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WATER POLLUTION ANALYSIS OF MUTHA RIVER ACROSS PUNE CITY USING BOD AS PRIMARY PARAMETER

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ABSTRACT

The five rivers in Pune city are, Mula, Mutha, Pawana, Ram and Dev River. Mutha river originates, in the Western Ghats at a village named Vegare, about 45 km to the west of Pune city, India. Mutha River has two tributaries, Ambi and Moshi. There are two dams on Mutha River, at Temghar and at Khadakwasla. Increasing urbanization coupled with industrialization during the past few decades are depleting aquatic ecosystems. With the rapid increase in the population of the city and the need to meet the increasing demands of human and industrial consumption, the available water resources of the city are getting depleted and the water quality has deteriorated. Mutha River is polluted due to the discharge of untreated sewage and industrial effluents. Present study was undertaken to study the level of pollution in Mutha River of Pune city. Water samples were collected from 20 different locations on Mutha river across the city. Various physico-chemical parameters were checked. Biochemical Oxygen Demand (BOD) is an important water quality parameter as it provides an index to assess the effect that the discharged waste water will have on the receiving environment. A comparative account of BOD values at various locations was taken to establish the pollution level of Mutha River in Pune city.

KEY WORDS : Mutha river, Pollution, BOD

INTRODUCTION

Humans can survive without food for a number of days, but without water survival is impossible. Water is essential not only for the lives of animals and plants, but also occupies an essential position in industries and agriculture. Water bodies are polluted because they carry municipal and industrial wastes (Gadhave *et al.*, 2015). Also run-offs from agricultural lands in their vast drainage basins pollute river water. Despite the various standards imposed and laws made by government many industries discharge their waste directly into the river worsening its quality further. The restoration of river water quality is a threat and a major challenge to the environmentalists.

There is a serious mismanagement in the urban water sector (Wagh *et al.*, 2008). The ever expanding urban sectors typically represent concentrated demands. The obvious reasons are large populations and large per capita use and waste at the same time. Depletion, pollution and destruction of local sources of water like rivers, lakes and tanks and in many cases even groundwater is common to most urban areas.

During the past few decades Pune City has been pressurised with increasing urbanization coupled with industrialization (Jadhav *et al.*, 2013). The increase in the population of the city is rapid. As a consequence of meeting the increasing demands of human and industrial consumption, there is a sharp decrease in available water resources of the city and the water quality has deteriorated considerably.

The five rivers in Pune city are, Mula, Mutha, Pawana, Ram and Dev River. Mutha river originates, in the Western Ghats at a village named Vegare, about 45 km to the west of Pune city. Mutha river has two tributaries, Ambi and Moshi (Jeevit Nadi, Living River Foundation, Pune). There are two dams on Mutha river, at Temghar and at Khadakwasla. In a recent survey carried out by the *Maharashtra Pollution Control Board* (MPCB) it was

found that rivers from Pune carry polluted water. In its recent report the MPCB has reported the water quality of rivers flowing through Pune city as "bad or very bad". According to MPCB report, domestic waste is also creating pollution in the rivers besides industrial waste. Pune generates 744 million litres per day (MLD) of waste through sewage and other means. Out of this 177 MLD of waste is entering the rivers without treatment (Joshi, 2017).

The BOD is a pollution parameter mainly to assess the quality of effluent or wastewater. Biochemical oxygen demand (BOD) is the amount of oxygen consumed by bacteria and various other microorganisms (Daoliang *et al.*, 2019) as they act upon the organic matter under aerobic conditions at a specified temperature. This decomposition of organic matter in presence of oxygen is called as the biochemical oxygen demand (Panos Seferlis, 2008). The BOD is a test which is used to determine the molecular oxygen used during a specified incubation period (generally 5 days), when the organic matter is degraded (demand) and the oxygen oxidises the inorganic matter like sulphides and ferrous ion. It is a simple and practical indicator of the total organic matter that can be degraded by the organisms. It also indicates any other chemicals that spontaneously react with O_2. The procedure to determine BOD is straight forward. Water is incubated in sealed bottles and decrease in O_2 over time monitored (Dodds *et al.*, 2020). The original water sample must be diluted and analyzed again if all the O_2 is consumed over the time of the incubation. During the time of incubation, heterotrophic organisms which are naturally present use O_2 to respire the organic carbon that is biologically available. Any other chemicals that spontaneously react with O_2 (e.g., sulphide) will also use O_2, allowing to assess total BOD in wastewaters. For accurate determination of BOD in water seeding with sewage organisms, elimination of interferences from residual chlorine and other bactericidal substances should be precisely carried out. The degree of pollution in the sample will specify the need for dilution required. Samples which show low DO values are usually aerated to increase the initial DO content above the value required for BOD. Air is bubbled through a diffusion tube into the sample till the DO is at least 7 mg/L. The sample is divided into two parts. DO is determined on one portion of the aerated sample while another portion is seeded and incubated for the BOD determination.

To determine the relative oxygen requirements for aqueous microbes to consume organic materials in wastewaters, effluents in wastewater treatment plant, or natural waters BOD_5 has been used as an indicator for the amount of organic pollutants in most aquatic systems, especially a good indicator for biodegradable organic compounds. BOD_5 is not considered as a suitable parameter for a process control of water treatment processes and for a real-time water quality monitoring system due to a 5 day incubation period, in which a rapid feedback is essential. The BOD_5-based biodegradation test that relies upon the presence of a viable microbial community has a difficulty in consistently acquiring accurate measurements. BOD_5 generally has an uncertainty of 15%~20%. The physicochemical characteristics of water bodies have often been studied from time to time. These properties help to identify the sources of pollution, to conduct further investigations on the eco-biological impacts and also to initiate necessary steps for remedial actions in case of polluted water bodies. Moderately polluted rivers may have a BOD value in the range of 2 to 8 mg/L. Rivers may be considered severely polluted when BOD values exceed 8 mg/L (Daoliang Li *et al.,* 2019). Municipal sewage that is efficiently treated by a three-stage process would have a value of about 20 mg/L or less.

The present study was carried out on Mutha river flowing across Pune city. Samples were collected from twenty different locations spread from the emergence of mutha river near Khadakwasla and till its confluence with Mula river near Sangam Bridge. 20 samples were collected and physical properties observed. BOD was carried out for all the samples.

MATERIALS AND METHODS

To assess the water quality of Mutha River, Twenty sampling locations from Khadakwasla Dam downstream, till Sangam Bridge (where the Mula and Mutha Rivers join together) were selected. The locations of these sites are shown in Map in Fig. 1.

The water samples were collected in the month of February 2020. Samples from the sampling sites were collected and stored in glass bottles. The bottles were thoroughly cleaned and rinsed with distilled water before collection. The collected samples were labelled properly. The samples were brought to laboratory at Department of

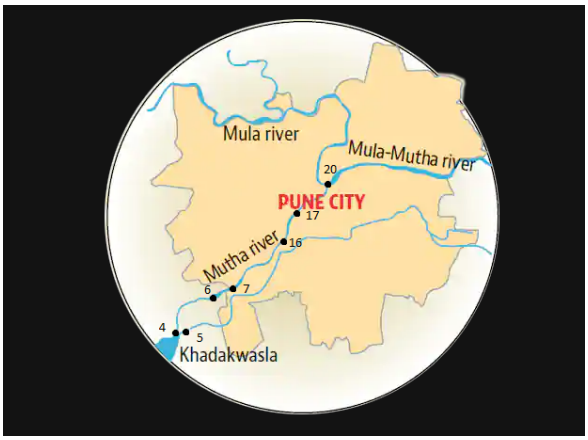

Fig. 1. Mutha river map with sampling sites

Microbiology, H. V. Desai College, Pune. These samples were analyzed for basic physical parameters. BOD determination was done for all the samples extensively. BOD was determined as per APHA (1992).

RESULTS AND DISCUSSION

The pH values as indicated from the above table at all the 20 locations across Pune city do not show much variation. They vary from 5 to 6 at most of the locations indicating acidity in river water (Mane *et al.*, 2013). This acidity could be a result of the wash off from various small and large industries located all along the river. Domestic sewage could also be the reason for the observed acidity.

The turbidity observed is also similar in most of the places (Pali Sahu *et al.*, 2015). The water was found to be more turbid at three locations which are in centre of city. This is probably due to addition of higher domestic sewage and vehicles washing near these places.

No colour was observed for the samples from Khadakwasla dam to Sangam bridge location. This is a good indication of no dyes or colours mixing in the river.

DO is a very important parameter of water quality. The values of DO observed across the 20 locations vary from 1.6 mg/L to 4.8 mg/L. This is an indication of high pollution. This may be the result of excessive algal growth due to high phosphorus content in river (Kshirsagar *et al.*, 2011). Another possibility is the decomposition of submerged plants which contributes to low DO (Jagtap *et al.*, 2019). Temperature does affect DO often showing low DO values at high temperatures but the temperature during the period when the samples were taken were moderate and hence this cannot be considered as a factor responsible for low DO values.

As can be seen from the table above the BOD values show a wide range from 11 mg/L to 77 mg/L. This reflects a very highly polluted state of the river from its start to its joining the Mula River.

A high BOD indicates two things: -

1. There is a high level of microorganisms in the water, and
2. There is a high content of organic material in the water that is broken down by the organisms. This is an indication of organic pollution (Daoliang *et al.*, 2019).

BOD is increased by dumping off waste rich in phosphates and nitrogen compounds as these two favour algal growth causing algal bloom and death of other underwater plants due to lack of Sunlight. The presence of excess organic matter favours microbial growth and reduces available dissolved oxygen.

The BOD is lowest at the source of the river though still in pollution values. As the river flows towards the city the value shows a slight increase probably the turbulence adding the settled organic matter into water. The samples from Khadakwasla dam show a sharp increase in BOD. This is a result of the very high human activity in the dam water which ranges from dumping of domestic waste, left over foods, wash waters of the stalls lined along the dam to washing of animals by villagers from nearby villages. This is a nonstop activity in this area leading to pollution of dam water in recent times. The samples collected at two locations near Nanded city show a very high BOD as compared to the previous ones. This is a consequence of the huge set ups and dwelling sites at Nanded city which obviously lead to pollution of river at his location.

The BOD at three points beyond this is in the same range as the river banks have human settlements and small scale industries which let off the waste in the river.

At the next location Vitthalwadi there is a further increase in BOD. This is also a densely inhabited area. Adding to the human activities the temple at Vithalwadi attracts devotees in large numbers which definitely adds a big amount of organic waste to river.

Prayeja city location shows the highest BOD in the path of the river. It's a true representative of extended urbanisation which is definitely stressing the existing city limits. Human intervention is

leading to high BOD values. Small industries and workshops producing varied types of wastes lead to an increase in BOD. This could be due to addition of organic wastes or may be due to inhibition of the microorganisms which degrade the organic waste.

Beyond this the river enters Pune city showing high BOD. This increase is dangerous for the health of city population. This could also mean high numbers of microorganisms in the water which may be pathogenic leading to increase in water borne infections (Jagtap *et al.*, 2019).

Remedial measures (Jagtap *et al.*, 2019).

1. Construction of more number of STPs to cope up with the increased population of city and specially the expanded limits of the city.
2. Bioremediation is a process that uses mainly microorganisms, plants, or microbial or plant enzymes to detoxify contaminants in the soil and other environments in order to clean a polluted site. The benefits of bioremediation include lower costs and less disruption of the contaminated environment when compared to other cleanup methods. Some examples of bioremediation related technologies are phytoremediation, mycoremediation, bioventing, bioleaching, landfarming, bioreactor, composting, bioaugmentation, rhizofiltration, and biostimulation.

Contaminants treated using bioremediation include oil and other petroleum products, solvents, and pesticides. Some types of microbes digest contaminants, usually changing them into small amounts of water and harmless gases like carbon dioxide and ethene.

The various sites on different locations can be identified and appropriate bioremediation processes employed.

This would help to reduce BOD by reducing organic loads, to reduce metal pollution which probably reduces the microbial load degrading the organic matter. Although microorganisms cannot destroy metals, they can alter their chemical properties via an array of mechanisms.

3. Increasing the efficiency of the existing Waste Water Treatment Plants in order to effectively and efficiently handle the load on rivers.
4. The new settlements in the extended city limits should have self sustainable resources to handle their waste in order to effectively reduce river pollution.

CONCLUSION

The present investigations of the Mutha river across Pune city with BOD as the primary parameter has lead us to a conclusion that the quality of water which was subjected to the present study was not acceptable from the point of view of studied

Table 1.

Sample No	Place	pH	Turbidity	colour	DO mg/L	BOD
1	Khadakwasla dam 1	5	+	-	4.8	11
2	Khadakwasla dam 2	5	+	-	4.4	72
3	Khadakwasla dam 3	5	+	-	4	57.2
4	Khadakwasla door 1	5	+	-	4	17.6
5	Khadakwasla door 2	5	+	-	3.6	13.2
6	Nanded city 1	5	+	-	1.6	39.6
7	Nanded city 2	5.9	+	-	1.6	39.6
8	Canal (veer baji bridge 1)	5	+	-	4.8	39.6
9	Canal (veer baji bridge 2)	5.5	+	-	3.6	22
10	Canal door	5	+	-	4.4	35.2
11	Vithalwadi 1	6	+	-	1.6	72
12	Vithalwadi 2	6	+	-	4	57.2
13	Vithalwadi 3	6	+	-	4	57.2
14	Santosh hall	5	+	-	4	57.2
15	Prayeja city	5	+	-	1.6	72
16	Mhatre bridge	6	++	-	4	57.2
17	Joshi bridge	6	++	-	1.6	72
18	Bhide bridge	5	++	-	4	57.2
19	Shahu setu	5	+	-	1.6	72 mg/L
20	Sangamwadi	5	+	-	4	57.2

parameter. The Mutha river is highly polluted and hence the responsibility of protection and treatment of river should be taken more seriously. The present status of the river can be dangerous to the life of people of Pune city in general. It is not the sole responsibility of the Government agencies but also of residents of Pune for whom Mutha River is the life line.

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