Assessing Anthropogenic Impact on Water Quality in the Musi River: A Study of Urbanized and Industrialized Hyderabad

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Abstract - *Water, vital for life on Earth, faces severe challenges in Hyderabad due to rapid industrial and urban expansion. Over the past three decades, this growth has heightened water consumption and deteriorated water quality. The Musi River, a tributary of the Krishna River, undergoes a drastic transformation as it flows through Hyderabad, turning into a sewerage drain due to the discharge of untreated sewage and pollutants from industries. The city discharges a staggering 700 to 800 million liters of untreated sewage into the Musi River daily. Groundwater, the primary water source, gets contaminated, compelling reliance on municipal water from distant locations. Downstream residents, often economically disadvantaged, are forced to consume the contaminated water due to limited alternatives. The study area, the Musi basin, spans specific longitudes and latitudes and experiences diverse uses along its course. To comprehend pollution extent and pollutant fate, river water samples were systematically collected. Physical and biological parameters were analyzed to understand the river's water quality dynamics. The downstream stretch experiences significant changes, indicating recovery attributed to dilution and bio-physical transformations. Sewerage Treatment Plants contribute to water pollution, with identified inlets from areas with various industries and substantial populations. Water quality parameters such as pH, DO, BOD, EC, SAR, and total coliform were analyzed, revealing challenges from industrial and domestic discharges. The study underscores the urgency of robust water quality management to safeguard downstream communities facing diverse health problems due to contaminated water. Regular testing and comprehensive monitoring are crucial for maintaining water quality and ensuring the safety of water resources.*

Key Words: Musi River, Urban Sewage, Pollution, Water Quality, Health Impacts

1.INTRODUCTION

Water is a crucial resource for sustaining life on Earth. However, the rapid expansion of industrial development and urbanization over the last three decades in Hyderabad city has not only significantly increased water consumption but has also had a profound impact on water quality (Salve et al., 2008). Unfortunately, the city lacks proper outlets for wastewater disposal, leading to the discharge of waste into the Musi River. Consequently, the Musi River's ecological balance has been severely disrupted, affecting even the groundwater sources in the region (Hujare et al., 2008).

The Musi River, a tributary of the Krishna River, initially flows through Hyderabad metropolitan city in Telangana state with a substantial discharge in the upstream areas. However, as it reaches Hyderabad city, the river undergoes a transformation into what can be described as more of a sewerage drain. This drastic change is attributed to the high disposal of domestic sewage and pollutants from nearby industries. Astonishingly, Hyderabad city discharges approximately 700 to 800 million liters of untreated sewage water into the Musi River each day. This concerning situation is exacerbated by the municipalities surrounding Hyderabad.

The infiltration of surface water from the Musi River and nearby lakes to the aquifers has led to the contamination of agroundwater sources in the region. As a consequence of this groundwater contamination and a declining the groundwater table, the city is compelled to rely on municipal water sources. However, this municipal water, crucial for meeting the city's water needs, is sourced from distant locations, necessitating significant expenditure of resources, (Pullaiahcheepi et al. 2012). This predicament particularly affects the downstream residents, who often belong to lower economic strata and are compelled to consume the available contaminated waters due to limited alternatives.

The degradation of water quality in the Musi River has reached a concerning level, contributing to a host of health issues observed in the downstream villages. The compromised water quality becomes a breeding ground for pathogenic bacteria, viruses, and parasites present in the wastewater. As a result, the communities residing in these areas are confronted with a myriad of health problems, underlining the urgent need for comprehensive and effective water quality management strategies to safeguard the well-being of the affected population.

2. STUDY AREA

The study area, encompassing the Musi basin, is situated between 780 to 790 44′ east longitudes and 160 40′ to 170 50′ northern latitudes. The Musi River flows through the Hyderabad metropolitan area, with a total catchment size of 1,275 km2. Approximately 90 km from its source, the river enters Hyderabad city, where it commences receiving sewage from both point and non-point sources. Over a stretch of 47 km, extending from Gandipet to Pratapasingaram, the Musi River is impacted by sewage inflow. However, for the remaining 119 km downstream of the city, the water is utilized for irrigation purposes. Ultimately, the Musi River joins the Krishna River at Wadapally in Nalgonda district. This geographical overview outlines the critical points of sewage influence and the varied uses of the Musi River along its course.

2. METHODOLOGY

To assess the extent of pollution, identify various sources, and determine the fate of pollutants, river water samples were systematically collected at different points along the Musi River. A total of 11 samples were obtained: before entering the city, within the city, after leaving the city, and at the confluence with the Krishna River. This comprehensive approach aimed to monitor changes in river water composition across different locations.

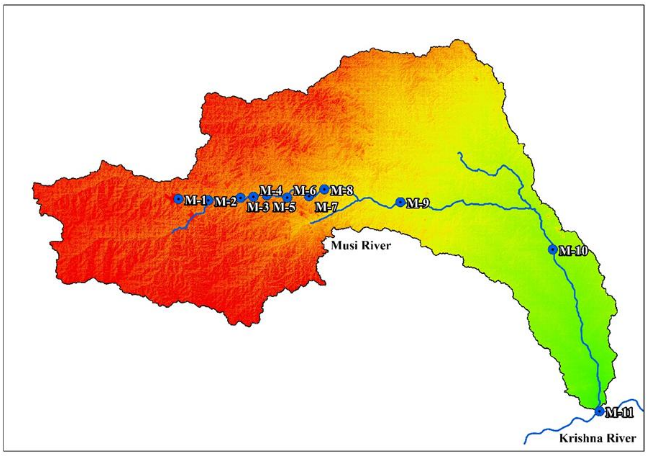

Fig -1: Study area map showing the sample locations (basin-scale) and sewage treatment plants (STPs) for time-series sample collection

To better understand the physical and biological parameters, analyses were conducted on samples taken from the middle part of the river, as well as from a distant location where the Musi River is not utilized for irrigation. These specific sampling points were marked using a Garmin hand GPS device during the collection process (Fig. 1).

Water samples were collected from the middle course of the river using buckets from various bridges. To ensure accurate analysis, these collected water samples were carefully stored in HDPE bottles, maintaining their integrity until transported to the laboratory for further examination. This meticulous sampling strategy provided a holistic view of the river's water quality across different segments and allowed for a thorough investigation into the environmental dynamics.

The physical parameters of the river water samples were meticulously assessed, including pH, EC (Electrical Conductivity), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Coliform, Boron, Fluoride and Sodium Absorption Ratio (SAR) as presented in Table 1.

In-situ measurements of pH and EC were conducted using the probes of the Hanna Edge instrument. Following sample collection, the water samples were promptly transported to the laboratory and stored in a freezer at -4°C to maintain their integrity.

For further analysis, water samples were filtered in the lab using Millipore nylon membrane filters with a 0.45μm pore size. The filtered samples were then acidified with ultra-pure nitric acid and stored in a refrigerator for subsequent examinations.

Sampling for the study specifically targeted Sewage Treatment Plants (STPs) managed by the Hyderabad Metropolitan Water Supply and Sewerage Board, with oversight from the Telangana State Pollution Control Board (TS-PCB) within the Musi River basin. Comprehensive in-situ measurements, including DO, pH, and EC, were complemented by detailed lab tests to determine BOD and Total Coliform levels. This approach ensures a thorough understanding of the water quality parameters crucial for assessing the environmental conditions of the Musi River.

4. RESULTS AND DISCUSSION

A noticeable escalation in all observed physical parameters was identified downstream from Gandipet (STP-1), marking the point where the river begins to receive sewage water. This trend persists for approximately 42 km until Pratapasingaram. Beyond this juncture, there is a discernible shift in the parameters, indicating a return to a more typical water composition.

Physical and biological parameters assessed at the extreme downstream location of Wadapally, just before the Musi River merges with the Krishna River, provide insights into the recovery of the Musi River from anthropogenic impacts. The observed recovery is attributed to factors such as dilution and bio-physical transformations during the downstream transport of pollutants. However, a detailed analysis of how chemical parameters evolve during this recovery process is an aspect that requires further investigation.

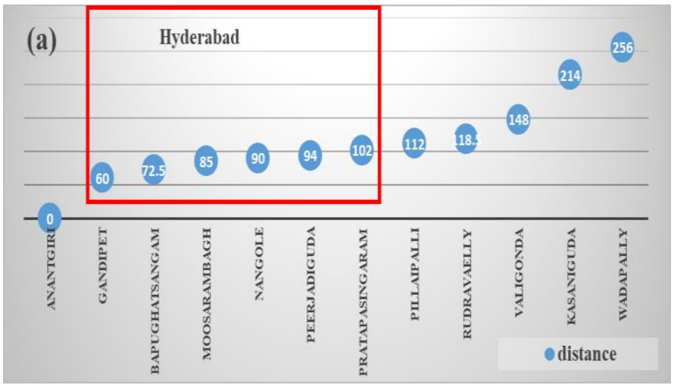

Fig -2: Showing distribution of sewage treatment plants from samples were collected

The average values of samples collected from 11 Sewerage Treatment Plants (STPs) are summarized in Table 1. Notably, various inlets to the Musi River were identified as sources contributing untreated domestic sewage and industrial effluents. These inlets stem from locations such as Jeedimetla, Kukatpally, Peerjadiguda, Nagole, Charlapally, Bapughat Sangem, and Moosarambagh. These areas are characterized by the presence of small to medium-scale industries, metal industries, pharmaceutical industries, electrical industries, and substantial populations generating both industrial and household waste.

an indicator of the water body's oxygen status. Significant DO depletion suggests the presence of substantial biodegradable organic matter in the river water. During monsoon periods, DO values generally increased, reaching the highest level of 6.8 mg/l in downstream areas that received municipal sewage and domestic wastewater. DO depletion may also result from phytoplankton respiration and sediment oxygen demand, with a potential contribution from a large proportion of inflow from bed springs due to lower catchment flow.

Table -1: Arithmetic average of various parameters of samples collected from STPs.

S.no	Locations	DO	pH	Con	BOD	Total coliform	FA	Boron	SAR
1	Gandipet	5.2	8.1	478	3	22	_	BDL	_
2	Bapughat sangem	Nill	7.7	1489	36	350	0.15	0.04	2.9
3	Moosarambagh	Nill	7.9	1429	51	540	0.1	BDL	4.3
4	Nagole	Nill	7.8	1484	42	350	_	BDL	4.1
5	Peerjadiguda	Nill	7.8	1555	34	1500	0.2	0.04	3.9
6	Pratapa singaram	Nill	7.8	1511	30	1600	_	0	4
7	Pillaipalli	3.9	7.78	1248	25	540	_	BDL	5.1
8	Rudravelly	6.2	7.47	1640	3.6	79	5	0.05	1.6
9	Valigonda	6.8	7.25	1645	5	84	5.1	0.06	1.9
10	Kasaniguda	6.1	7.43	2615	4	63	_	0.03	1.2
11	Wadapally	6.5	7.05	1088	2.8	20	_	BDL	1.1

Testing water quality parameters is crucial to ensure its suitability for various purposes, including drinking, domestic use, agriculture, and industry. The selection of parameters for water testing depends on the intended use and the desired level of quality and purity. Water can contain fluctuating, dissolved, suspended, and microbiological impurities, necessitating a range of tests

Physical tests such as pH, total dissolved solids (TDS), and electrical conductivity (EC) are essential to assess basic water characteristics. Chemical tests, including biochemical oxygen demand (BOD), dissolved oxygen, fluoride (FA), boron, sodium absorption ratio (SAR), and total coliform, provide insights into the chemical composition of water. For achieving higher water quality and purity, testing for trace metals, heavy metal contents, and organic pollutants like pesticide residues is recommended.

In developed countries, these criteria are rigorously monitored to ensure the safety and quality of drinking water. Regular testing of water quality parameters is necessary to maintain and improve the overall quality of water resources. The pH levels in the study area ranged from 7.05 to 8.1 mg/l, potentially influenced by industrial effluents and sewerage discharges. The fluctuating dissolved oxygen (DO) levels, ranging from 3.9 to 6.8 mg/l along the river stretch, serve as

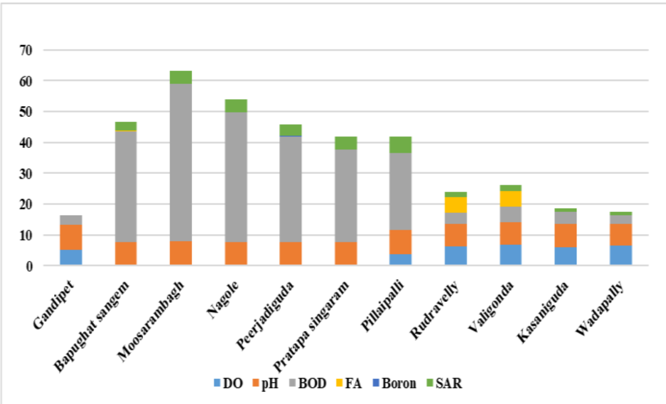

Fig -3: Showing the conc. of different parameters like DO, pH, BOD, FA, Boron, SAR to upstream to downstream.

Biochemical oxygen demand (BOD), a measure of organic pollution, showed values varying from 3 to 51 mg/l, exceeding the standard limits (WHO, 1984: 5 mg/l). Electrical conductivity (EC) values ranged from 478 to 2615 mg/l, with higher concentrations observed in the downstream area of Kasaniguda. Sodium absorption ratio (SAR) values ranged from 1.1 to 4 mg/l, falling within the excellent category (<10) based on the calculated SAR values for all water samples.

Total coliform concentrations varied from 22 to 1600 mg/l, with higher concentrations observed in the urban stretch from Bhapughat Sangem to Pillaipalli. These findings indicate various water quality challenges, emphasizing the impact of anthropogenic activities on the Musi River.

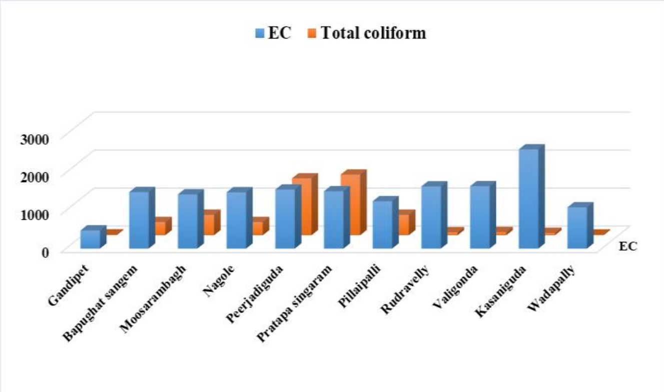

Fig -4: Showing the Conc. of Electrical conductivity (EC) and Total coliform (TC) to upstream to downstream.

3. CONCLUSIONS

Due to the rapid growth of Hyderabad, a substantial volume of wastewater is generated in the city, and with no alternative outlets for disposal, this untreated wastewater, along with domestic sewage and industrial effluents, is discharged into the Musi River. This practice has significant adverse effects on the river's ecology and the well-being of downstream villagers. The poor water quality not only negatively impacts the health of farmers but also renders the water unsuitable for drinking purposes.

Groundwater, being the primary source of water in these areas, is crucial for the communities, making knowledge about its availability and sustainability essential for effective management and future development. The stretch from Bhapughat Sangem to Pillaipalli exhibits elevated levels of physio-chemical parameters, exacerbating the Musi River's conditions. The situation in these regions is further deteriorated by the heavy dumping of organic waste and sewage from various sources, including industrial and municipal sources. Anthropogenic activities contribute significantly to the contamination of the water table.

Implementing proper wastewater treatment systems, both at the source level and before disposal, can substantially reduce pollutant loads. Utilizing advanced scientific technologies for safe treatment is crucial for minimizing the accumulation of pollutants downstream, improving water quality, protecting the river's ecology, and reducing health impacts on downstream villagers. Sustainable development practices, such as wastewater treatment systems and natural filtration techniques, can contribute to the preservation of the Musi River environment and mitigate various skin and health hazards associated with water pollution

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