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"Assessment of Water Quality in the Mula-Mutha River: Challenges, Solutions, and Analysis"

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Abstract - Mula and Mutha River being the major rivers provide adequate supply of water for the various needs. While, Mula-Mutha River in pune (India) is one of the most vulnerable water bodies to pollution because of their role in carrying municipal and industrial wastes and run-offs from agricultural lands in their vast drainage basins. Despite of the various standards and laws made by government many industries were discharging their waste directly into the river making its quality poor day by day. As this water is further used for drinking and other purposes at the downstream of the rivers, its quality has much importance. The water treatment plants in Pune have been under constant development ensuring to accomplish the need of water. The constant increase in this pollution of water has brought down the efficiency of water treatment plants. Thus, there is a need for analysis of water to be done prior to usage. This is a study for assessment of the river water quality specifically Mula-Mutha river, to find its current suitability, condition and further analysis. This study also includes study of enacted solutions to river treatment and evaluation of the drawbacks they include.

Key Words: Municipal and Industrial Wastes, Run-offs, Quality of water, Water Treatment

1. INTRODUCTION

Increase in globalization and industrialization country faces the various challenges for providing clean and safe water to the public. As more number of rivers are getting polluted, the acting bodies such as municipalities are finding it difficult to treat river water to safe levels and supply it to people. In terms of its fast growth and development, Pune city becomes one of the growing and emerging cities of India. More and more people from outside town and cities are migrating into Pune city. The population increase in Pune city during the last 2-3 decades has been particularly rapid with a resultant effect on the increase of water pollution level. To serve the vast population, Ten sewage treatment plant are there in Pune city, which have a total capacity of 567 MLD (Million Litres per day). The plant has almost 50%-55% efficiency of treating waste water and remaining untreated effluents are usually discharged into the rivers directly

Various researchers have provided the river water quality assessment through years depicting the water quality of that period and researchers have been coming up analysis of the same. The constant researches through these years have been depicting depletion of water quality in mula-mutha River and further check of the present water quality is done in this study. At the initial journey of both the rivers, the river water was used for agriculture, irrigation and domestic use only. In those days river water was the only source of water for the residents staying on the bank of river. But due to rapid industrialization and civilization the priority of river was changed along with the initial uses of river water the river was used as a dumping ground to through the unwanted things and disposal of sewage wastes in to the river body.

Hence, due to mixing of unwanted materials in to the water body, the river now looks like canal carrying waste water towards the purification unit, basically in the summer season this type of scene was observed. In the form of agricultural run-off a large quantities of fertilizers and pesticides are discharged in to the river water. Generally, fresh water is a good resource which is required for human existence, agricultural as well as industry. For the proper development fresh water is one of the essential parameter now days. As per the literature survey in our country near about 70% of the surface water becomes polluted due to discharge of sewage and various types of effluents in to the river body. We are well-known that human life and water quality are interrelated with each other. To the ecosystem water is one of the most important compounds. Because of human activities water gets polluted. By studying physical, chemical and biological parameters of water one can get idea of water quality. Hence, it is essential to observe the quality of drinking water at regular time interval.

1.1 About Mula-Mutha

The Mula-Mutha is a river in India, formed by the confluence of the Mula and Mutha rivers in the city of Pune, which later meets the Bhima River, which itself later meets the Krishna River and finally emptying to the Bay of Bengal.

The Mula-Mutha River in Pune is a significant water body that plays a vital role in the city's ecosystem and livelihoods. Originating from the Sahyadri mountain ranges, this river traverses through Pune, serving as a primary water source for irrigation, drinking, and industrial purposes. Over the years, the Mula-Mutha River has faced substantial challenges due to urbanization, industrialization, and increasing population pressures. Pollution from untreated sewage, industrial effluents, and agricultural runoff has severely degraded the water quality of the river. This pollution not only affects aquatic life but also poses risks to human health. Efforts to revive and protect the Mula-Mutha River have gained momentum with initiatives focusing on pollution control, riverbank restoration, and community awareness. However, addressing these challenges requires concerted efforts from

government bodies, industries, local communities, and environmental organizations.

The future health of the Mula-Mutha River hinges on sustainable water management practices, stringent pollution control measures, and the collective responsibility of stakeholders to ensure the preservation of this vital natural resource for generations to come.

2. LITERATURE SURVEY

The assessment of water quality in the Mula-Mutha River, situated in Pune, India, presents significant challenges owing to various anthropogenic influences and natural processes affecting the river ecosystem. This literature survey delves into existing studies focusing on the assessment, challenges, solutions, and analysis related to water quality in the Mula-Mutha River. Various authors had done analysis on Mula-Mutha River some of them are as follows.

D.G. Kanase et al (2005) studied the physio-chemical characteristics of major River of Pune city in 2005.They studied and analyzed the Pawana & Mulaand Mutha River. The analysis was carried out for the parameters namely Ph, Acidity, Alkalinity, Total Hardness, Calcium, Magnesium, Chloride, Nitrate, Sulphate and Phosphate. The data obtained by the analysis revealed that the Ph is between 7.5 & 8.6, DO, Chloride, Nitrate, Sulphate and Phosphate are within the desirable limits. Chandanshive et al. (2013) also did the analysis on Mula-Mutha River in 2013. Their paper highlights the pollution level and their impact on aquatic life. According to their studies 72 species were reported in 1942 in the river. It has been observed by the various studies that fish diversity is gradually decreasing since last 14-15 years, mainly due to increase in population and pollution load. The physio-chemical aspect of water pollution of Mula-Mutha Rivers was analyzed seasonally. It is observed during their research that the level of pollution was optimum during post-monsoon and pre-monsoon seasons. In the polluted stretch of this river, many tolerant as well as air breathing fish fossils are found at many places.

A. B. More et al. (2014) carried out the analysis of Mula Mutha River in 2014. As per result analysis, it is found that some stations are highly polluted. Different stations are polluted by different pollutant like solid waste, chemical waste, organic & inorganic waste. In present study the analysis area is confined to stretch of rivers Mula and Mutha. Mula River receives heavy loads of agricultural runoff through non-point sources. Mutha River since it passes through the city of Pune receives heavy loads of domestic sewage with some industrial waste. V.M. Wagh, V.S. Ghole, P.N. Wavde studied and analysed water quality of the mutha river studying the quality by testing it with parameters to ensure the organic pollution in mutha river. The result values for dissolved oxygen, total hardness and EC were also found high in those locations.

The literature surveyed reveals a complex scenario of water quality degradation in the Mula-Mutha River, predominantly driven by urbanization, industrialization, agricultural activities, and inadequate waste management practices. The studies collectively underscore the urgent need for holistic management approaches integrating regulatory measures, technological interventions, community participation, and policy reforms to restore and sustain the health of the Mula-Mutha River ecosystem.

3. EXPERIMENTAL SECTION

3.1 Selection of sampling stations

In order to analyse the effects of pollution, stretch of the river various station points were selected for sampling. A total of 3 locations were selected along the stretch of the river. Table1 shows the selection of samplings stations.

Table1. Selection of sampling stations

Sample Station	Name of Sampling Station	River
S1	Bund Garden, Smashan Bhoomi	Mula-Mutha
S2	Narayan peth , ashtbhuja (Bhede pool), Kabutar Kana near Z bridge	Mutha
S3	Sant gynyaneshwar ghat, Khadki Cantonment board near holkar bridge	Mula

3.2 Water Sampling

Samples were taken from the locations S1, S2 and S3 during three timings of the day (Morning, Afternoon and Evening) for one day. The Samples were collected in sterilized Plastic Bottles and samples of 1 litres of water were collected from each sampling station. In all 9 samples were collected (3 sampling stations 3 times samples). Timing of collecting these samples was Morning 8a.m., Afternoon 2 p.m., Evening 7 p.m.)

3.3 Parameters to be measured

The list of the pearemters to be measured is given as-pH, DO (Dissolved Oxygen), BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), Chlorides, Sulphates, Nitrates, Calcium, Magnesium and Hardness.

4. RESULT AND DISCUSSION

4.1 Results

Variation of properties of water during the Morning (9 a.m.) and 6 pm time at the respective stations S1, S2 and S3 has been given in the table2 and 3 below.

Table2. Variation of properties of water during the Morning (9 a.m.) time at the respective stations S1, S2 and S3

Parameters	S1	S2	S3
pH	5.05	7.7	5.6
DO	3.84	6.2	2.09
BOD	61	10	59
COD	385	286	383
Chlorides	51.42	53.4	53.1
Sulphates	36.09	20.31	21.08
Nitrates	33	21	32
Calcium	36.09	31.82	33.53
Magnesium	29.3	13.89	33.01
Hardness	140	79	138

Table3. Variation of properties of water during the Morning (6 p.m.) time at the respective stations S1, S2 and S3

Parameters	S1	S2	S3
pH	5.22	7.65	5.7
DO	3.4	5.71	1.88
BOD	59	11	58
COD	391	281	388
Chlorides	51.5	53.6	52
Sulphates	34	19.72	20.97
Nitrates	32	20	31
Calcium	37.85	33.22	34.46
Magnesium	32	14.2	34.12
Hardness	138	77	137

4.1.1 pH

pH is the logarithmic Hydrogen ion concentration in moles per litre. It expresses the acidity or alkalinity of the solution. The Variation of pH at stations S1, S2 and S3 has been given in the fig1 below.

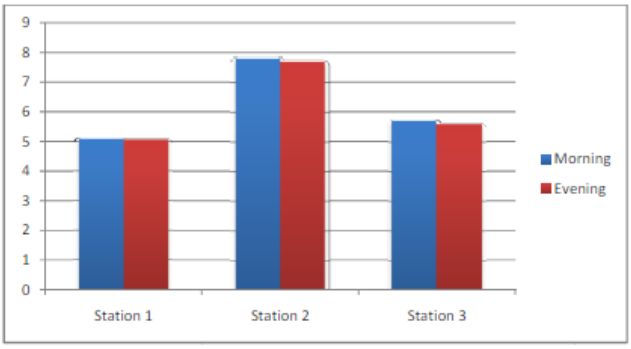

Fig.1. Variation of pH at stations S1, S2 and S3

The Hourly fluctuations of pH were observed at all the sampling station Mula River. The minimum pH of the surface water is 5.08 (Bund Garden in the morning pH levels normally vary due to environmental influences, particularly Alkalinity. The variation of result may be due to the presence of dissolved salts and carbonates of the surrounding soil. As per the BIS the pH range for potable water should be in the range of 6.5 to 8.5. So in the consideration of pH, the water at 2 stations is not within the range of standards.

4.1.2 DO (Dissolved Oxygen)

Dissolved oxygen refers to the level of free, non-compound oxygen present in water or other liquids. It is an important parameter in assessing water quality because of its influence on the organisms living within a body of water. In limnology (the study of lakes), dissolved oxygen is an essential factor second only to water itself. A dissolved oxygen level that is too high or too low can harm aquatic life and affect water quality. The DO was found out to be lowest at station 3 (Khadki Cantonment) and highest at station 2 (Narayan Peth). As per Indian standards the desirable limit of DO is 7.6-7 mg/L. But in our case the desirable limit was not found at all three stations. The Variation of DO at stations S1, S2 and S3 has been given in the fig2 below.

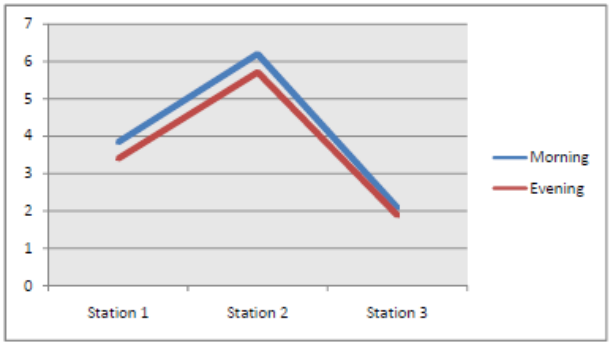

Fig.2. Variation of DO at stations S1, S2 and S3

4.1.3 BOD (Biochemical Oxygen Demand)

Biochemical oxygen demand (BOD) is the amount of dissolved oxygen (DO) needed (i.e. demanded) by aerobic biological organisms to break down organic material present in a given water sample at certain temperature over a specific

time period. The Variation of BOD at stations S1, S2 and S3 has been given in the fig3 below.

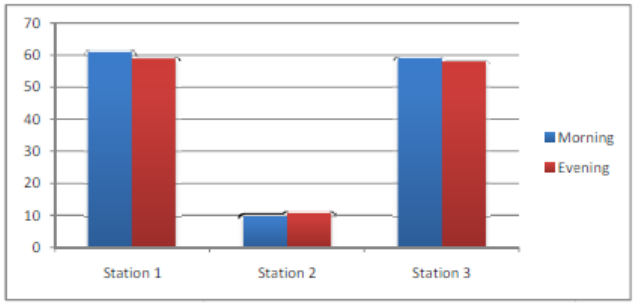

Fig.3. Variation of BOD at stations S1, S2 and S3

Max BOD was found at Station 3 while, minimum was found at station 2. The sudden increase in BOD may be is caused due to addition of pollutants and organic load in the river. The BOD must be below 30 mg/L.

4.1.4 COD (Chemical Oxygen Demand)

Chemical oxygen demand is the amount of oxygen needed to oxidize the organic matter present in water. Chemical oxygen demand testing is used to determine the amount of oxidation that will occur and the amount of organic matter in a water sample. The Variation of COD at stations S1, S2 and S3 has been given in the fig4 below.

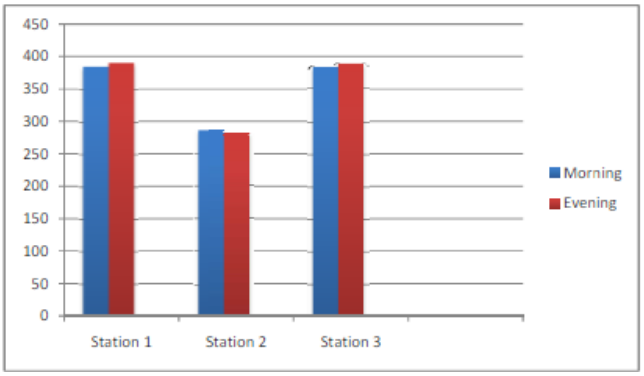

Fig.4. Variation of COD at stations S1, S2 and S3

Chemical oxygen demand testing is also used to determine the amount of inorganic chemicals in a sample. The COD must be below 250 mg/L as per IS 10500:2012, but all the stations exceed the limit.

4.1.5 Chlorides

Chloride is a compound of chlorine with another element or group, especially a salt of the anion Cl^- or an organic compound with chlorine bonded to an alkyl group. The risks of chlorides include high blood pressure, salty taste, corroded pipes, fixtures and appliances, blackening and pitting of stainless steel. The sources of chlorides are fertilizers, industrial waste, minerals in soil and seawater. The chlorides are found in the range of BIS. The acceptable limit and permissible limit is 250 and 1000 mg/L respectively.

4.1.6 Sulphates

Sulphates are the salt or ester of sulfuric acid, a divalent group or anion SO_4 characteristic of sulfuric acid and the Sulphates. The effects of over sulphates include bitter, medicinal taste, corrosive, laxative effects, rotten egg odour from hydrogen sulphide gas formation. The sources include urban and rural sewage, industrial wastes, natural deposits and salts.
The acceptable and permissible limit of sulphates is 200 and 400 mg/L respectively. The result is found within the prescribed limit.

4.1.7 Nitrates

Nitrates are the salt or ester of nitric acid, containing the anion NO_3 or the group NO_3, also the substances with nitric acid, especially so as to introduce nitro groups. The risks of exceeding nitrates are blue baby disease in infants. The Sources of nitrates are human sewage and livestock manure, fertilizers, erosion of natural deposits.
The acceptable limit is considered 45 mg/L and all the samples were found to be safe within the limit.

4.1.8 Calcium

It is a chemical element that is present in teeth, bones, and chalk. Calcium is a mineral your body needs to build and maintain strong bones and to carry out many important functions. The risks of high amount of calcium includes scale formation, poor lathering and deterioration of quality of clothes, incrustation in pipes, scale formation.
The maximum allowable limit is 200 mg/L while, our samples are well within the limit.

4.1.9 Magnesium

It is the chemical element of atomic number, a silver-white metal of the alkaline earth series. It is used to make strong lightweight alloys, and is also used in flash bulbs and pyrotechnics, as it burns with a brilliant white flame.
The maximum allowable limit is 100 mg/L and the samples are also below this limit.

4.1.10 Hardness

The simple definition of water hardness is the amount of dissolved calcium and magnesium in the water. The general effect of hardness includes poor lathering with soap, deterioration of the quality of clothes, scale formation, can lead to skin irritation and affect the quality of food.
The maximum hardness allowed is 600 mg/L and all the samples are within this limit.

5. CONCLUSION

Through the analysis of River Water Quality data it can be stated that Increasing Water pollution is a major problem in all the rivers. Contaminated water is the biggest health risk and continues to threaten both quality of life and public health. From this analysis on Mula Mutha River it can be concluded that-

1. The analysis and result clearly shows that river water quality is polluted at a certain limit and not much pure.
2. It is clear from the present analysis that the environment of the Mula and Mutha River showed no improvement in Water quality as compared to previous years, but has been getting deteriorated in years. There is need to have proper collection and treatment of waste and need to regulate the flow.
3. The Water Quality is almost same at the three sampling stations and there aren't much variation in the Water Quality at those 3 stations. Many results though show that Khadki Station has relatively a little more pollution.

Water is indispensable not only for the existence of the mankind but also for human development and healthy functioning of ecosystem. It is concluded from the present study that the pH value exceeds the desirable range as per BIS, means that water is alkaline. Dissolved oxygen found very less as recommended by ICMR Standards and the values of biochemical oxygen demand (BOD) are found higher, in the observed water samples. As DO decreases BOD increases. All locations need proper treatment for water to use, the water effectively without any pollution will be taken for the river water then it can be used for domestic and irrigation purpose as well as for aquatic life.

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