Study of chemical characteristics of various water samples of Godavari River near Nashik

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***Abstract*—The Godavari River is a vital water source in Nashik, India since it supplies water to over 80% of the city, making it a critical resource that requires seasonal monitoring to prevent health hazards. This study was initiated to analyze the physical and chemical characteristics of water samples from ten different locations along the river, including Gangapur Dam, and to assess their compliance with Bureau of Indian Standards (BIS) for drinking water. The central hypothesis was that water quality would vary across locations and some samples would exceed permissible limits, indicating contamination. Using standard analytical techniques, the study evaluated parameters such as total dissolved solids (TDS), total solids (TS), suspended solids (TSS), pH, hardness, chlorides, sulfates, calcium, and magnesium. Results showed significant variation among samples, with several—particularly Samples 2, 5, and 10—exceeding BIS limits for TS, sulfates, and magnesium. While calcium and chloride concentrations remained within safe ranges, notable differences in pH and hardness indicated site-specific contamination sources. A charcoal filtration test showed visible reduction in solid residue. The findings suggest that parts of the Godavari River are subject to localized pollution, likely due to human and agricultural activity, and highlight the need for regular monitoring and expanded testing including microbiological parameters. The study concludes that while some sites remain within safe limits, others pose potential risks to public health and underscore the urgency of ongoing water quality surveillance and responsible water management.**

I. INTRODUCTION

The Godavari River, often referred to as the 'Dakshin Ganga,' is one of the major rivers in India and serves as a crucial water source for millions. Flowing through densely populated and industrially active regions, the Godavari is subjected to continuous input from urban sewage, agricultural runoff, and industrial discharge [2][3]. Given its religious, ecological, and economic significance—especially in cities like Nashik—assessing the river's water quality becomes critical for public health and environmental conservation.

Previous research has shown that rivers passing through urban areas tend to accumulate pollutants, resulting in changes to physical and chemical characteristics such as increased total dissolved solids, pH shifts, and higher concentrations of heavy metals and other salts [4][5]. The Bureau of Indian Standards (BIS), under IS 10500:2012, outlines acceptable limits for drinking water quality, focusing on parameters like pH, TDS, chlorides, hardness, calcium, magnesium, and sulphates [6].

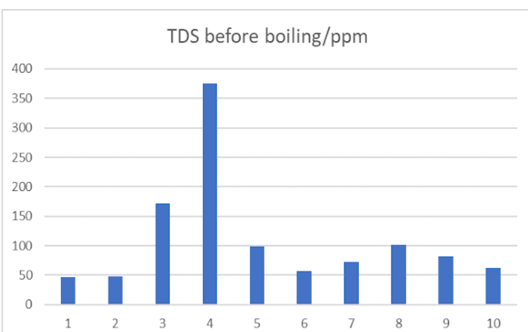
In light of these concerns, this study was conducted to examine the physical and chemical characteristics of ten water samples taken from the Godavari River and nearby water bodies in Nashik. The purpose of the work is to evaluate the quality of these samples based on BIS standards and identify any potential signs of contamination. We hypothesized that samples from certain areas would exceed permissible limits due to increased human and industrial activities. The results confirmed significant deviations in TDS, sulphates, and magnesium levels in some samples, indicating possible contamination. This study emphasizes the need for continuous monitoring and suggests further investigation into seasonal changes and microbiological contaminants to ensure water safety and long-term sustainability.

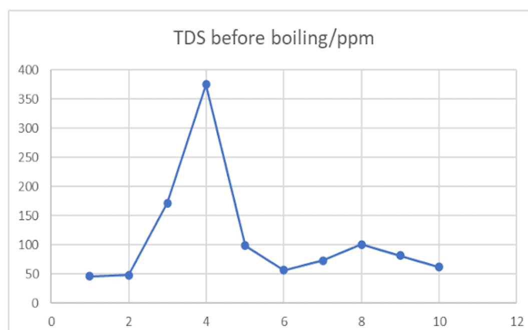
II. RESULTS

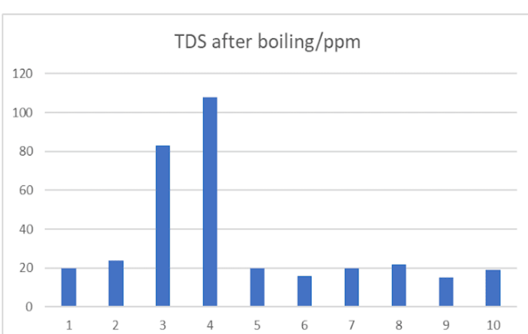
Variables1-4:- Physical Characteristics of Water Samples

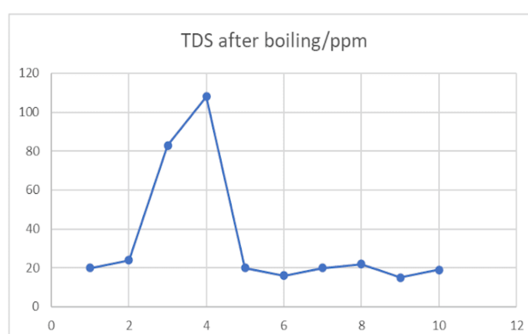
This section includes: Total Solids (TS), Total Dissolved Solids (TDS before and after boiling), Total Suspended Solids (TSS), and pH levels before and after boiling for all ten water samples.

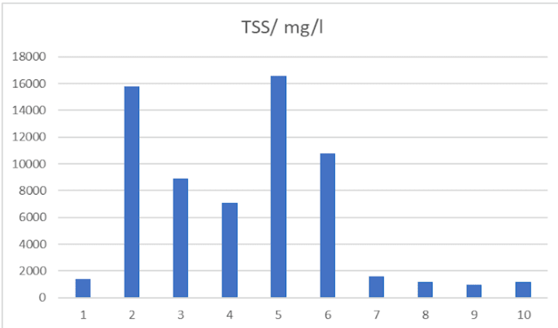
Sample	Mass of beaker before boiling/gm	Mass of beaker after boiling/gm	TS/ mg/l	TDS before boiling/ppm	TDS after boiling/ppm	TSS/ mg/l	pH before boiling	pH after boiling
1	101.59	101.66	1400	46	20	1380	7.6	9.6
2	102.87	103.66	15800	48	24	15776	7.7	9.4
3	100.36	100.81	9000	172	83	8917	7.8	9.6
4	103.85	104.21	7200	375	108	7092	8	9.5
5	102.55	103.38	16600	99	20	16580	7.9	9.3
6	99.34	99.88	10800	57	16	10784	7.9	9.5
7	100.79	100.87	1600	73	20	1580	7.7	9.7
8	101.96	102.02	1200	101	22	1178	7.8	9.5
9	100.86	100.91	1000	82	15	985	7.9	9.6
10	102.14	102.20	1200	62	19	1181	7.9	9.9

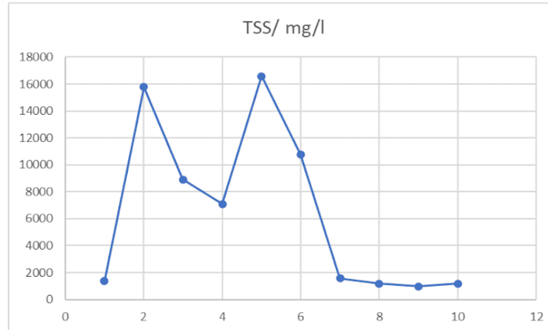




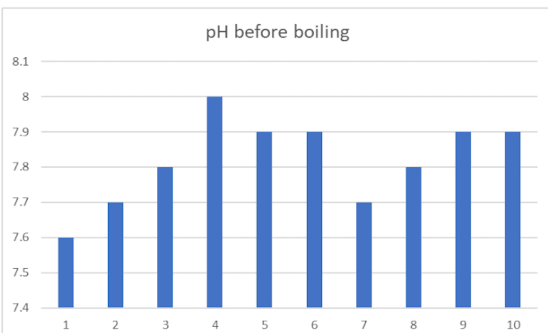


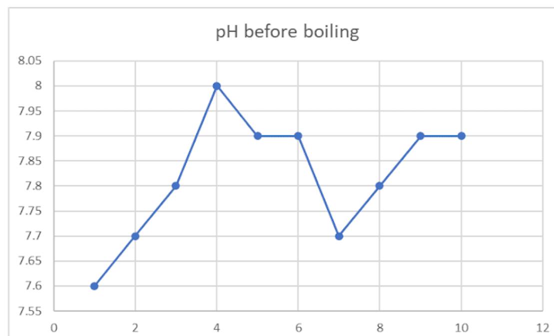


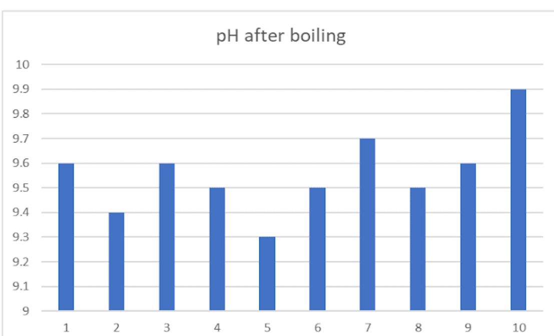


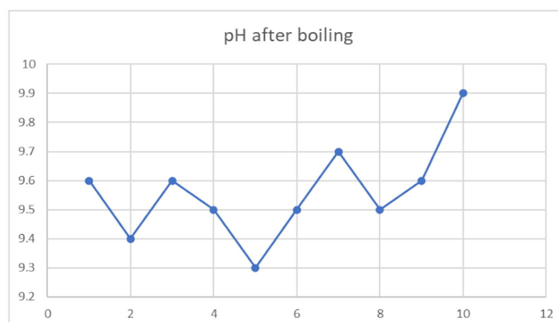


Conclusion Variables 1-3 :-Total Solids (TS), Total Dissolved Solids (TDS), and Total Suspended Solids (TSS): Samples such as Sample 2 (TS = 15,800 mg/L) and Sample 5 (TS = 16,600 mg/L) recorded excessively high total solids, far exceeding the BIS acceptable limit of 500 mg/L. TDS values before boiling were notably high in some samples, reflecting poor water purity, likely due to dissolved minerals or contaminants.









Conclusion Variable 4-:

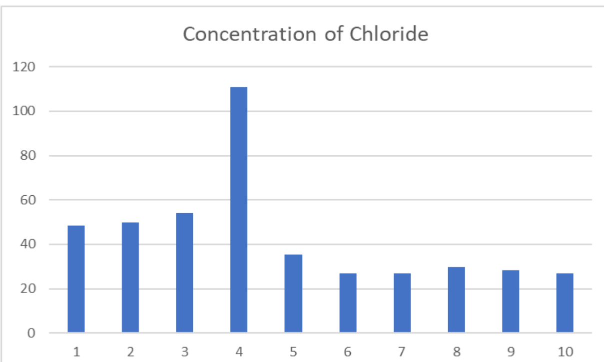
pH values for all samples ranged from 7.6 to 8 (before boiling) and 9.3 to 9.9 (after boiling), indicating an increase in alkalinity post-treatment. While the values remain within acceptable BIS limits (6.5–8.5)

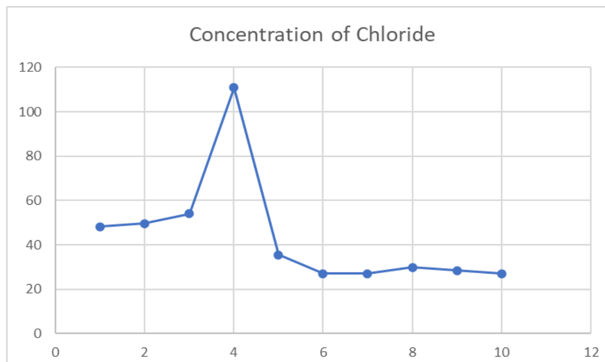
Variable 5 Chloride:

Includes volume of 0.02 N $AgNO_3$ used and corresponding chloride concentration (mg/L) for each sample, measured through titration.

Samples	Volume of 0.02 N of AgNO3 required / ml	Concentration of Chloride
1	3.4	48.28

2	3.5	49.7
3	3.8	53.96
4	7.8	110.76
5	2.5	35.5
6	1.9	26.98
7	1.9	26.98
8	2.1	29.82
9	2.0	28.4
10	1.9	26.98



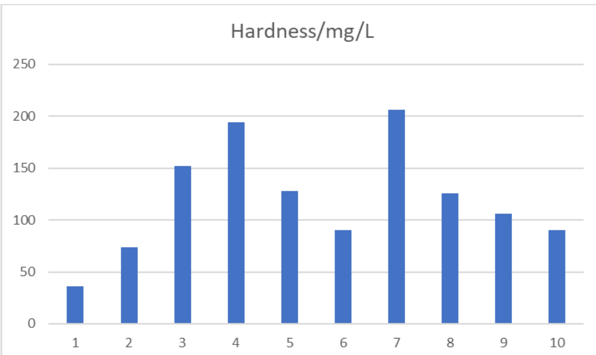


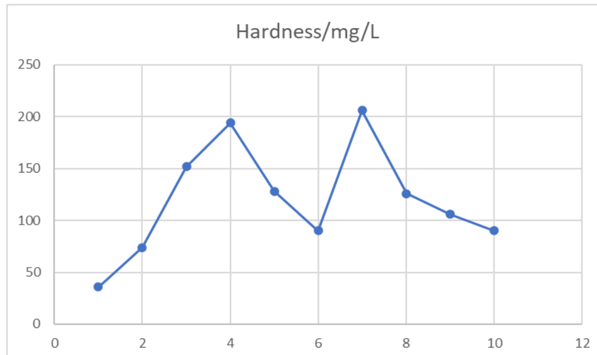
Conclusion Variable 5:
Chloride levels varied across samples, with Sample 4 (110.76 mg/L) nearing the permissible limit (250 mg/L), while others such as Sample 6 and 10 remained significantly lower. Elevated chloride levels may indicate contamination from industrial or agricultural runoff as seen in sample 4.

Variable 6 Hardness:
Includes volume of EDTA used (ml) and total hardness (mg/L) measured using EDTA titration method with Eriochrome Black T indicator.

sample	Volume of EDTA required/ ml	Hardness/ mg/l
1	1.8	36
2	3.7	74
3	7.6	152
4	9.7	194

5	6.4	128
6	4.5	90
7	10.3	206
8	6.3	126
9	5.3	106
10	4.5	90



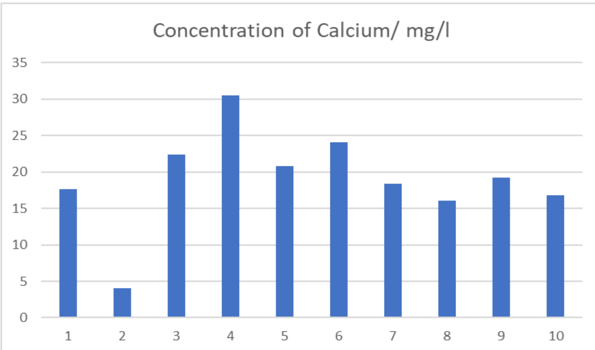


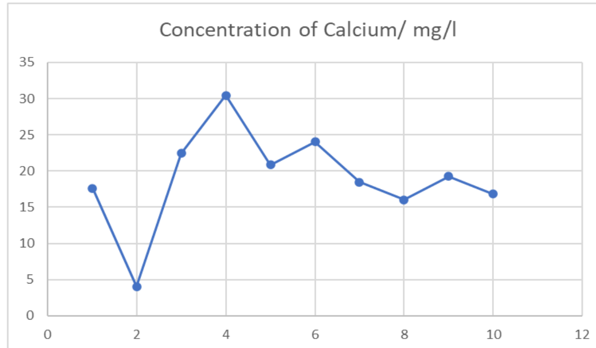
Conclusion Variable 6-
Samples such as Sample 7 (206 mg/L) and Sample 4 (194 mg/L) exceeded the BIS limit of 200 mg/L for total hardness. High water hardness could result from elevated calcium and magnesium levels, impacting water usability for domestic and industrial purposes.

Variable 7 Calcium:
Includes volume of EDTA used and calcium concentration (mg/L), determined via titration using NaOH and murexide indicator.

samples	Volume of EDTA Required/ ml	Concentration of Calcium/ mg/l
1	2.2	17.6352
2	0.5	4.008
3	2.8	22.4448
4	3.8	30.4608
5	2.6	20.8416
6	3.0	24.048
7	2.3	18.4368
8	2.0	16.032

9	2.4	19.2384
10	2.1	16.8336

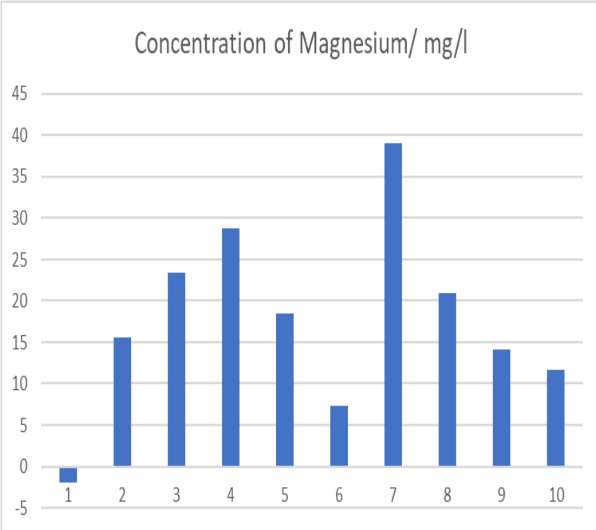


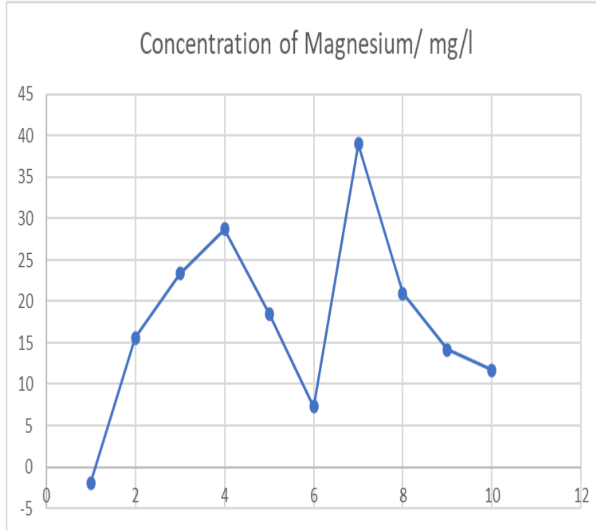


Conclusion Variable 7:- The calcium concentrations across the ten water samples varied significantly, ranging from 4.008 mg/L (Sample 2) to 30.46 mg/L (Sample 4). All measured values remained within the BIS permissible limit of 75 mg/L for drinking water. Samples with higher calcium content, such as Sample 4 (30.46 mg/L) and Sample 3 (22.44 mg/L), contribute to water hardness but remain safe for consumption. The lower concentrations, such as in Sample 2 (4.008 mg/L), suggest a reduced calcium mineral presence which is expected since sample 2 is taken from the start of the river.

Variable 8 Magnesium:
Includes Calculated magnesium concentrations (mg/L) for each sample based on differences in EDTA volumes used in hardness and calcium tests.

Samples	Concentration of Magnesium/ mg/l
1	0.00 (-1.95)
2	15.59
3	23.39
4	28.75
5	18.52
6	7.31
7	38.98
8	20.95
9	14.13
10	11.70





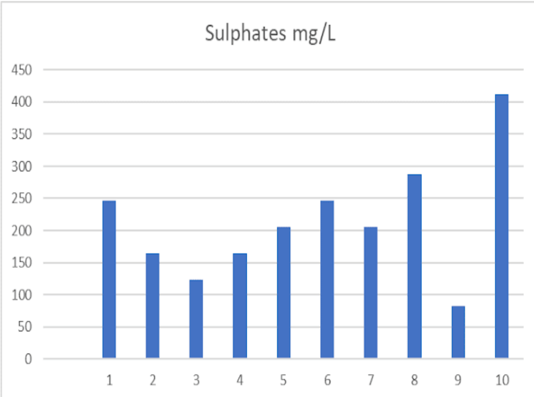
Conclusion Variable 8:-

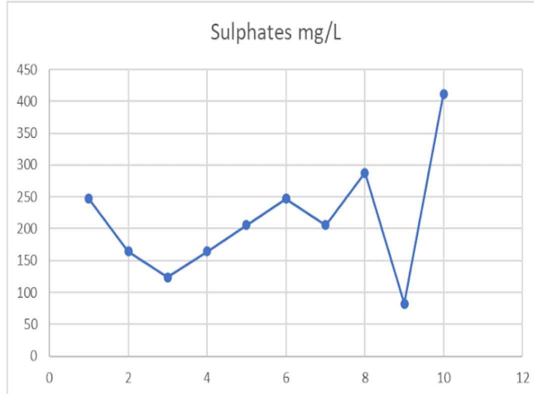
The magnesium concentrations showed significant variation, with values ranging from -1.95 mg/L (Sample 1) to 38.98 mg/L (Sample 7). It is important to note that Sample 7 (38.98 mg/L) exceeds the BIS permissible limit of 30 mg/L, indicating potential contamination or geological influences. Other samples, such as Sample 4 (28.75 mg/L) and Sample 8 (20.95 mg/L), approached but did not exceed the permissible limits.

Variable 9 Sulphate:

Includes crucible weights before and after testing, mass of $BaSO_4$ precipitate, and calculated sulphate concentration (mg/L).

samples	Mass of crucible before gm	Mass of crucible after gm	Mass of BaSO4 mg	Sulphates mg/L
1	42.69	42.75	60	246.9
2	46.04	46.08	40	164.6
3	41.74	41.77	30	123.45
4	37.90	37.94	40	164.6
5	45.69	45.74	50	205.75
6	46.02	46.08	60	246.9
7	41.72	41.77	50	205.75
8	45.67	45.74	70	288.05
9	37.90	38.02	20	82.3
10	42.68	42.78	100	411.5

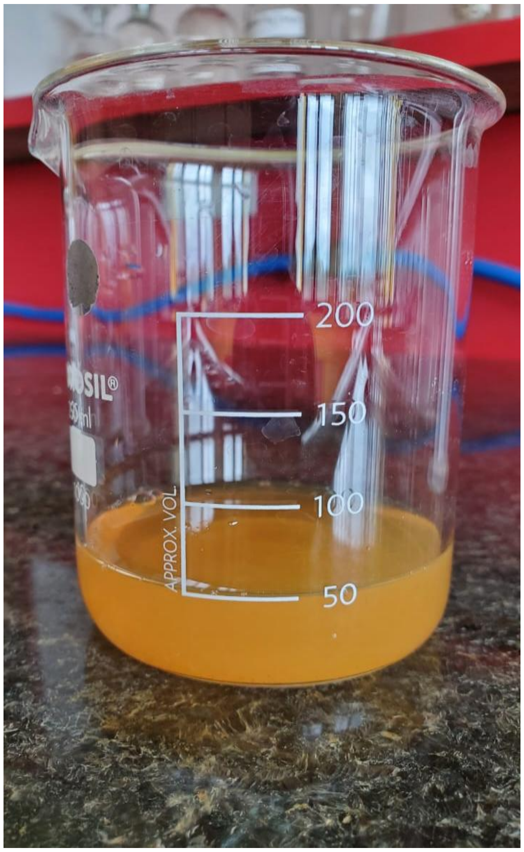




Conclusion Variable 9:- : -Sulphate concentrations ranged from 82.3 mg/L (Sample 9) to 411.5 mg/L (Sample 10). Four samples (Samples 1, 6, 8, and 10) exceeded the BIS permissible limit of 200 mg/L, with Sample 10 showing the highest value. Elevated levels likely result from industrial effluents, agricultural runoff, or natural mineral sources. Immediate monitoring and treatment are recommended to address high sulphate concentrations and ensure water safety.

Variable 10 Charcoal results:
Includes comparative visual/observational results before and after charcoal treatment for insoluble solids; quantitative values not provided.

samples	Before	After
1		

2		
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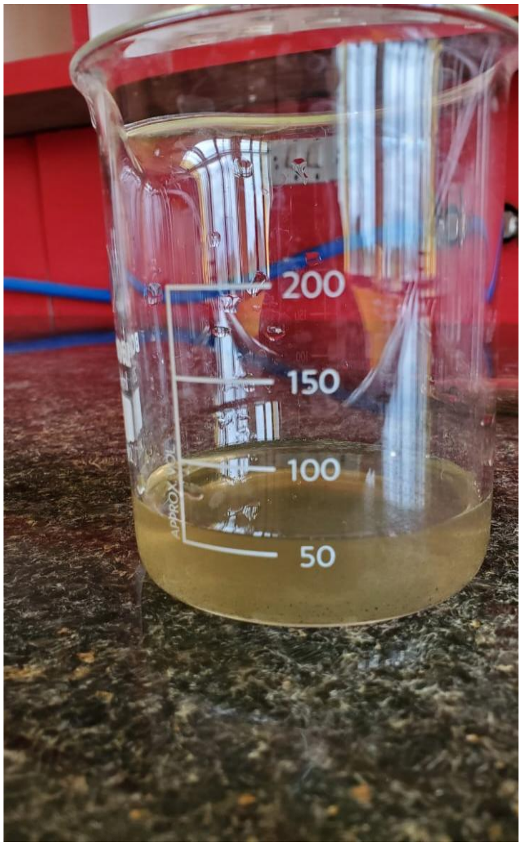
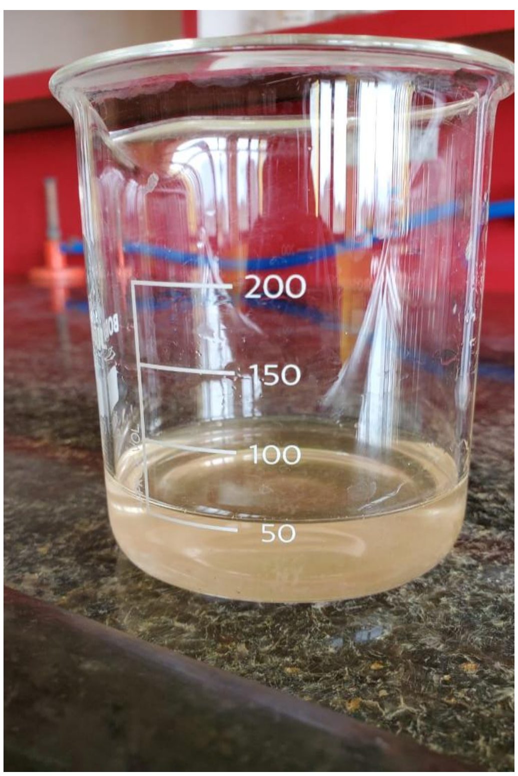
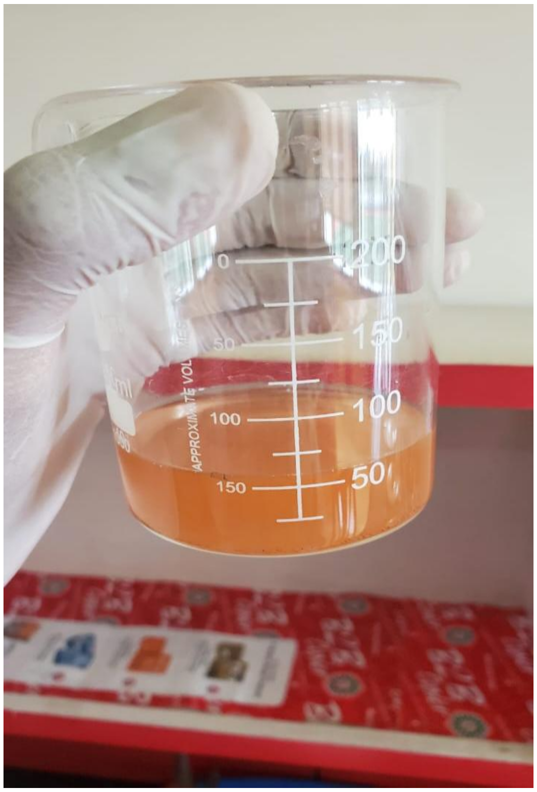
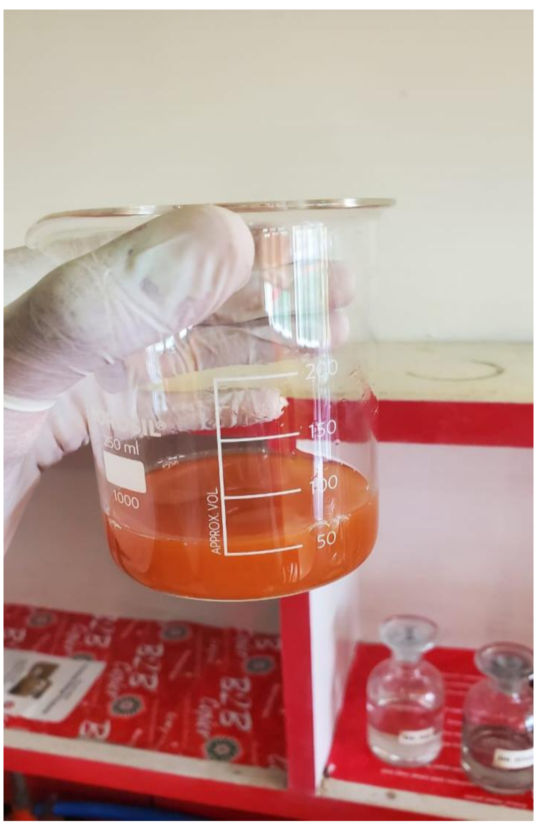
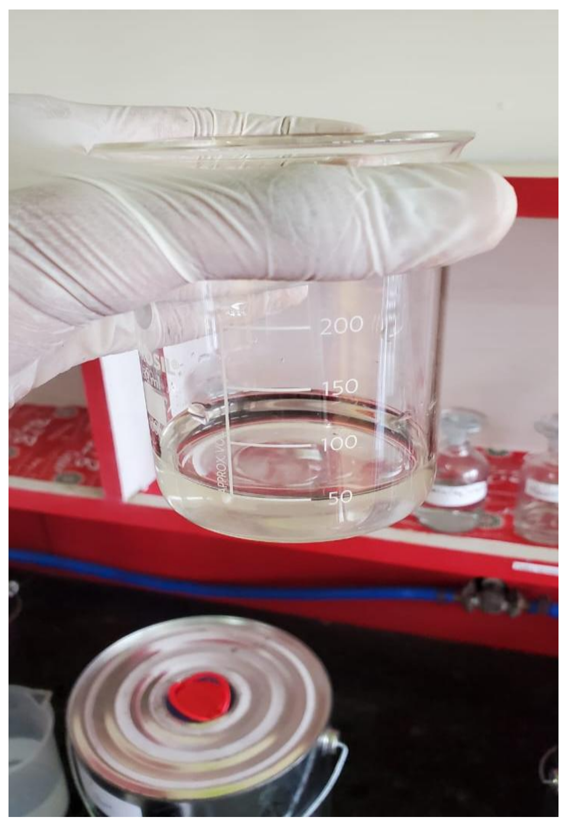
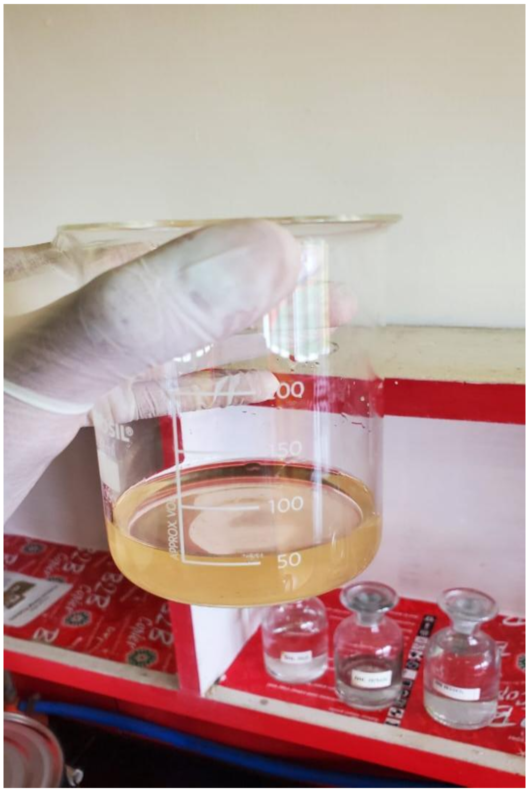
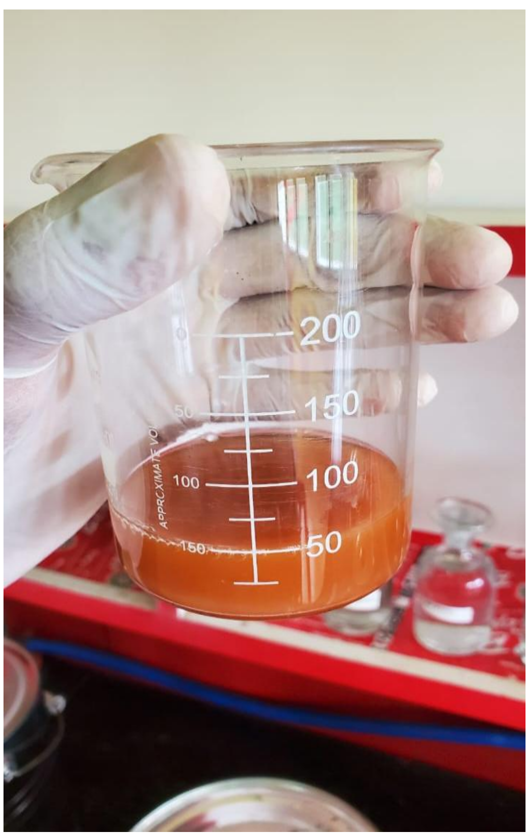
4	200 150 100 50 APPROX VOL	200 150 100
5	200 150 100 50	200 100

6		
7		

8		
9		

10		

Conclusion Variable 10:-While quantitative conclusions could not be made, it is visible that the filtration after addition of charcoal eliminated significant amounts of insoluble solid residue present within the various water samples. The primary cause of these insoluble solids is water pollution, forms of which include dumping of industrial waste.

III. DISCUSSION

The analysis of water samples from the Godavari River near Nasik revealed significant variations in key physical and chemical parameters, some of which exceeded the permissible limits set by the Bureau of Indian Standards (BIS). High total solids (TS) and total dissolved solids (TDS) levels in certain samples, such as Sample 2 (15,800 mg/L) and Sample 5 (16,600 mg/L), indicate potential contamination from suspended matter and dissolved impurities, which could impact water usability and safety. Similarly, the pH values increased after boiling, suggesting the presence of alkaline substances that may alter the water's chemical balance. Such contamination is likely to be a result of dumping of toxic substances by local vendors, shopkeepers and civilians. Heavy industrial waste in this instance would be less of a contributor due to them being isolated away from the areas of the river which recorded detrimental amounts of Total Solids and Total Dissolved Solids.

Chloride concentrations, while generally within safe limits, were significantly elevated in Sample 4 (110.76 mg/L), indicating possible contamination from human or industrial activities. Water hardness varied across locations, with Samples 7 (206 mg/L) and 4 (194 mg/L) approaching or exceeding the BIS limit of 200 mg/L. This suggests high levels of dissolved calcium and magnesium, which can affect water quality for domestic and industrial applications. Water Hardness showed no specific trends across the locations, leading to the conclusion that different geographical areas of the river are subject to various causes - and varying degrees of those causes - that result in the irregular nature of Water Hardness.

Further analysis of calcium and magnesium concentrations confirmed their role in influencing total hardness. Although all calcium levels remained within the BIS limit (75 mg/L), magnesium exceeded the permissible limit (30 mg/L) in Sample 7 (38.98 mg/L), suggesting potential geological or anthropogenic sources of contamination. Sulphate levels in Samples 1, 6, 8, and 10 surpassed the BIS limit of 200 mg/L, with Sample 10 reaching an alarming 411.5 mg/L, indicating contamination possibly linked to industrial effluents or agricultural runoff.

Overall, this study demonstrates that while some water samples from the Godavari River near Nasik are within safe limits, others exhibit significant deviations that necessitate corrective action. Future research incorporating microbiological analysis, seasonal variations, and long-term monitoring to reveal more contributing factors such as natural causes (like animal excrement and changing weather conditions) would provide a more thorough assessment of the river's water quality and its potential risks to public health and the environment.

IV. MATERIALS AND METHODS

Obtaining the samples

Sample 1: Gangadwar Cave, Nashik
Sample 2: Gangadwar, Nashik
Sample 3: Trimbak Kusharvarti, Nashik
Sample 4: Near Hotel Shiv Shakti (Godavari), Nashik
Sample 5: Chakrairi HA Runni, Nashik
Sample 6: Kashyape Dam, Nashik
Sample 7: Anandvalli, Nashik
Sample 8: Ramkund, Nashik
Sample 9: Tapovan, Nashik
Sample 10: Gangapur Dam, Nashik

Variables

1)Total Dissolved solids (T.D.S)
2)Total solids (T.S)
3)Total suspended solids (T.S.S)
4)pH
5)Chlorides
6)Sulfates
7)Hardness
8)Magnesium
9)Calcium
10) Charcoal Treatment

1)T.D.S :- The amount of dissolved solids was determined using the residue left after evaporating, which was then diluted up to 50 ml and the T.D.S was determined using pen type T.D.S meter model TDS–3

2) T.S:- 50 ml of unfiltered samples were taken in a clean preweighed beaker and boiled up to dryness. The beaker was later cooled and weighed again. The amount of total solids present was then calculated using the formula:-

Total solids, (mg/l) = (A-B X 1000 X 1000) / (ml of sample)

Where:

A= Final weight of the beaker in gm.

B= Initial weight of the beaker in gm.

3) T.S.S:- The amount of total suspended solids was calculated using the relation:

T.S.S= T.S-T.D.S

4) pH:- The pH of the samples were measured before boiling and after boiling and diluting it up to 50 ml using electronic pen type pH meter model HANNA HI96107

5) Chlorides: - The concentration of Chlorides was measured by titrating 50 ml of sample against 0.02 N $AgNO_3$ solution using potassium chromate as indicator. Yellow colour changes to persistent red. The concentration of chloride was calculated using the relation:

Chloride, mg/l = ((ml X N of $AgNO_3$) X 1000 X 35.5) / (ml of sample)

6) Sulfates :- Sulphates was estimated gravimetrically. A sample of 100 ml was warmed with 0.5 ml of conc. HCl for five minutes followed by a drop wise addition of 20 ml $BaCl_2$. Then the precipitate $BaSO_4$ was filtered through and washed with hot distil water. The precipitate was then dried, ignited and weighed. The concentration of sulphate ions has been calculated by using the formula:-

Sulphate, mg/l= (mg of $BaSO_4$ X 411.5) / ml of sample

7) Hardness :- A suitable volume of sample (~50 ml) was taken in a conical flask and added 1 ml NH_4Cl + NH_4OH buffer solution to maintain the pH. This content was titrated against 0.01 M EDTA using eriochrome black T as indicator. The colour changes from wine red to dark blue. The hardness was calculated using the following relation:

Hardness as mg/l = b X 1000 / ml of sample

Where b = ml of EDTA used

8) Calcium: A suitable volume of sample was taken into a conical flask and 2 ml of NaOH was added. This

content was titrated against 0.01 M of EDTA using murexide (ammonium purpurate) as an indicator. The colour changes from pink to purple. The concentration of Calcium was then calculated using the relation:
Calcium, mg/l = (a X 400.8) / ml of sample
Where a= volume of EDTA used
9) Magnesium: The concentration of magnesium was determined by using the following relationship:
Magnesium, mg/l = (b-a X 400.8)/ Volume of sample X 1.645
Where b= volume of EDTA used in hardness
a= volume of EDTA used in calcium
10) Charcoal: - Take 50 ml of sample in a beaker. Add small chunks of charcoal to the sample. Filter the solution and compare the results.

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