PHYSICO-CHEMICAL ANALYSIS OF MUSI RIVER WATER-JUSTIFICATION FOR AGRICULTURAL UTILIZATION

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ABSTRACT:

This study evaluates water quality in Hyderabad's Musi River (Himayathsagar to Nalgonda) using key parameters as per Indian Standards. While pH met irrigation norms, Electrical Conductivity showed moderate salinity. Alarmingly, Biological Oxygen Demand exceeded irrigation limits by 3-4 times and drinking standards by 150 times, indicating severe organic pollution from untreated waste. The findings highlight the river's unsuitability for agricultural or domestic use without treatment, necessitating urgent remediation measures to restore water quality and protect public health.

Keywords: Musi River, Water pollution, BOD, EC, Indian Standards, Hyderabad.

INTRODUCTION

Hyderabad, recognized as one of the most densely populated metropolitan areas globally, generates substantial volumes of solid, liquid, and gaseous waste daily from domestic households, industries, agriculture, and vehicular activities. These wastes contain a complex mix of pollutants such as detergents, pesticides, nitrates, fluoride, and heavy metals (CPCB, 2000)[1] .During rainfall and routine washing activities, these contaminants are transported via surface runoff into an extensive network of drainage systems, ultimately discharging into the Musi River and severely impacting its water quality. Additionally, the over-extraction of groundwater in the Musi river basin has facilitated the migration of surface pollutants into subsurface aquifers, thereby compromising groundwater integrity. In several regions, the water from the Musi River is used directly for irrigation, potentially leading to the accumulation of hazardous substances in the soil. Furthermore, intensive agricultural practices in the peri-urban zones, often characterized by the excessive and unbalanced use of chemical fertilizers and pesticides, exacerbate the issue. The combined influence of contaminated irrigation water and indiscriminate agrochemical use poses a significant risk to soil quality and ecosystem health. Motivated by these challenges, the present study aims to investigate and contribute to the restoration and sustainable management of the Musi River. This research is driven by a personal commitment to environmental conservation and a strong desire to safeguard Hyderabad—endearingly known as the "Pearl City." It is my aspiration to witness the city regain its ecological balance and natural beauty, echoing the purity and charm it once symbolized.

Method & Material

Musi River Zone of Hyderabad (Himayathnagar to Nalgonda), Telangana, was selected as study area. Ten water samples were collected in three replicas at ten selected locations. These polluted waters were analyzed as per Indian Standard Procedure

(IS 11624:1986) [2] (CPCB 2000) [1].The collected water samples were used for analysis. The Electrical Conductivity (EC) of the water samples was by Elico Conductivity Meter (IS 3025 (Part 14):2003) [3]. The pH was also measured by pH Meter using glass electrode assembly (IS 3025 (Part 11):2012) [4].The Biochemical Oxygen Demand (BOD) of Musi River water samples were determined using the Winkler titration method. (IS 3025 (Part 38): 1989)[6]

pH:

Materials Required: All Glassware used are class A

pH meter, Make- Elico , Beakers (100 mL), Distilled water (for rinsing), Musi River water samples (collected in clean bottles), Filter paper, Tissue paper, Buffer solutions (pH 4.0, 7.0, and 10.0 for calibration).

Calibration of pH Meter

Before proceeding with the pH measurements, the pH meter must be calibrated using standard buffer solutions, with pH values of 4.0, 7.0, and 10.0. The electrode is first rinsed with distilled water and gently dried using tissue paper. It is then immersed in the buffer solution (starting with pH 7.0), and the instrument is adjusted accordingly. Calibration with other buffer solutions follows to ensure precise readings.

Measurement of pH

After calibration, a small amount of the filtered river water sample is poured into a clean beaker. The electrode is again rinsed and dried before being immersed in the sample. The pH meter is allowed to stabilize, and the reading is recorded. The electrode is rinsed thoroughly between each sample to prevent cross-contamination. This process is repeated for all samples collected from different locations along the river.

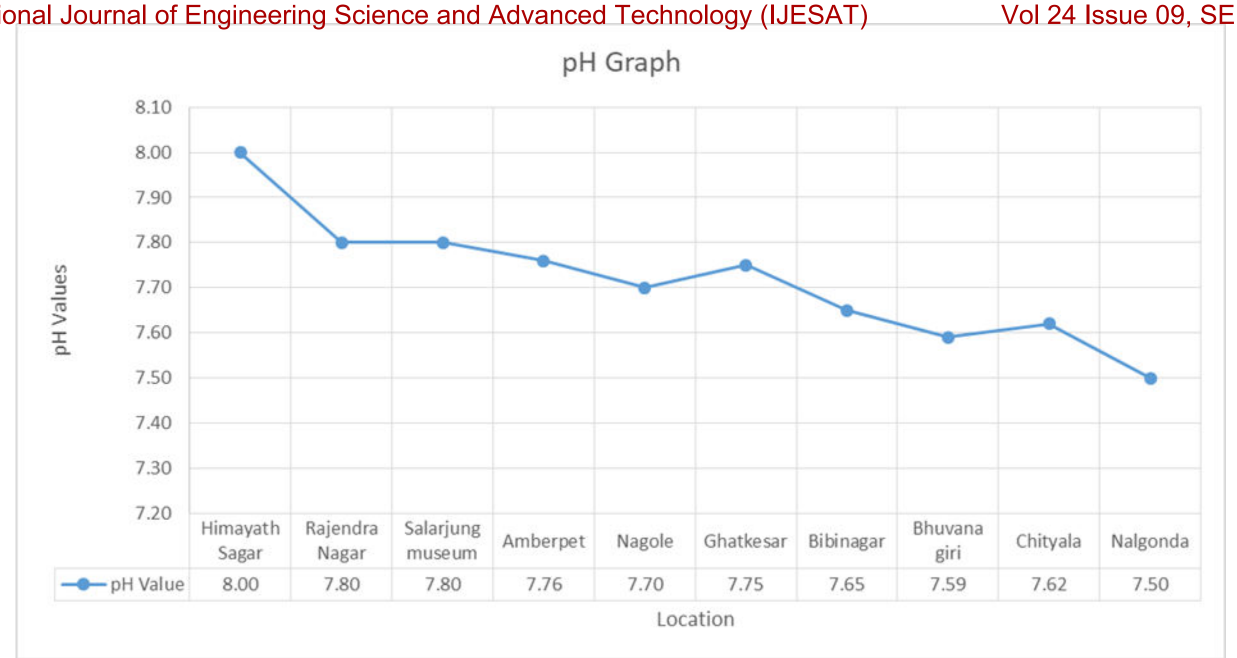
Recording Observations

The pH values are systematically recorded in a (table), which includes details such as sample location, of collection, and the corresponding pH value.

The pH values of water samples collected from various locations along the Musi River belt during the study period ranged between 7.50 and 8.00, indicating a neutral to slightly alkaline nature. This range falls well within the ideal pH limit 6.5–8.5 prescribed by (IS 11624:1986) [2] for irrigation water. The observed pH range is favorable for most crops, however, long-term monitoring is recommended, as fluctuations due to industrial discharge, urban runoff, or seasonal variations could alter water chemistry.

Table-1

S.NO	Location	pH
1	Himayathsagar	8.00
2	Rajendranagar	7.80
3	Salarjung museum	7.80
4	Amberpet	7.76
5	Nagole	7.70
6	Ghatkesar	7.75
7	Bibinagar	7.65
8	Bhuvanagiri	7.59
9	Chityala	7.62
10	Nalgonda	7.50
11	Minimum	7.50
12	Maximum	8.00
13	Mean	7.71



Electrical Conductivity (EC)

Materials Used: All chemicals are AR grade

Conductivity meter (make: Elico) with a cell constant of 1.0 cm^{-1}, clean sample container (to avoid contamination), Standard 0.01 M KCl solution (known conductivity: 1413 µS/cm at 25°C).

Calibration

Calibrate the conductivity meter using a 0.01 M KCl standard solution (conductivity = 1413 µS/cm at 25°C). Ensure the electrode is properly rinsed with distilled water before calibration.

Measurement

Collect the sample in a clean container to prevent contamination. Maintain the sample temperature at 25°C to eliminate temperature-induced variations. Immerse the electrode into the sample, ensuring no air bubbles interfere with the reading. Allow the reading to stabilize before recording the value. The final EC value is expressed in micro Siemens per centimeter (µS/cm).

Conversion Formula: 1dS/m=1000µS/cm

Recording & Observation & Discussion

The Electrical Conductivity (EC) values of Musi River water samples collected from various locations along the Musi River ranged between 2.20 to 2.90 dS m^{-1}, with a mean value of 2.33 dS m^{-1}. These elevated EC levels indicate moderate salinity, which can be attributed to high concentrations of dissolved salts, including sulphates, chlorides, and other solutes from untreated domestic and industrial wastewater discharged into the river.

According to (IS 3025 (Part 14):2003) [3] standards, the permissible limit of EC for irrigation water is 2.25 dS m^{-1}. While the mean value 2.33 dS m^{-1} slightly exceeds this threshold, the range suggests that some locations have acceptable salinity levels ≤ 2.25 dS m^{-1}, whereas others may pose a risk of soil salinization if used for prolonged irrigation. High EC can lead to reduced water uptake by plants, osmotic stress, and accumulation of salts in the root zone, ultimately affecting crop productivity.

Table-2

S.No	Location	EC
1	Himayathsagar	(dS m-1)
2	Rajendranagar	2.90
3	Salarjung museum	2.32
4	Amberpet	2.35
5	Nagole	2.30
6	Ghatkesar	2.28
7	Bibinagar	2.28
8	Bhuvanagiri	2.26
9	Chityala	2.22
10	Nalgonda	2.23
11	Minimum	2.20
12	Himayathsagar	2.20
13	Rajendranagar	2.90

Biological Oxygen Demand (BOD)

Sample Collection

Water samples are collected from various points along the Musi River using clean, airtight BOD bottles. Care is taken to fill the bottles completely, without any air bubbles, as the presence of air may alter the dissolved oxygen content.

Initial DO Determination (Represented by DO_0)

Immediately after collection, the initial dissolved oxygen (DO_0) in the sample is fixed using Winkler reagents. First, 2ml manganese sulfate solution is added to the sample, followed by 2ml alkali- iodide- azide solution. These react with the dissolved oxygen to form a brown precipitate of manganese hydroxide. Upon adding 2ml concentrated sulfuric acid, the ppt dissolves & the solution becomes acidic and the manganese compound releases iodine, which is equivalent to the amount of oxygen present. The liberated iodine is then titrated with a 0.025 N sodium thiosulfate solution using 1% starch as an indicator. The endpoint is identified when the blue color disappears. This provides the initial DO_0 value of the water sample. The same procedure is repeated for remaining water samples, Recording Observations

The DO_0 values are calculated by using the following formula

DO_0 = V X NX 8 1000

$V_2 (V_1 – v)/V_1$

V= volume of Hpo consumed, 0.025 N Hypo, V_2 = volume measured (200ml), V_1= Volume of BOD bottle (300ml), v = (2ml $MnSO_4$ + 2ml H_2SO_4)

Incubation Period

Another portion of the same water samples are incubated in a G- lab Bacteriological incubator at 20°C in amber colored bottles for five days in complete darkness. This step ensures that photosynthesis does not interfere with the oxygen levels during incubation. The sealed bottles are kept undisturbed throughout the incubation period.

Final DO Determination (represented by DO_5)

After five days, the final DO_5 is measured using the same Winkler titration procedure as before. The change in DO over the five-day period represents the amount of oxygen consumed by microorganisms in breaking down the organic matter present in the water.

The DO0 values are calculated by using the following formula

$$DO_5 = \frac{V \times N \times 8 \; 1000}{V_2 (V_1 - v)/V_1}$$

<u>Recording Observations</u>

Sample Location	V(ml) of hypo for DO_0	DO_0 (mg/L)	V(ml) of hypo for DO_5	DO_5 (mg/L)	BOD(mg/L) $DO_0 - DO_5$
Himayathsagar	8.0	8.0	4.8	4.8	3.2
Rajendranagar	7.6	7.6	3.9	3.9	3.7
Salarjung museum	8.1	8.1	4.2	4.2	3.9
Amberpet	7.1	7.1	3.7	3.7	3.4
Nagole	6.9	6.9	3.5	3.5	3.4
Ghatkesar	7.2	7.2	3.9	3.9	3.3
Bibinagar	7.8	7.8	4.0	4.0	3.8
Bhuvanagiri	6.7	6.7	3.6	3.6	3.1
Chityala	7.7	7.7	3.9	3.9	3.8
Nalgonda	8.2	8.2	3.8	3.8	4.4
Minimum	-	-	-	-	3.1
Maximum	-	-	-	-	4.4
Mean	-	-	-	-	**3.6**

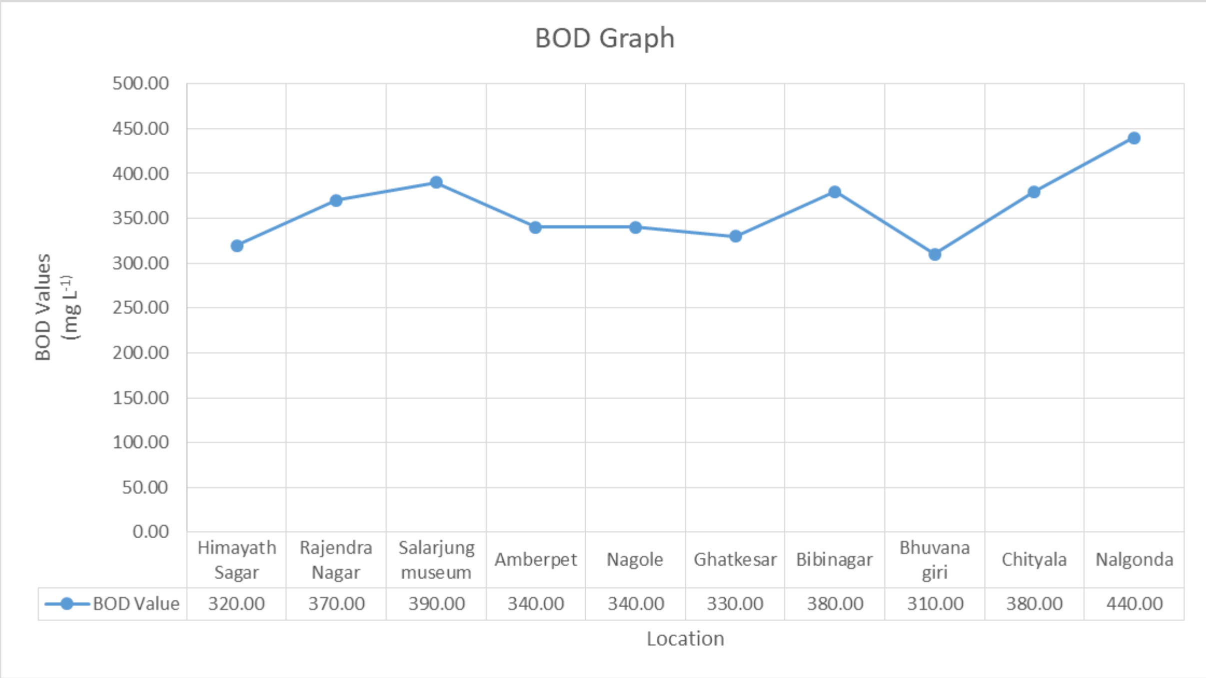
The analysis of Biological Oxygen Demand (BOD) in water samples collected from multiple locations along the Musi River revealed concentrations ranging from 310 to 440 mg L^{-1}, with a mean value of 360 mg L^{-1} (Table). These measurements indicate severe organic contamination of the river water. As per Irrigation Water Quality (IS: 11624-1986) [3] Maximum Permissible Limit for BOD: 100 mg L^{-1},

Observed Range: 310-440 mg L^{-1} 3.1 to 4.4 times higher than permissible therefore Unsuitable for irrigation purposes.

As per Drinking Water Standards (IS 10500:2012) [5], Permissible Limit for

BOD: 2 mg L^{-1} Observed Values are considerably higher than permissible and is unfit for human consumption without extensive treatment.

The extreme BOD levels indicate substantial organic pollution, likely from untreated domestic and industrial effluents.



Results & Discussion

Table: Physico-Chemical, Chemical and Biological characteristics of water samples collected at Ten different locations along the Musi river belt (Mean of Ten samples)

Location	pH	EC ($dS\ m^{-1}$)	BOD ($mg\ L^{-1}$)
Himayathsagar	8.00	2.90	320
Rajendranagar	7.80	2.32	370
Salarjung museum	7.80	2.35	390
Amberpet	7.76	2.30	340
Nagole	7.70	2.28	340
Ghatkesar	7.75	2.28	330
Bibinagar	7.65	2.26	380
Bhuvanagiri	7.59	2.22	310
Chityala	7.62	2.23	380
Nalgonda	7.50	2.20	440
Minimum	7.50	2.20	310
Maximum	8.00	2.90	440
Mean	**7.71**	**2.33**	**360**

pH Analysis: The pH of the Musi River water samples falls within the slightly alkaline range (7.5 – 8.0), which is within the permissible limit (6.0 – 8.5) as per IS: 11624-1986 for irrigation and agricultural use.

Electrical Conductivity (EC) Analysis: The EC values of the Musi River water samples range between 2200 – 2900 µS/cm, slightly exceeding the permissible limit (< 2250 µS/cm) as per IS: 2296-1982 for irrigation water.

Biochemical Oxygen Demand (BOD) Analysis: The BOD levels of the Musi River water samples (3.2 – 4.4 mg/L) fall within the permissible limit (< 10 mg/L) as specified in IS: 2490 Part I – 1981 for effluent irrigation. However, certain areas exhibit relatively higher BOD values, indicating potential organic contamination.

Conclusion

The water quality analysis for pH, EC & BOD of Musi River reveals generally acceptable conditions for irrigation use, though with some site-specific considerations. The pH range (7.5-8.0) falls within IS: 11624-1986 standards (6.0-8.5), indicating suitability for most crops, though slightly alkaline conditions at certain locations permit periodic monitoring. Electrical conductivity (2200-2900 µS/cm) marginally exceeds the IS: 2296-1982 limit (<2250 µS/cm), suggesting the need for careful management through salt-tolerant crop selection, controlled irrigation practices, and proper drainage systems to prevent soil salinity build-up. Biochemical oxygen demand (3.2-4.4 mg/L) remains within permissible limits (IS: 2490 Part I-1981 <10 mg/L), though localized elevations indicate areas requiring attention to organic pollution sources.

While the Musi river water meets basic irrigation standards, the proactive measures will help maintain long-term soil health and crop productivity while protecting the aquatic ecosystem, these measures might help reduce pollution, improve water quality, and restore the ecological health of the Musi River.

Recommendations

1. **Promotion of Bio composting and Waste Segregation**

   The government should incentivize bio composting and enforce waste segregation at source to minimize organic waste entering the Musi River.

   Public awareness campaigns and community participation programs should be implemented to encourage proper waste disposal.

2. **Establishment of CETPs in Industrial Zones.**

Common Effluent Treatment Plants (CETPs) should be set up in industrial clusters like Patancheru and Jeedimetla to treat combined industrial wastewater before discharge into the river.

Strict monitoring and compliance mechanisms must be enforced to ensure industries adhere to effluent standards.

3. **Sewage Diversion and Improved Drainage Systems**

A separate sewage drainage network should be developed to prevent untreated domestic wastewater from flowing into the Musi River.

Existing sewage treatment plants (STPs) should be upgraded to enhance efficiency.

4. **Strict Industrial Regulations and Penalties.**

Industrial licenses should be linked to pollution control compliance, with heavy penalties for violations. Regular inspections and real-time effluent monitoring systems should be mandated for high-polluting industries.

5. **Farmer Education on Sustainable Agriculture.**

The Telangana government should conduct training programs for farmers on: Balanced fertilizer use to reduce nutrient runoff. Organic farming alternatives to minimize chemical pollution. Water-efficient irrigation practices to decrease agricultural discharge into the river.

Abbreviations:

BOD : Biological oxygen demand
EC : Electrical conductivity.
CPCB : Central pollution Control board
AR : Analytical reagent
µS : micro Siemens
IS : Indian Standard
DO : Dissolved Oxygen
CETP : central environmental planning Technology
STP : Sewage treatment Plant.

Acknowledgement: Here with i am submitting research paper entitled "Physico-Chemical Analysis of Musi River Water- Justification for Agricultural utilization" for publishing in your

journal, this work is original, and this work is not incorporated / not published by any journal, book, magazine.

Corresponding Author: Afroze Asfia (On behalf of all authors)

Competing interest: I/We declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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