SEASONAL ASSESSMENT OF HEAVY METAL CONTAMINATIONS IN RIVER GODAVARI AT NANDED CITY, MAHARASHTRA, INDIA

S. V. Hari Krishna[1*], B. Ananda Kumar[2], N. Vijaya Kumar[3], A. Chandra Leela[4], G. Rama Swamy[5]

Abstract:
This work intends to assess the variation of concentrations of heavy metals such as Al, Cr, Mn, Fe, As and Pb during summer, monsoon and winter seasons in river Godavari at Nanded city. The two sampling stations were so selected in such a way that one the river Godavari enters the Nanded city and the second where the river leaves the city, is a stretch of five kilometers where the river is stressed by the both urban and industrial activities of the city. The results have shown that there is a significant increase in metals specifically Al, Cr, Mn and Fe were added to the river from Nanded city. This seasonal assessment shows the variations in the metal concentrations and it relates to the volume of water available in the river.

Keywords: River Godavari, Nanded city, heavy metals contaminations and seasonalvariations.

[1]Department of Public Health, Palakollu Municipality, Palakol-534260, AP, INDIA
[2]Department of Chemistry, Sri Y.N. College (A), Narsapur -534275, AP, INDIA
[3]Department of Chemistry, DNR (A) College, Bhimavaram -534202, AP, INDIA
[4]Department of Chemistry, Andhra University, Visakhapatnam - 530003, AP, INDIA
[5]Department of Basic Science, Vishnu Institute of Technology (A), Bhimavaram - 534202, AP, INDIA

***Corresponding Author:** S. V. Hari Krishna
Email: harikrishna6821@gmail.com

DOI: -10.53555/ecb/2022.11.9.85

Introduction

The existence of life on earth depends on the existence of resources, their quantity and quality as well. Natural resources remain constant whereas the consumers increase exponentially. As a result, the consumption of resources followed by the production of waste and dumping of unwanted materials into nature itself also increases exponentially. Water is one of such resources. Water being a universal solvent dissolves many kinds of materials and transport them from one place to another within and outside the living system, this unique property of water is now becoming curse to life as water getting polluted (Hari Krishna *et al.,* 2018). Among inland water bodies, river placed first with respect to the rate of pollution (Panda *et al.*, 2006). Water pollution is one of the global challenges that the present generation must aim to improve water quality and reduce its adverse impact on ecosystem and human health (Camilo *et al.*, 2021).Heavy metals are non-biodegradable; therefore, they tend to bioaccumulate, also their concentration magnify overtime in living organisms (Cabral Pinto *et al.*, 2017, Fu and Wang, 2011, Kumar *et al.*, 2020a).

As two-thirds of our planet Earth is covered with abundant water, our earth is called a 'blue planet'. The most ironic part of it is the scarcity of drinking water amidst plenty. In the last 2000 years, the human population has grown 50 times whereas the quantity of water remained the same. The quality of water has been degrading day by day in the name of modern development in which, the need-based sustainable development has turned into greed-based exploitative development showing scant regard to ecology and environment. Intensive and extensive human activities in sectors like agriculture, aquaculture, industry and urbanization are responsible for making the water unfit for its designated uses. It also enhanced the variety of pollutants such as heavy metals in the environment especially rivers are becoming point sources of pollution.

Metals such as Copper (Cu), Iron (Fe), Manganese (Mn), Nickel (Ni) and Zinc (Zn) are essential micronutrients for life processes in plants and microorganisms whereas many other metals viz., Cadmium (Cd), Chromium (Cr) and Lead (Pb) have no known physiological activity and they proved to be toxic beyond certain limits (Brunis*et al.,* 2000). These are toxic because of their non-biodegradable nature and accumulate in the different body parts (Arora *et al.*, 2008). Pb inputs are the resultants of human activity (Clark, 2001). Metals that are commonly found in earth's crust are also added to the surface waters as natural pollutants, they may be toxic or non-toxic. Attention should be paid on non-toxic metals too (Magdlena*et.al.*, 2021). As rivers play a major role in carrying municipal sewage and industrial effluents, this study intended to measure seasonal variations in the heavy metals loads upstream and downstream of river Godavari at Nanded City during May-2017, July-2017 and November-2017.

Study Area

River Godavari at Nanded city, the river originated from Bramhagiri mountains at the elevation of 1,067 m in Trimabakeshwar, Nashik district, Maharashtra state and it flows towards south east. On the way to Nanded city, river Godavari receives water from its tributaries, river Pravara and river Purna.

About 5Km of river passing through the Nanded city, where it is loaded with domestic contaminants as well as the effluents of several industries. Two samples were taken at the upstream where the river enters and other is at the downstream where the river leaves the Nanded city. The two sampling stations were noted as SS-1 and SS-2. SS-1 and SS-2 lies at 19º08'46.3"N; 77º18'26.3"E, Nanded upstream and 19º08'38.7"N; 77º20'11.9"E, Nanded downstream respectively.

Sampling Station -1 (SS-1) is about 630 Km away from the river origin, the intention of taking sample here is to know the water quality after the river is stressed at the upstream and also before the river is stressed at the downstream by various anthropogenic and industrial activities of Nanded city.

Sampling Station - 2 (SS-2) is about 5 Km away from the SS-1, in this stretch of 5 Km, the river is stressed by the urban sewage and industrial effluents of the Nanded city. By comparing the data obtained from the samples of this station with the data of SS-1 reveals the damage occurred to the quality of river water during the stretch of SS-1 and SS-2.

Collection and analysis of Samples

Sampling was done on the same day between 11 am and 12 pm at two sampling stations (SS-1 & SS-2) during summer, winter and monsoon seasons. Water samples were collected in two polythene containers; they were filtered and preserved with 6N nitric acid solution.

Samples were analyzed for heavy metals with ICP-MS (Inductively Coupled Plasma Mass Spectrometry). Standard method-1640 (USEPA, 1997) was followed to determine the concentrations of heavy metals in water samples.

Results and discussion

The results obtained from the samples taken in the month of May-2017, July-2017 and Nov-2017 are shown in tables 1-2 and figures 1-2 at the above said sampling stations. Tables 3-5 and figures 3-5, data reflecting the variations in concentration of metals from SS-1 to SS-2.

Table 1: ICP-MS report of concentration of heavy metals in µg/L at SS-1.

Heavy Metals	Summer	Monsoon	Winter	Standard Limits	
				BIS	WHO
Al	176.557	174.231	166.433	30	30
Cr	29.111	2.796	9.132	50	50
Mn	1754.02	28.402	48.81	100	400
Fe	2932.11	205.227	794.014	300	300
As	4.227	0.687	0.471	10	10
Pb	7.218	6.013	7.481	10	10

Note: Parameters which exceed the standard values are highlighted with red colour.

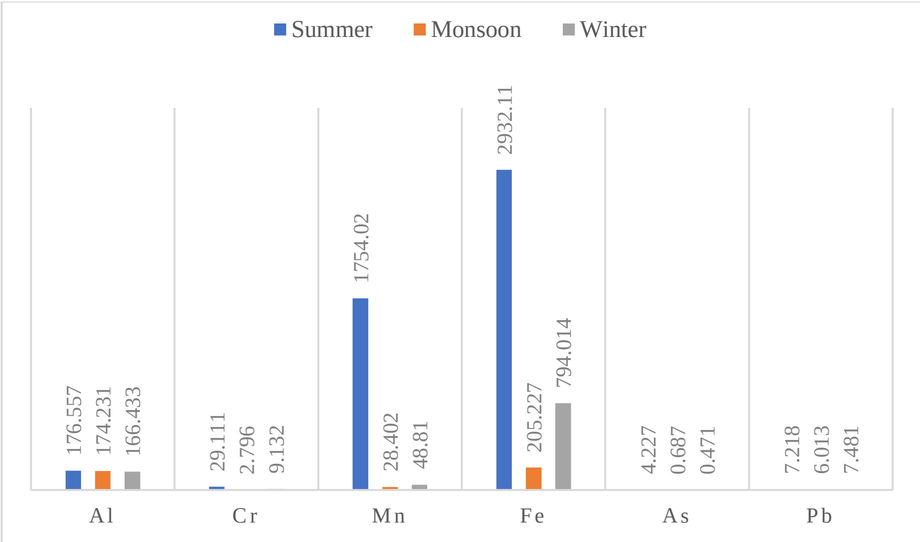

Fig. 1: Seasonal variations of heavy metal concentrations in µg/Lat SS-1

It is evident from table 1, at SS-1, the concentrations of Aluminium (Al), Mn and Fe were above the acceptable limits prescribed by BIS. Al was recorded during all seasons. Mn was recorded during summer season. Fe was recorded during summer and winter seasons; it was below the standard limits during monsoon. Excess concentrations of Fe during summer and winter but not at during monsoon indicating that the rain water diluting the concentration of Fe load in the river. Kar *et al.*,(2008) also recorded higher concentrations of Fe during summer season in river Ganga in West Bengal. River Purna is one of the tributaries of river Godavari pouring its polluted water with high organic load (Jumle*et al.*, 2005). Exceeding values of Pb were recorded by Ghorde*et al.*, (2014) in river Godavari at this sampling station in the year 2010-'11. But, in this study Pb was well below the standard limits of BIS and WHO.

Table 2: ICP-MS report of concentration of heavy metals in µg/L at SS-2.

Heavy Metals	Summer	Monsoon	Winter	Standard Limits	
				BIS	WHO
Al	16547.89	162.001	725.992	30	30
Cr	62.403	2.556	16.75	50	50
Mn	3522.02	23.248	74.92	100	400
Fe	17848.9	427.548	2556.92	300	300
As	9.74	0.478	0.801	10	10
Pb	3.594	6.759	8.034	10	10

Note: Parameters which exceed the standard values are highlighted with red colour.

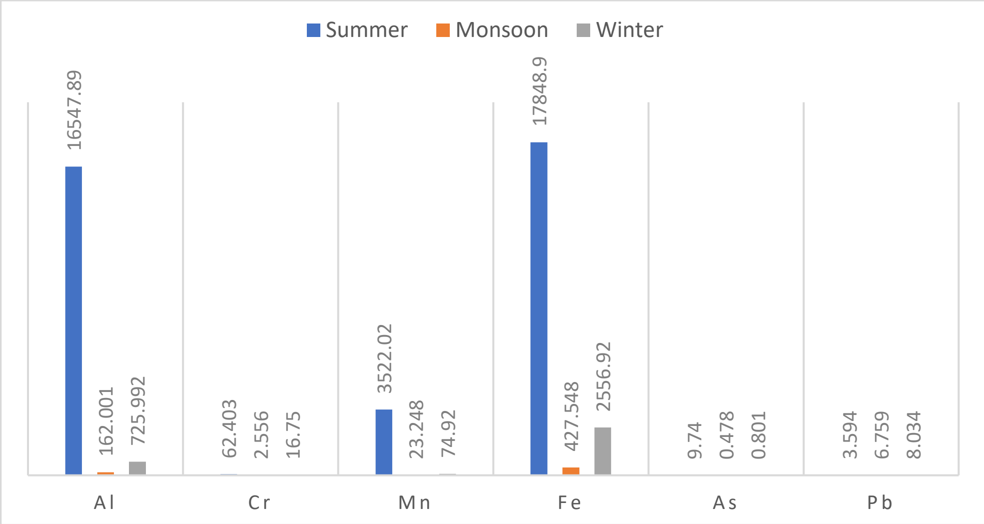

Fig. 2: Seasonal variations of heavy metal concentrations in µg/Lat SS-2

It is evident from table 2, at SS-2, the concentrations of Al, Cr, Mn and Fe were exceeded the acceptable limits as prescribed by BIS and WHO. The concentrations of Al and Fe were exceeded during all seasons, whereas Cr and Mn were exceeded during summer season. Macdonald and Chirstopher (2011) recorded exceeded values of Cr and Mn in surface waters of Warri river, Nigeria. Vinod *et al.*, (2005) recorded higher values of Cr in the waters of river Gomti during summer than that of winter season, Mohiddin *et al.*, (2011) also recorded higher values of Cr and Pb during summer season and lower values in winter season in Buriganga river, Bangladesh.

Table 3: ICP-MS report of concentration of heavy metals in µg/L during summer.

Heavy metals	Summer		Standard Limits	
	SS-1	SS-2	BIS	WHO
Al	176.557	16547.89	30	30
Cr	29.111	62.403	50	50
Mn	1754.02	3522.02	100	400
Fe	2932.11	17848.9	300	300
As	4.227	9.74	10	10
Pb	7.218	3.594	10	10
Note: Parameters which exceed the standard values are highlighted with red colour.				

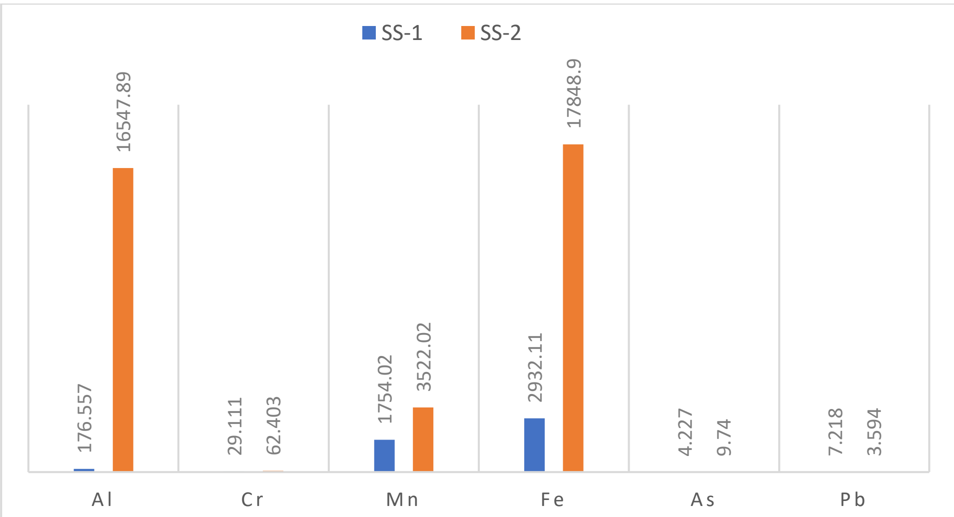

Fig. 3: Variation of heavy metal concentrations in µg/L at SS-1 and SS-2 during summer.

From table 3, exceeding values of Al raised to 93 times from SS-1 to SS-2, whereas Mn and Fe are raised to 2 and 6 times respectively during summer. Nayan et al. (2019) recorded 80% of surface waters sources have higher Mn concentrations during dry season, in Jai-Bharali river basin, North Brahmaputra Plain. Shaikh (2009) were also recorded similar trends of Mn at these stations during in March-2008. Deshmukh *et al.*, (2007) recorded highest values of Fe in river Godavari at this station in May-1999, it was 6400 µg/L, when it comes to May-2017, it was 17848 µg/L and nearly it was raised by 2.7 times in 18 years of time. Though Cr was below the standard limits at SS-1, it was exceeded when it comes to SS-2. The increment of concentrations of these metals from SS-1 to SS-2, significantly indicating that the contaminations added to the river Godavari are from the activities of Nanded city.

Table 4: ICP-MS report of concentration heavy metalsin µg/L during monsoon.

Heavy metals	Monsoon		Standard Limits	
	SS-1	SS-2	BIS	WHO
Al	174.231	162.001	30	30
Cr	2.796	2.556	50	50
Mn	28.402	23.248	100	400
Fe	205.227	427.548	300	300
As	0.687	0.478	10	10
Pb	6.013	6.759	10	10

Note: Parameters which exceed the standard values are highlighted with red colour.

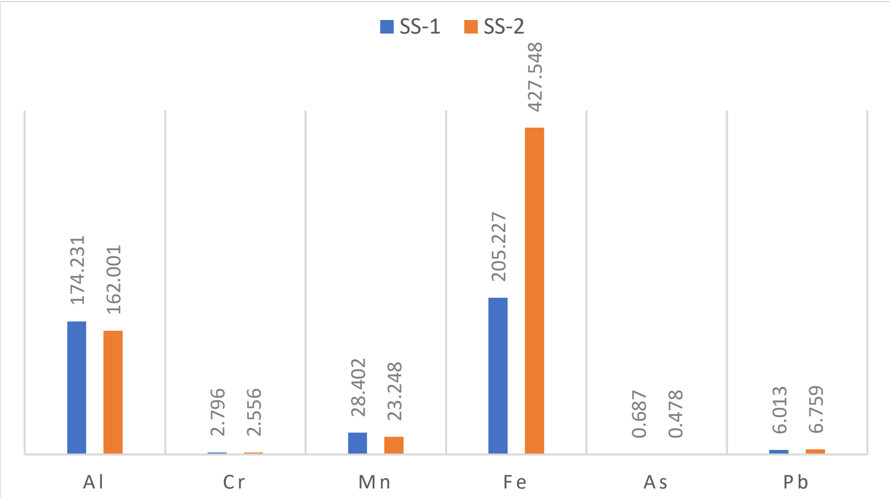

Fig. 4:Variation of heavy metal concentrations in µg/L at SS-1 and SS-2 during monsoon.

From table 4, it is observed that there was a slight decrement in the concentration of Al from SS-1 to SS-2 during monsoon, but the concentration of Fe was doubled. And remaining metals are well below the standard limits.

Table 5: ICP-MS report of concentrations heavy metalsin µg/Lduring winter.

Heavy metals	Winter		Standard Limits	
	SS-1	SS-2	BIS	WHO
Al	166.433	725.992	30	30
Cr	9.132	16.75	50	50
Mn	48.81	74.92	100	400
Fe	794.014	2556.92	300	300
As	0.471	0.801	10	10
Pb	7.481	8.034	10	10

Note: Parameters which exceed the standard values are highlighted with red colour.

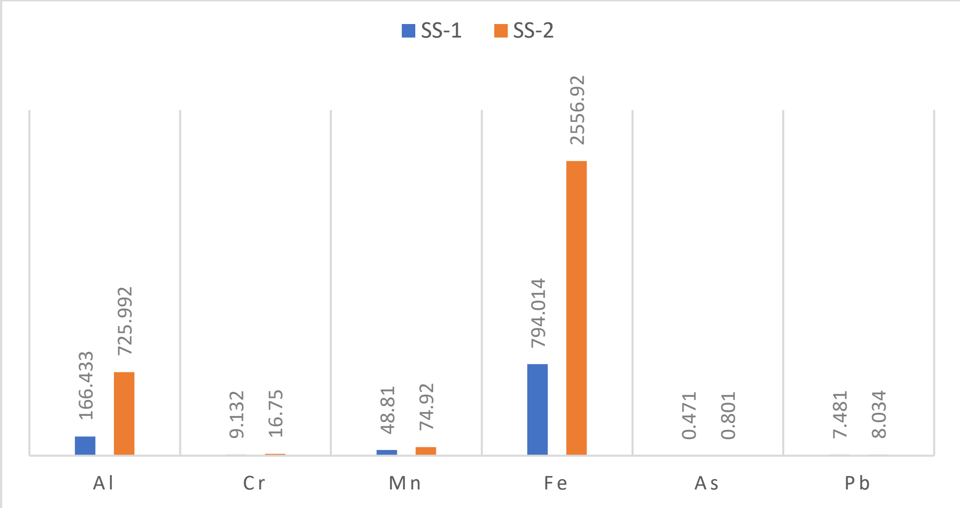

Fig. 5: Variation of heavy metal concentrations in µg/Lat SS-1 and SS-2 during winter.

It is revealed from table 5, concentration of Al and Fe are raised to four times and three times respectively from SS-1 to SS-2 during winter season. Remaining metals are recorded below the standard limits.

Conclusion

The analysis of river Godavari water at Nanded city revealed that Al and Fe were found highest concentrations and were exceeded the standard limits. In surface waters the main sources of aluminum is leaching from soils (Gworek, 2006; Kubiak *et al.,* 2013) Though, Fe was within the standard limits during monsoon at SS-1, it exceeded when it goes to SS-2. This is clearly indicating that the Fe is loaded to the river from the Nanded city. Also, it is evident that metals such as Al, Cr, Mn and Fe were significantly raised at SS-2 from SS-1 during summer season. As inflow of water from the upstream to the Nanded city is controlled at Vishnupur dam, the volume of water in the river Godavari from SS-1 is very less. But the quantity of treated as well as untreated sewage and industrial effluents merging to the river remains same. In addition to this, the usage of ground water is high during summer, the metal contamination of ground water flows through the sewage also reflects in the river water. This cumulatively enhances the certain concentrations of metals in the river Godavari at SS-2 during summer. The same trend was observed during winter season but relatively less, when compared to summer season. Arsenic (As) and Pb were recorded below the prescribed standard limits during all seasons. This study of seasonal assessment of metal contaminations in river Godavari at Nanded city fetched the information that there is a contamination of Al, Cr, Mn and Fe between SS-1 and SS-2, show significant increment concentration when volume of water in the river is low i.e. during summer and winter. Due to more volume of water brought from the upstream as well as dilution effect by rain water, the same metal concentrations were decreased at both the sampling stations during monsoon season. Lower concentration of metals during monsoon were attributed to dilution effect and higher concentrations during summer were attributed to the increased ground water utilization for industrial and agricultural activities, and also to natural geological sources (Nayan *et al.,* 2019).

References

1. APHA, (1998) 20th Edition, Standard Methods for the Examination of water and waste water Washington, DC, American Public Health Association.
2. Arora M., Kiran B., Rani S., Rani A., Kumar B. and Mikttal N. (2008); Heavy metal accumulation in vegetables irrigated with water from different sources. Food chemistry, 111, 811-815.
3. BIS (1983) Standards for water for drinking and other purposes, New Delhi, Bureau of Indian Standards Publication.
4. Burnis M. R., Kapil S. and Oehme F. W. (2000); Micorbial resistance to metal in the environment, Ecotoxicol. Environ. Saf., Vol. 45. Pp. 198-207. Doi 10.1006/eesa.1999.1860.
5. Camilo Zamora-Ledezma, Daniela Negrete-Bolagay, Freddy Figueroa,Ezequiel Zamora-Ledezma, Ming Ni, Frank Alexis, and Victor H. Guerrero (2021); Heavy metal water pollution: A fresh look about hazards,novel and conventional remediation methods, Environmental Technology & Innovation 22 (2021).

6. Cabral Pinto, M.M.S., Silva, M.M.V., Ferreira da Silva, E.A., Marinho-Reis, A.P., (2017); The cancer and non-cancer risk of santiago island (cape verde)population due to potential toxic elements exposure from soils. Geoscience 7.
7. Clark R. B. (2001); Marine Pollution, Oxford. Oxford University Press.
8. Deshmukh J. U., Ambore E. and Pulle J. S. (2007); Heavy metal pollution of Godavari river due to industrial effluents from M.I.D.C Nanded, Maharashtra, India. Journal of Industrial Pollution Control. 23 (1) (2007).
9. Fu, F., Wang, Q., (2011); Removal of heavy metal ions from wastewaters: A review. J. Environ. Manage. 92, 407–418.
10. Ghorade I. B., Lamsture S. V., and Patil S. S. (2014); Assessment of heavy metal content in Godavari river water. International Journal of Research in Applied, Natural and Social Scinences, 2(6): 23-26.
11. Gworek, B., 2006. Aluminium in the natural environment and its toxicity. Ochr. ´Srod. Zas. Nat. 29, 27–38 (in Polish).
12. Hari Krishna S. V., Reddi E. U. B., Ananda Kumar B (2018); A study on Assimilation and Healing Capability of River Godavari; International Journal of Innovative Sciences and Research Technology, 3(2): 886-888.
13. Jumle R. M., Kolhe S. V., and Wasink U. S. (2015), Assessment of Water Quality in the River Purna, District – Akola, Maharashtra. International Journal of Chemical and Physical Sciences, ISSN: 2319-6602, Vol. 4 Special Issue.
14. Kar D., Sur P., Mandal S. K., Saha T. and Kole R. K. (2008); Assessment of heavy metal pollution in surface water, Int. J. Environ. Sci. Tech., 5(1): 119-124.
15. Kubiak, J., Machula, S., Stepanowska, K., Biernaczyk, M., 2013. The influence of the content of aluminium on the biocenosis of the waters of lakes with poorly urbanized reception basins. In˙ zynieriaEkol. 35, 95–105 (in Polish).
16. Kumar, A., Cabral-Pinto, M., Kumar, A., Kumar, M., Dinis, P.A., (2020); Estimation of risk to the eco-environment and human health of using heavymetals in the Uttarakhand Himalaya, India. Appl. Sci. 10, 1–18.
17. Macdonald D. W., and Christopher E. O. (2011); Pollution studies on Nigerian rivers: heavy metals in surface water of warrriiver, Delta State, Journal of Biodiversity and Environmental Sciences, 1(3): 7-12.
18. Magdlena Senze, Monika Kowalaska-Goralska and Katarzyna Czyz (2021); Availability of aluminum in river water supplying dam reservoirs in Lower Silesia considering the hydrochemical conditions, Environmental Nanotechnology, Monitoring and Management, 16.
19. Mohiuddin K. M., Ogawa Y., Zakir H. M., Otomo K. and Shikazono N. (2011); Heavy metals contamination in water and sediments of an urban river in a developing country, Int. J. Environ. Sci. Tech, 8(4): 723-736.
20. Nayan J. Khound., Parag P., and Krishna G. B. (2019); Toxic Trace Metals in the Surface Water Sources of Jia-Bharali River Basin, North Brahmaputra Plain, India – A Hydrochemical elucidation. Water Resources, Vol. 46, No. 1, pp, 117-127.
21. Panda U. C., Rath S, Nayak P and Bhatta D (2006); Application of factor and cluster analysis of characterization of river and estuarine water system – A case study; Mahanadi River (India). Journal of Hydrology, 331; 434-445.
22. Shaikh Praveen Rajjak (2009); Iron and Manganese Contents in Godavari River Water at Nanded, Maharashtra. Nature Environment and Pollution Technology An International Quarterly Scientific Journal. Vol. 8(3), pp 575-578.
23. USEPA (1997); Determination of trace elements in water by pre concentration and Inductively Coupled Plasma Mass Spectrometry. U. S. Environmental Protection Agency, Office of Water, Office of Science and Technology, Engineering and Analysis Division, Washington, DC.
24. Vinod K. S., Kunwar P. S. and Dinesh M. (2005); Status of heavy metals in water and bed sediments of river Gomti – A tributary of the Ganga river, India. Environmental Monitoring and Assessment, 105: 43-67.
25. WHO (1971); International Programme on Chemical Safety. Environmental Health Criteria 194. World Health Organization, Geneva.