



Studies on Heavy Metal Contamination and Physico-chemical Properties of Godavari River Water at Rajahmundry, Andhra Pradesh

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ABSTRACT

The present study is aimed to examine the water quality of the Godavari River at Rajahmundry A.P., India. Water samples from Kotilingala Revu, Kovur Godavari river bridge, Saraswati Ghat, Dowleswaram, Pushkar Ghat were collected and analysed for pH, Electrical conductivity, Total hardness, TDS, DO, BOD, COD, Nitrates. The concentration of six heavy metals were analysed quantitatively using Atomic Absorption Spectrophotometer.

Keywords: Trace elements, Water quality, Godavari River, Rajahmundry, Physico-chemical, Water Parameters, Bureau of Indian Standard (BIS).

INTRODUCTION

After Ganges, the Godavari is the longest river in India, covers total area of 312,812 km²^{1,2}. It originates near Nashik, flows through five states and empties into the Bay of Bengal³. State wise distribution of Godavari basin is represented in Figure 1 and 2.

In Andhra Pradesh, it flows through the Papi hills^{4,5}. In Rajahmundry region, the river water is polluted by many industries, domestic sewage and municipal wastages. In this research work, water samples from Kotilingala Revu, Kovur Godavari river bridge, Saraswati Ghat, Dowleswaram, Pushkar

Ghat in Andhra Pradesh were collected and quality of collected samples were analysed.

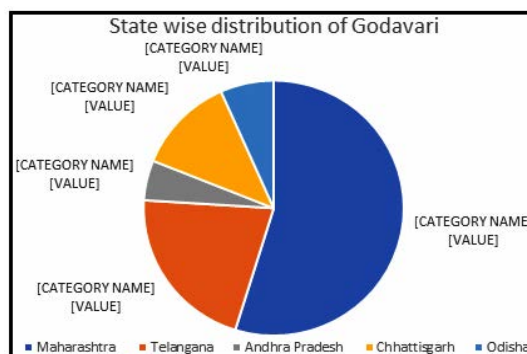


Fig. 1. State wise distribution of Godavari River





Fig. 2. Path of the Godavari through the South Indian Peninsula

MATERIALS AND METHODS

Study area

In Rajahmundry, the Godavari River is polluted by industrial effluents and domestic

waste water⁶. The name of the water quality sites, latitude and longitude are shown in Table 1. Water samples were collected once in every month from the water quality monitoring station Rajahmundry and samples were collected from the surface waters of the River. Samples were collected from June 2020 to May 2021.

The analysis included 14 water quality parameters like pH, electrical conductivity, total hardness, total dissolved solids, dissolved oxygen, biological oxygen demand, chemical oxygen demand and nitrates were monitored by sampling at 5 stations for 12 months (2020–2021). The quality of water samples were analysed as per the standard methods⁷. Trace metal analysis was carried out using Atomic Absorption Spectrometer (AAS) following standard methods given in APHA (2012)⁸.

Table 1: Water quality stations on River Godavari, Andhra Pradesh India

Site number	Name of water quality site	Latitude and longitude	Region
S1	Kotilingala Revu	latitude—17°01'00.1"N, longitude—81°46'13.1"E	Rajahmundry
S2	Kovur Godavari river bridge	latitude—16°59'52"N, longitude—81°45'21"E	Rajahmundry
S3	Saraswati Ghat	latitude—16°59'36.06"N, longitude—81°46'18.98"E	Rajahmundry
S4	Dowles waram	latitude—16°57'2.51"N, longitude—81°46'55.18"E	Rajahmundry
S5	Pushkar Ghat	latitude—16°59'03.2"N, longitude—81°47'02.7"E	Rajahmundry

RESULTS AND DISCUSSION

Among the 840 observations, only maximum, minimum, mean and standard deviation values are shown in Table 2.

pH

During the study period, the water pH was slightly basic at all stations (Table 2). It ranged from 7.65 to 9.56. The mild alkaline nature of river water attributed to the presence of CO₂ in water as bicarbonate⁹.

Electrical conductivity

The level of salinity indicated by electrical conductivity¹⁰. According to WHO standards, EC value within 400 μ mho/cm is acceptable¹¹. The current investigation showed that EC value was 101 to 170 μ mho/cm, which indicated the lower level of ionic concentration Table 2.

Total dissolved solids

TDS showed a maximum value in Kotilingala Revu from September 2020 to January

2021 (410 to 441 mg/L) followed by Dowleswaram from September 2020 to December 2020 (410 to 398 mg/L). According to USPHS (United States Public Health Services, 1962) standard, TDS value should not exceed 500 mg/L¹².

DO, BOD, COD

In the present study, the range of DO over a period of one year from June 2020 to April 2021 was found to be high at all five stations, mean value in between 6.85 to 7.44 shown in Table 2. During the study period, DO content was found in between 5.12 to 8.04 at all five stations. The oxygen balance of an aquatic environment plays an important role in pollution. The B.O.D and C.O.D. are interrelated mainly due to effluents. Present study agrees with previous report, investigated by Srinivasarao *et al.*, (2008)¹³. The present study indicated that the quality of river water is in permissible limits (BIS 10500 (2012))¹⁴ because of maximum level of dissolved oxygen.

Hardness

Hardness mainly due to dissolved Ca, Mg

salts. In the present study, hardness found from 190 mg/L to 356 mg/L at all sites. The hard water causes kidney stones in humans¹⁵.

Nitrate

Concentration of nitrates was highest in

Dowleswaram, January 2021 (18 mg/L) followed by Kotilingala Revu, January 2021 (16.3 mg/L) and least in Pushkar ghat, June 2020 (3.8 mg/L). Because of flood, nitrates contributing algae from rocks minimizes fixation of nitrates during June to September 2020 in all stations.

Table 2: Maximum, minimum, mean and SD values of water quality parameters

Parameters		S1	S2	S3	S4	S5
pH	Max	9.56	8.95	9.05	9.56	8.90
	Min	7.98	7.89	7.99	7.86	7.65
	Mean	8.30	8.29	8.64	8.41	8.26
	SD	0.3980	0.3157	0.3499	0.4755	0.2943
Electrical conductivity	Max	145	140	167	170	138
	Min	117	101	104	110	111
	Mean	130	121	121	139	126
	SD	9.5956	11.0138	15.8508	16.5300	8.0501
Total hardness mg/L	Max	325	300	290	356	290
	Min	200	200	190	280	210
	Mean	287	254	234	291	258
	SD	34.8937	35.3886	32.7781	35.7149	23.7679
TDS mg/L	Max	442	392	376	410	389
	Min	257	198	221	320	259
	Mean	359	294	296	353	320
	SD	56.7058	46.8549	48.8532	30.2851	44.2576
DO	Max	7.98	7.80	8.04	7.90	7.45
	Min	5.12	6.06	7.08	6.24	5.86
	Mean	7.08	7.03	7.44	7.15	6.85
	SD	0.8033	0.4851	0.3387	0.4012	0.6381
BOD	Max	20.2	19.2	17.8	15.2	16.7
	Min	10.8	12.2	12.2	10.5	10.9
	Mean	15.7	14.8	14.0	12.8	13.6
	SD	3.1808	2.0218	1.5564	1.1033	1.6140
COD	Max	110.2	110.8	110.2	113.1	114.3
	Min	69.8	69.6	71.2	70.8	77.8
	Mean	92.4	91.7	94.6	95.5	93.1
	SD	13.1239	14.5871	12.2742	12.9126	13.2803
Nitrates mg/L	Max	16.3	8.9	8.0	18.0	11.0
	Min	6.7	3.0	3.8	6.2	3.8
	Mean	10.7	4.8	5.0	11.3	6.20
	SD	3.0153	1.7281	1.2697	4.1574	2.0320
Chromium ($\mu\text{g/L}$)	Max	14.45	13.50	3.72	6.90	7.92
	Min	2.28	4.50	0.34	1.28	1.17
	Mean	8.14	9.44	1.96	4.38	4.14
	SD	3.3730	2.6448	1.0332	2.0431	2.4005
Copper ($\mu\text{g/L}$)	Max	18.12	28.08	3.08	6.28	8.88
	Min	6.20	1.40	0.20	0.20	0.18
	Mean	11.95	6.29	1.36	2.59	3.46
	SD	3.9826	7.0143	0.9014	1.8980	2.3940
Nickel ($\mu\text{g/L}$)	Max	17.08	19.28	11.28	12.38	11.20
	Min	4.10	3.45	1.56	1.30	1.10
	Mean	10.23	10.42	5.81	6.92	4.42
	SD	4.1921	4.1547	2.9878	3.0293	2.8891
Lead ($\mu\text{g/L}$)	Max	4.50	5.05	3.40	3.90	3.56
	Min	1.23	1.20	0.45	0.78	0.77
	Mean	2.77	3.19	1.47	2.21	1.92
	SD	0.9547	1.1690	0.9062	0.9861	0.8229
Zinc (mg/L)	Max	0.112	0.108	0.1	0.1	0.1
	Min	0.008	0.0008	0.003	0.008	0.0006
	Mean	0.089	0.0372	0.0789	0.067	0.0638
	SD	0.0251	0.0444	0.0306	0.0366	0.0443
Iron (mg/L)	Max	0.180	0.04	0.04	0.190	0.04
	Min	0.01	0.008	0.008	0.01	0.003
	Mean	0.0825	0.0917	0.01725	0.06083	0.01925

Chromium

Chromium is used in many industries¹⁶. These industries discharge Cr (III) and Cr (VI). Cr (VI) is carcinogenic and toxic¹⁷. From the Table 2, chromium concentration found from 0.34 to 14.45 µg/L (within acceptable limit 50 µg/L). The maximum chromium concentration (14.45 µg/L) was found at Kotillingala Revu in April 2021.

Copper

The intake of large amount of copper causes chronic health issues¹⁸. From the present investigation, copper concentration was found between 0.18 and 28.08 µg/L, within the acceptable limit of 50 µg/L¹⁴. The highest copper concentration (28.08 µg/L) was observed at Kovur in May 2021 and minimum copper concentration (0.18 µg/L) was found at Pushkar ghat in June 2020.

Nickel

Nickel concentration found in between 1.10 to 19.28 µg/L. The maximum nickel concentration (19.28 µg/L) was found at Kovur Godavari river bridge in April 2021.

Lead

Intake of excess of lead causes adverse health effects, severely affect the CNS, loss of memory. In adults, chronic lead toxicity leads to joint pain and gastrointestinal symptoms¹⁹. Lead concentration varies from 0.45 to 5.05 µg/L, but within the acceptable limit of 10 µg/L. The maximum lead concentration (5.05 µg/L) was found in Kovur Godavari river bridge at April 2021.

Zinc

Zinc concentration found from 0.0006 to 0.112 mg/L (acceptable limit 5 mg/L). The maximum lead concentration (0.112 mg/L) was found in Kotillingala Revu in May 2021.

Iron

The intake of large amount of iron leads tissue damage¹⁸. Iron concentration found in between 0.003 to 0.190 mg/L, however within the acceptable limit of 0.3 mg/L. The maximum iron concentration (0.190 mg/L) was found in Dowleswaram in January 2021.

According to BIS 10500 (2012), the requirement (acceptable limit) is given in Table 3.

Table 3: Drinking water standards for trace elements (BIS-10500-2012)

Trace elements	Acceptable limit
Chromium	50 µg/L
Copper	50 µg/L
Nickel	20 µg/L
Lead	10 µg/L
Zinc	5 mg/L
Iron	0.3 mg/L

In this study, various physico-chemicals parameters were recorded throughout the year. The results showed that, these parameters are seasonally varied and are found to depend on environmental and other factors. Most of the parameters are within acceptable range compared to given by USPHS (1962) and BIS 10500 (2012) standards. The results presented in this study are consistent with the previous observations^{20,21}. The pH, temperature, and the water disturbance affect the levels of these heavy metals in an aquatic environment. For example, heavy metals are released more easily into the water at lower pH and higher temperatures. Although many metals are considered essential, they become toxic at higher concentrations due to their ability to cause oxidative stress by forming free radicals, which can react with cellular structure proteins, enzymes and membrane systems²². The pollution of heavy metals in our atmosphere, soils and waters are all due to human activity²³. Heavy metals can be removed from water. Agricultural waste, such as dairy manure, remaining waste material from rice and peanuts, natural soil seem to be the best to remove heavy metals²⁴.

CONCLUSION

Based on findings, it was concluded that the water from the study area is basic in nature and saturated with dissolved oxygen. Godavari river is being polluted with the discharge of industrial effluents at Rajahmundry. There is an urgency to take up protection of river water.

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Conflicts of interests

The authors declare no conflict of interest.

REFERENCES

1. The Godavari River System. cwc.gov.in. Central Water Commission, Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation.
2. Babar M, Kaplay RD **2018** Godavari River: Geomorphology and Socio-economic Characteristics. In: Singh D. (eds) *The Indian Rivers*. Springer Hydrogeology. Springer, Singapore. https://doi.org/10.1007/978-981-10-2984-4_26.
3. Integrated Hydrological DataBook (Non-Classified River Basins). Central Water Commission., 9.
4. Polavaram project studies by NGT (page 56). <http://www.indiaenvironmentportal.org.in/files/file/Polavaram-project-report-NGT.pdf>
5. Amarnath C R, Thatikonda S. *Water*, **2020.**, 12:576. doi:10.3390/w12020576.
6. Akkaraboyina MK, Raju BSN. *Universal J. Environ. Res. Tech.*, **2012**, 2(2), 161-167.
7. American Public Health Association (APHA) Standard Methods for the Examination of Water and Wastewater. 21st edn., American Public Health Association, Washington, DC., **2005**, 2-61.
8. American Public Health Association (APHA), Standard methods for the examination of water and wastewater, 22nd edn. Edited by Rice EW, Baird RB, Eaton AD, Clesceri LS. American Public Health Association, Washington, D.C., USA., **2012**.
9. Azeez PA, Nadarajan NR, *Mittal DD. Pollut. Res.*, **2000**, 19(2), 249-255.
10. Rusydi AF. IOP Conf. Series: *Earth Environ. Sci.*, **2018**, 118, 012019. doi :10.1088/1755-1315/118/1/012019.
11. Meride Y, Ayenew B. *Environ. Syst. Res.*, **2016**, 5. DOI 10.1186/s40068-016-0053-6.
12. Bhalla R, Waykar BB. *Nat. Environ. Pollut. Technol.*, **2013**, 12(1), 125 -129.
13. Srinivasarao V, Khan AM. *J. Ind. Pollut. Control.*, **2008**, 24(1), 1-8.
14. Bureau of Indian Standards (BIS) 10500 Specification for drinking water. Indian Standards Institution, New Delhi., **2012**, 1–5.
15. Rai AK, Paul B, Mudra L, Kishor N. *J. Adv. Lab. Res. Biol.*, **2011**, 2(4), 136-140.
16. Ganguli A, Tripathi AK. *Appl. Microbiol. Biotechnol.*, **2002**, 58, 416–420.
17. Lee SE.; Lee JU.; Chon HT.; Lee JS. Microbiological reduction of hexavalent chromium by indigenous chromium-resistant bacteria in sand column experiments. *Environ. Geochem. Health.*, **2008**, 30, 141–145.
18. Hussain J.; Husain I.; Arif M. *Environ. Quality*, **2014**, 14, 31-41.
19. Ogwuegbu MOC, Muhanga. W. *J. Environ.*, **2005**, 1, 66–75.
20. Hussain J.; Husain I.; Arif M.; Gupta N. *Appl. Water Sci.*, **2017**, 7, 4539–4548.
21. Samanta S.; Kumar V.; Nag SK.; Saha K.; Sajina AM.; Bhowmick S.; Paul SK.; Das BK. *Aquat. Ecosys. Health Manag.*, **2021**, 24(4), 23–33.
22. Apau J.; Osei-Owusu J.; Yeboah A.; Gyamfi O.; Darko G.; Akoto O.; Dodd M.; *Sci. Afr.*, **2022**, 15, e01074.
23. Briffa J.; Sinagra E.; Blundell R. *Heliyon.*, **2020**, 6(9), e04691.
24. Joseph L.; Jun BM.; Flora JRV.; Park CM, Yoon Y. *Chemosphere.*, **2019**, 229, 142-159.