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ASSESING CONTAMINANT MIGRATION IN GROUNDWATER NEAR MUSI RIVER, TELANGANA STATE, INDIA

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ABSTRACT

The indiscriminate disposal of urban and industrial waste water in to open nalas (drains) or water bodies is a common practice in agglomerated metropolis leads to negative impact on the plant, animal and human life and also agrarian produce. Ground water samples collected from the Hyderabad urban periphery (Firzadiguda) downstream area of river Musi to a 60km (Valigonda) long stretch to ascertain the BOD and COD concentrations from pre- and post monsoon seasons (Calender year). There is no notable and or considerable differences in their elevated concentrations from both the seasons (Pre- and Post monsoon). The chemical oxygen demand (COD) concentrations is more than the biochemical oxygen demand (BOD) and both of the them are above their permissible limits for potable, agriculture and other activities. The high BOD indicates the presence of large number of micro organisms which shows the height of pollution. The BOD/COD ratio is more than 0.5 in the water sample and act as a indicator for high contamination.

KEY WORDS : Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Ratio, River Musi, Contamination

INTRODUCTION

Hyderabad the fifth largest city both in population and landscape and the eight most polluted amongst 46 metropolitan cities in India. Rapid industrialization and urbanization posing many consequential problems to the people living in the habitats. The River Musi is bifurcating the Hyderabad urban while passing from the center of the city. The River Musi before entering to the city peripheries is pure and more soft with excellent quality of water and has medicinal values. The western flank of Hyderabad is flooded with industries of various categories are entangled their effluents in to the river Musi (Blessy *et al.*, 2019).

The River Musi from the western periphery is thoroughly contaminated with the indiscriminate discharge of the untreated industrial effluents in to it. The domestic waste water from households, municipal waste water from communities and sewerages of industrial effluents also discharged in to the river channel, and further the river is carrying lodes of contaminants flowing towards the confluence point of river Krishna at Wadapally (Fig. 1). The contaminated waste water in the river is full of elemental concentrations both in suspended and particulate form, giving rise to its high density, filthy, foul smell and dirty color.

The present paper envisages the waste water quality over a 60 km transect of the Musi river downstream to the Hyderabad city (Fig. 1). The study is to determine the degree of pollution and its acceptable levels for the agriculture practices and other uses. A broader perspective approach is made to emphasize the lateral and vertical extent of ground water contamination in the area specified. This river Musi is a source for irrigation and agrarian produce in the downstream and vegetables grown with acrid stench.

STUDY AREA

The river Musi is located on the Deccan Plateau in the state of Telangana, southern India. The River Musi originated in the Ananthagiri hills of Vikarabad district around 70 kms in the upstream of

Fig. 1. Imagery map of study area

the city of Hyderabad and flows through the city and paths its way to mighty River Krishna at Wadapally which is 200 km away in the Nalgonda district (Ensink *et al*., 2009). The origin of Musi river is in the Deccan Traps of Basaltic terrain with rugged topography and flows to downstream over granites of Proterozoic period. The ground water in these areas is limited and confined to secondary structural features. The populace in this region depends on the availability of groundwater, which has very limited source due to plateau conditions and scanty rainfall.

Sample Collection

Ground water samples were collected from the existing bore wells all along the downstream on either sides of the River Musi. Water samples collected for two seasons both pre- and post-monsoon times (2018 and 2019) from different villages and their locations are shown in Fig. 2. A fresh water sample is collected from the bore wells in a plastic container, air tightened and later transported to the laboratory for chemical analyses. The bore wells chosen for the quality analyses with a minimum of 500 meters away from the river channel, so that it will be easier to ascertain the lateral and vertical extension of ground water pollution with river load of effluents.

The depth of bore wells in these villages are found to be in the range of 300-500ft, and the aquifers are of semi confined to confined type of hard rock terrain (Granites of Peninsular Gneissic Complex of Archaean era). The ground water occurrence in this area is confined to secondary structures like fractures and fissures which commonly present in the granite rocks (Blessy *et al.*,

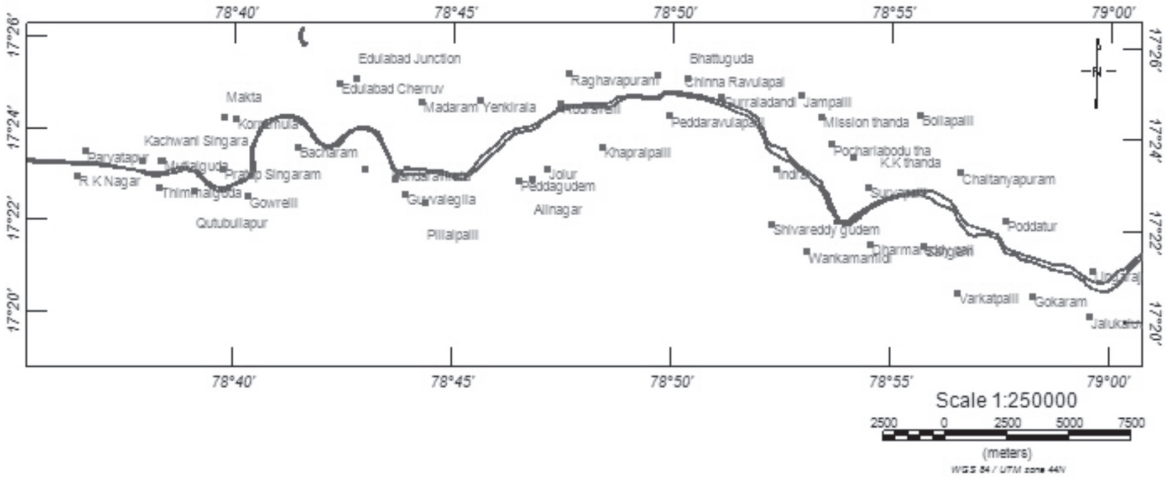

Fig. 2. Map showing the sample locations along Musi River

2019). The water table in the study area is varying 30-40ft in the near vicinity and 70-80ft after 1 km away from the river channel. The selection of sampling locations is based on the use of water either for domestic or for agriculture purposes. None of the villages use bore wells water for their drinking expect for washing, cleaning and for animals.

RESULTS AND DISCUSSION

Ground water samples collected along the Musi River to assess the organics like Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) concentrations to exacerbate the problem. There are series of problems that are focused on pollution and contamination of Musi water. Reports from the Governament agencies mention that every day 854 MLD (million liters per day) of sewage including muncipal and domestic waste and waste water being discharged into the Musi River from Hyderabad metropolitan region. The capacity or the number of sewage treatment plants along the river may not be sufficient enough to treat the total effluent and can only treat about 650MLD, and the remined untreated sewage is allowed to flow in to the river channel.

Biochemical Oxygen Demand (BOD)

Biochemical Demand (BOD) is a parameter and the amount required to oxidize organic matter present in the water biochemically. The BOD is an indirect measure of the concentration of Organic contamination in water (Simerjit and Jasvir, 2015). BOD does not oxide all the organic matter present in the waste, only the organics that are biochemically degradable during 'n' days of time period at certain temperature are oxidized. The standard for usual measurements is a five day period (BOD_5).

BOD forms the key indicator of organic load in any waste water system. A low BOD is an indicator of good quality and high BOD indicates polluted water (Robson, 2002). This property is expressed as the amount of dissolved oxygen required by aerobic biological organisms for degrading organic materials present in a given water sample at certain temperature over a specific period (Martin and Hine, 2000).

The BOD in the present study area varying from 60-197 ppm in both pre- and post -monsoon periods of the southern part of the river and 27-162 ppm is found in the northern part (Figure 3(a) and 3(b)). It is noticed that the BOD concentration is more in southern region. In general the BOD concentration is above the permissible limits for drinking and agricultural uses (Table 3), and the BOD accumulation is increasing towards downstream in the Sangem, Varkatpelly, Gokaram and Jalukaluva villages towards topographic lows. The village Chinnaravirala is represented with low BOD (60 ppm), Mission Tanda and Pocharlabodu Tanda are shown with high concentration of BOD (160ppm) in northern side of the river.

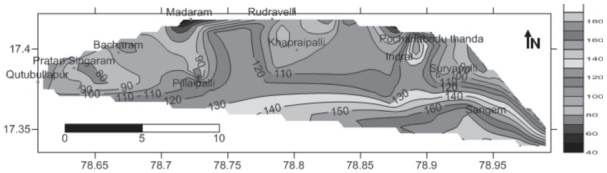

Fig. 3(a): BOD concentration during pre-monsoon period

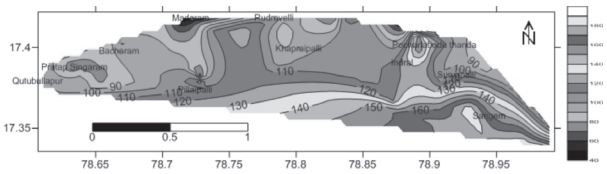

Fig. 3(b). BOD concentration during post -monsoon period

During the Pre-monsoon (dry season) lowest BOD value is recorded in Jampally village on the northern part of the river is 40.2 ppm, and the highest value noticed is 192 ppm at Varkatpally village on the southern part of river. In the post monsoon (wet season) lowest BOD value 28 ppm at Edulabad junction on the northern side and the highest value 190 ppm found at Jalukaluva village in the southern part with a mean value of 108.3 ppm (Table 1a). Seasonal variations in BOD was observed with a general increase during the pre-monsoon period (Das and Acharya, 2003 and Maya *et al*., 2007).

The mean value for complete 46 bore wells is 109ppm in the pre-monsoon, and during post-monsoon period it is 108 ppm (Table 1b). The higher BOD values in the pre-monsoon season could be due to percolation of biodegradable organic matter and leaching of inorganic iron and/or manganese in the ground water (Ngang and Agbazue, 2016). In general the southern part of the river found to be with higher values where the topography is low.

Chemical Oxygen Demand (COD)

Chemical Oxygen Demand is also a sum parameter

and is used to measure the content of organic matter in waste water. The equivalent amount of oxygen required to oxidize organic matter present in a water sample by means of strong chemical oxidizing agent is called COD (Shiva Kumar *et al.*, 1989). The COD values include the oxygen demand created by biodegradable as well as non-biodegradable substance; as a result COD values are qrater than BOD. In comparison with COD, BOD measurements have advantage in that it requires a short digestion period of about 3 hours rather than 5 days (incubation period) required for BOD measurement. For many types of water, it is possible to correlate COD with BOD.

The concentration of COD is shown in the Figure 4(a) and 4(b) for both pre - and post -monsoon periods. In general high concentrations of COD are noticed compared to BOD in ground water samples along the River Musi region. The average COD content 180 and 172 ppm and 185 and 171 ppm in

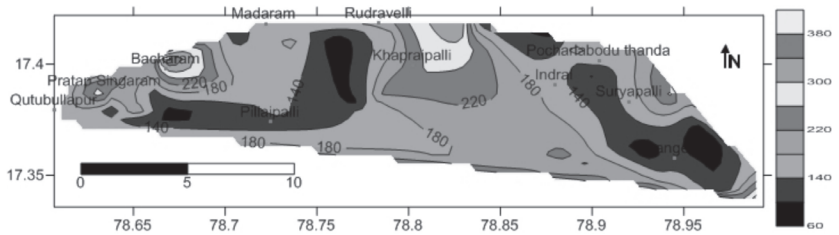

Fig. 4(a). COD concentration during pre-monsoon period

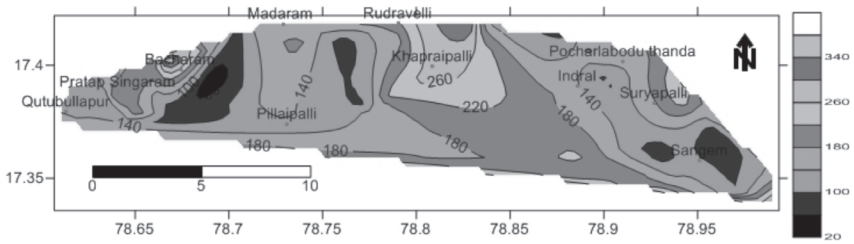

Fig. 4b. COD concentration during post-monsoon period

Table 1a. Statistical distribution in North part of the river Musi

	Pre-monsoon			Post-monsoon		
	COD	BOD	BOD/COD	COD	BOD	BOD/COD
Min	69	60	0.36	22	60	0.36
Max	399	192	2.61	380	192	4.55
Avg	185	123	0.88	171	123	1.22

Table 1b. Statistical distribution in South part of the river Musi

	Pre-monsoon			Post-monsoon		
	COD	BOD	BOD/COD	COD	BOD	BOD/COD
Min	56	27	0.18	56	28	0.17
Max	428	162	2.14	430	160	2.13
Avg	180	96	0.79	172	95	0.79

Table 2. Statistical distribution of complete area of Musi

	Pre-monsoon			Post-monsoon		
	COD	BOD	BOD/COD	COD	BOD	BOD/COD
Min	56	40.2	0.18	22	28	0.17
Max	428	192	2.61	430	192	4.55
Avg	177.67	109	0.789	166.9	108.3	0.89

both pre- and post- monsoons of north and southern regions respectively.

The mean COD concentration during pre-monsoon is 177.67 ppm, with a low value of 56 ppm at Poddatur village in the northern side of river and the high value 428 ppm is found in Korremla village bore well water (Table 1a and 1b). The low COD is noticed during post-monsoon is 22 ppm at Bacharam village and a high value of 430 ppm found at Korremla village with an average of 166.9 ppm. A high COD is noticed during the pre-monsoon period may be due to prolonged accumulation of seeped organic leachate in to the aquifer (Isoimi *et al.,* 2012 and Adenkunle, 2008). The high COD concentration in noticed in all the selected sites of Musi river are above the permissible limits of WHO & BIS:19500 (Table 3) indicates the pollution by degradable organic waste from various sources.

High COD may cause oxygen depletion on account of decomposition of microbes to a level detrimental to aquatic life (Sivakumar *et al*., 1989). It is on account of oxygen present in water that is required or used in various chemical reactions (mainly oxidation) occurring in the water. COD is used as a measure of oxygen requirement of a sample that is susceptible to oxidation by strong chemical oxidant (Simerjith and Jasvir, 2015).

BOD / COD ratio

The ratio of BOD to COD values obtained during pre- and post-monsoon periods are presented in Figure 5(a) & 5(b). The BOD, COD ratios were drawn to both north and south parts of the river individually and to complete area is also made possible and shown separately Table 1(a) & 1(b). In the complete area the average ratios are 0.789 and 0.890 in pre- and post-monsoons respectively (Table 2). According to Ngang and Agbazue, 2016 and Das Gupta and Yildiz, 2016 the BOD to COD ratio is an indicator for the organic load in waste water, The BOD concentration increases, the ratio also increases proportionately.

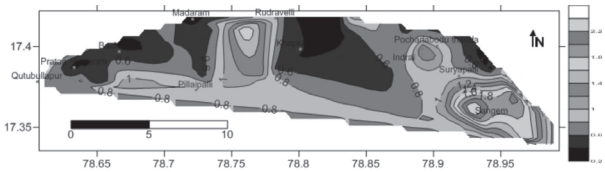

Fig. 5a. BOD/COD Ratio in the pre-monsoon period

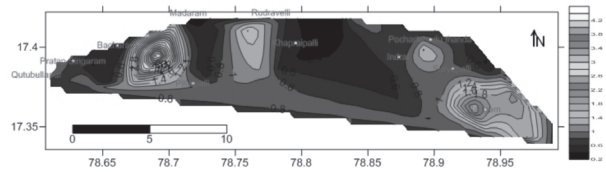

Fig. 5b. BOD/COD Ratio in the post-monsoon period

Table 3. Permissible limits for COD and BOD (Source: WHO : 2008, BIS:2016)

	WHO		BIS	
	COD	BOD	COD	BOD
Drinking water	0	0-5	0	0-5
Industrial water	50	2.0-8.0	250	2.0-8.0
Irrigation water	250	3.0	250	3.0

Low ratios are found only in four locations during pre-monsoon period in the north part of the Musi (Kachwani Singaram (0.24), Edulabad Junction (0.17), Chinna Ravulapally (0.18) and Chaitanyapuram (0.26) (Figure 5(a) and 5(b)). The organic load in these locations is insignificant and other parts of the study areas are significant and highly polluted.

Poddutur, Bacharam, Peddagudem and Sangem villages are the highly polluted villages where the BOD to COD ratio is beyond 2.0, and these waters may not amenable to treatment and are not advisable to utilize for any activity. Use of these waters will pose adverse implications on the survival of life.

CONCLUSION

It is inferred from the findings that the elevated concentrations of COD and BOD have shown organic matter presence in the Musi River that might carry disastrous effects on aquatic life and human health. The COD and BOD are abnormally high levels of WHO permissible limits either for drinking, irrigation and waste water. The BOD to COD ratio supposed to be less than 0.3, but in reality it is very high and indicates highly polluted. The BOD/COD ratio may be treated as indicator in characterizing the intensity of pollution.

The eventual aim should be the treatment of waste water before it is used in agriculture in the downstream of Hyderabad. The natural remediation efficiency of the river system may be improved with the construction of bunds for waste stabilization along the river.

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