of the river. There has been a steady influx of population from the Mumbai region to these parts due to the affordability factor. These factors necessitated the monitoring of the water quality of the river. The drastic variations observed in the levels of the selected parameters, in comparison to the accepted levels raise severe questions on the awareness level of the population in general. The high levels of Conductance, COD, BOD, Alkalinity, TDS and Total Hardness are indicators of the grave state of the river. The concept of '*the polluter pays*' needs to be implemented in its 'letter and spirit', in addition to massive awareness among the masses to restore some of the lost glory of the river. The local governing bodies have a major role to play too.

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