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WATER QUALITY ANALYSIS OF YAMUNA RIVER IN DIFFERENT AREAS OF AGRA CITY

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ABSTRACT

Holy River Yamuna is the largest river and main source of water for the various cities is getting highly polluted due to heavy discharge of sewage and industrial effluents, containing heavy metals, into surface water as a result of rapid urbanization, industrialisation and population growth. The major objective of this research was to take an in-depth analysis of water quality and heavy metal pollution of Yamuna River in different areas of Agra city during pre and post-rainy season. The analytical results show that Zn and Cu metals are within the permissible limit but the concentration of Fe, Zn, Cr and Mn increased in post rainy season. It was also analysed that the concentration of Cr may be higher due to existence of various leather industries in the Agra city. It was noted that water quality of *Taj Ganj* area was highly alarming with respect to other parts.

Key words: *Heavy metals, Dissolved Oxygen, Biological Oxygen Demand, pH*

INTRODUCTION

Holy River Yamuna which is the largest holy river and main source of water are the backbone of various cities are getting polluted day by day due to the discharge of sewage into surface water as a rapid urbanization and population growth[1, 2, 3]. This pollution may be defined as "the introduction of impurities into the substances present in the atmosphere creates different hazards to the human health, harmful to living as well as ecological system, or damage the structural or interfering with genuine use of the environment''[4-8]. The accumulation of organic matter and heavy metals in surface water and groundwater was due to the pollution from urban and semi-urban constructions, domestic sewage and waste dumpling in a huge amount, and the unsanctioned mining activities, and sedimentation in the urban. As a result of this, human as well as river ecology system becomes worst [4-6]. According to the statistical data it was observed that about two third of the world's population will be facing water shortage and pollution levels have significantly increased by the year 2025 [9-12]. The reason behind

the rapid pollution of the river water was industrial as well as organic discharge into the water etc. In addition to this, the research conducted by TERI exhibits that the moderate level of toxic metals in the river also polluted the river Yamuna water [13-15].

Heavy metals are defined as the member of an imprecise subset of elements having metallic properties and include transition metals. The contamination of ground/surface water and their effect on quality and quantity of water is rapidly enhanced due to the presence of these metals, perilous products, and organic substances. According to a report given by WHO, in 2006, about nearly 80 % of human diseases arises due to the adulteration of groundwater. This contamination is the biggest source of toxicity in various aquatic system [5].These metals increased the environmental pollution from industrial discharges, leaching of metal ions into lakes and rivers by acid rain. [9, 14,15]. Presence of these toxic metals in the river is very harmful to aquatic life and long-term persistent of these metals in the environment get accumulated in the water bodies [6,12]. Cobalt (Co), copper (Cu), nickel (Ni), chromium (Cr), manganese (Mn), iron (Fe), magnesium (Mg), molybdenum (Mo) etc. are indispensable in order to maintain various biochemical and physiological functions. In living organisms these metals functions very well when their concentration is very low but when their concentration crossed the limiting value they become very toxic. Besides this, the non-essential heavy metals are always found to be toxic even when present at very low concentration. Such type of non-essential heavy metals are Gold (Au), lead (Pb), lithium (Li), mercury (Hg), platinum (Pt), silver (Ag), titanium (Ti), vanadium (V), cadmium (Cd) etc. [9,15, 10].

Intensive care of these heavy metal contamination in rivers is significant as these metals accumulated and cause a serious threat to living organism and environment because of biomagnifications [16,17]. The total pollution in the river was expressed using Heavy metal pollution index (HPI) tool in this the individual effect of each metal ion on the overall water quality was measured [18-20]. Various research on the heavy metals was performed in the Yamuna River water, however, no work was performed which covers the urban and rural area of the river. Based on the overall background, the main purpose of this research was to analyse the metal ion concentration at the city of Taj Mahal, Agra, during pre-rainy and post-rainy season.

MATERIALS AND METHODS

2.1. Sample Collection and Analysis:

Agra is positioned in western Uttar Pradesh. Its North Latitude was 27.11' degree and East Longitude was 78.0' degree to 78.2' degree. Its Altitude is 169 meters above sea level. The Yamuna river water here is polluted due to the presence of heavy metal. The water sample was taken from four different areas of Agra city i.e. Taj Ganj, Jiwani Mandi, Kailash Mandir, Poiya Ghat during pre-rainy and post-rainy seasons. The water samples were collected in an acid washed bottle to avoid unpredictable changes. The collected water samples were placed at 4°C and further transported for analysis. The analytical reagent (AR) grade chemicals and deionised water was used throughout the study. The detection limits of these metals were found to be 0.02 for Fe, 0.01 for Cu, 0.01 for Mn, 0.002 for Cd, 0.02 for Ni, 0.005 for Zn, 0.05for Pb and 0.02mg/l for Cr respectively.

RESULTS AND DISCUSSION

3.1. pH analysis:

pH analysis of water samples collected from different regions of Agra shows that the river water is alkaline in nature. The results of pH analysis clearly indicate that the water samples were in the range of 7.78 to 8.48 and within the permissible limit of 6.5-8.5 drinking water quality standards of BIS (as shown in Table 1).

Table 1: pH value at different locations of Agra

Area	pH
Taj Ganj	8.48
Jiwani Mandi	8.34
Kailash Mandir	7.69
Poiya Ghat	7.78

3.2. Dissolved oxygen (DO) and Biological Oxygen Demand (BOD) Analysis:

The dissolved oxygen content of the analysed river water samples observed to be minimum from 4.32 mg/l to 4.9 mg/l (during pre-rainy season) and 6.52 mg/l to 8.83 mg/l (during post-rainy season). These results showed that during post-rainy season the dissolved oxygen levels were more than that of pre-rainy season. The decreasing level of dissolved oxygen concentration was due to the respiration of biota, bio-transformation's of organic matter, increasing temperature, and inorganic unenthusiastic. Similarly, the biological oxygen demand varied from 11.01 mg/l to 20.27 mg/l during pre-rainy season and 12.25 mg/l to 24.46 mg/l during post-rainy season. These results show high value of BOD at different regions was an indicator of pollution in the river due to the organic matter.

3.3. Heavy metal concentration analysis:

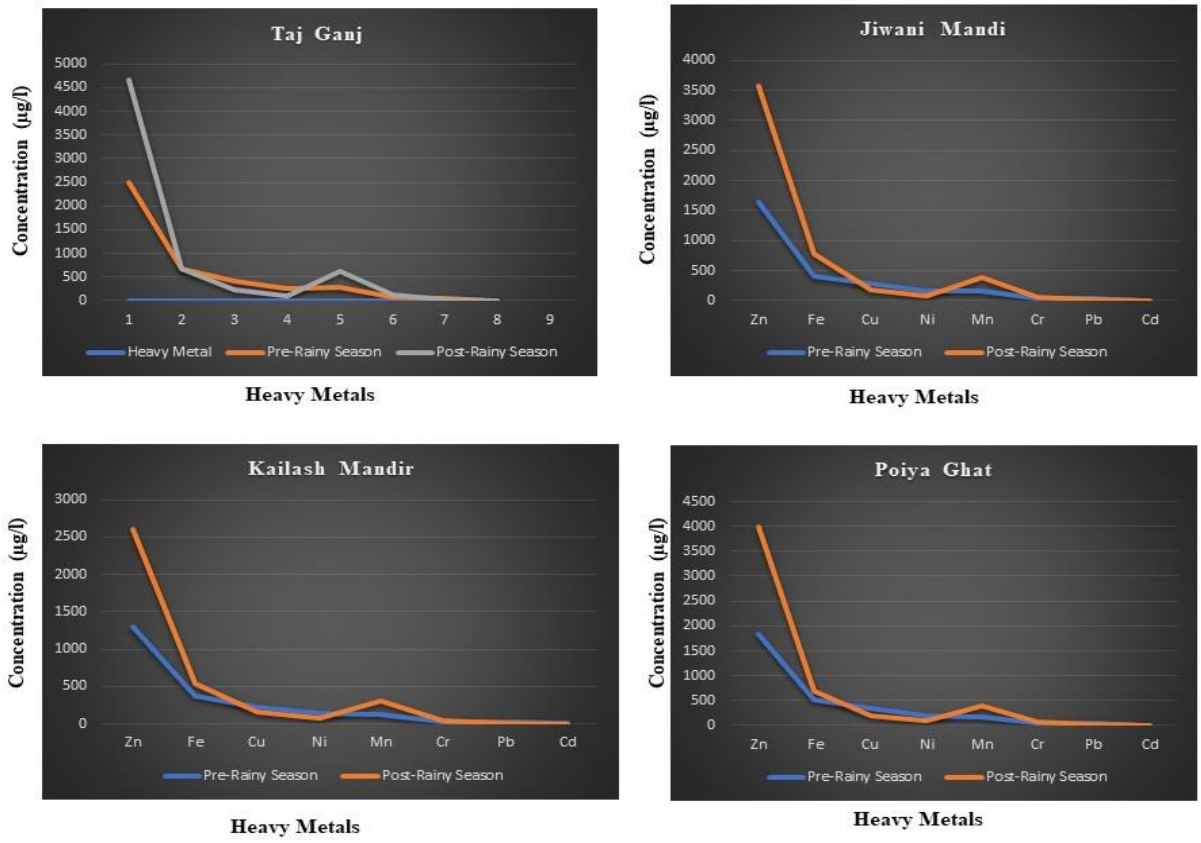
The analysis of heavy metal concentration during pre-rainy season and post-rainy seasons was shown in Table 2. The mean concentration was calculated and the following order was observed during pre-rainy season: Zn >Fe> Cu> Ni≥ Mn> Cr>Pb> Cd and during post rainy season the order was Zn> Fe>Mn>Cu>Ni>Cr>Pb>Cd. The maximum concentration was found at Taj Ganj area due to the large amount of chemical and fertilizer industrial discharges. The concentration of heavy metals was above the maximum permissible limits given by BIS except Zn-Cu-Mn (pre-rainy season) and Zn-Cu (post-rainy season). The concentration of Fe was found to be 1.7 to 2.4 times higher than maximum limit during pre-rainy season while in post-rainy season the mean concentration of Fe increased 1.5 times and reported to be 1.2 to 3.6 times higher than the permissible limit. The concentration of Pb, Cd was found to be 3 to 7 times (Pb) and 1.3 to 2.7 times (Cd) higher than the maximum permissible limit during pre-rainy season while in post-rainy season the concentration of Pb was 3 to 4 times and the concentration of Cd was 1.3 times higher than the permissible limit. The concentration of Zn and Cu was within the permissible limit and hence, does not create any pollution in the Yamuna River water. During post-rainy season, the Cr mean concentration was found to be increased 1.9 times was due to the existence of leather tanning industries. The mean concentration of Ni was increase during pre-rainy season while decreased during post-rainy season. The existence of stainless steel and refining industries enhances the concentration level of Ni in the river. In addition to this, the mean concentration of Mn was found within the maximum permissible limit during pre-rainy season whereas its concentration increases during the post-rainy season. The concentration of Pb, Cd, Cu and Ni metal ions was found to be decreased during post–rainy season owing to the effect of dilution, whereas some metal ion (such as Zn, Fe, Mn and Cr) concentration increased as a result of desorption of these metals from sediments due to dilution. The increasing concentration of these metal ions during pre-rainy season in

comparison to post-rainy season follow the order Mn>Cr>Zn>Fe. Table 2 and Fig. 1 show the heavy metal ion concentration at different locations of Agra.

Table 2: Heavy metal ion concentration at different locations of Agra

Heavy Metals	Pre-rainy season					Post-rainy season				
	Concentration (µg/l)				Mean	Concentration (µg/l)				Mean
	Taj Ganj	Jiwani Mandi	Kailash Mandir	Poiya Ghat		Taj Ganj	Jiwani Mandi	Kailash Mandir	Poiya Ghat	
Zn	2500	1635	1300	1837	1818	4670	3563	2600	3980	3703
Fe	670	410	370	530	495	680	774	536	690	667.5
Cu	405	290	230	335	315	237	177	158	190	190.5
Ni	263	160	135	190	187	99	85	81	89	88.5
Mn	287	158	127	169	185	630	395	306	405	434
Cr	70	30	20	40	40	120	60	38	70	72
Pb	50	30	20	40	35	17	11	09	14	12.7
Cd	9	3	3	5	5	1.7	0.5	0.3	0.7	0.8

Fig.1: Heavy metal ion concentrations at different regions of Agra



Here, 1: Zn; 2: Fe; 3: Cu; 4: Ni; 5: Mn; 6: Cr; 7:Pb; 8:Cd

CONCLUSION

Heavy metals content of the river Yamuna in Agra was collected and analysed during pre- and post-rainy season. The results of analysis shows that Yamuna river water in Taj Ganj area is highly polluted by heavy metals and cannot be used for domestic, irrigational purposes. The concentration of Cr, Pb and Cd were not within the permissible limits as per BIS and creates various health problems in human health. The reduction of heavy metals pollution is highly necessary before the use for domestic and industrial purposes.

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Conflict of Interest:

The author(s) declares no conflict of interest.

REFERENCES

1. Gupta, N., Yadav, K.K., Kumar, V. and Singh, D., 2013. Assessment of physicochemical properties of Yamuna River in Agra City. *International Journal of ChemTech Research*, *5*(1), pp.528-531.
2. Chadetrik, R., Arun, L. and Prakash, D.R., 2015. Assessment of physico-chemical parameters of river Yamuna at Agra region of Uttar Pradesh, India. *Int. Res. J. Environ. Sci*, *4*(9), pp.25-32.
3. Joshi, P., Chauhan, A., Dua, P., Malik, S. and Liou, Y.A., 2022. Physicochemical and biological analysis of river Yamuna at Palla station from 2009 to 2019. *Scientific Reports*, *12*(1), pp.1-19.
4. Kumar, M., Sharif, M. and Ahmed, S., 2020. Impact of urbanization on the river Yamuna basin. *International Journal of River Basin Management*, *18*(4), pp.461-475.
5. Ahmed, S., Akhtar, N., Rahman, A., Mondal, N.C., Khurshid, S., Sarah, S., Khan, M.M.A. and Kamboj, V., 2022. Evaluating groundwater pollution with emphasizing heavy metal hotspots in an urbanized alluvium watershed of Yamuna River, Northern India. *Environmental Nanotechnology, Monitoring & Management*, *18*, p.100744.
6. Aggarwal, M., Anbukumar, S. and VIJAYA KUMAR, T., 2022. Heavy metals concentrations and risk assessment in the sediment of Ganga River between Kanpur and Prayagraj, UP, India. *Sādhanā*, *47*(4), pp.1-11.
7. Dung TT, Cappuyns V, Swennen R, Phung NK. From geochemical background determination to pollution assessment of heavy metals in sediments and soils. *Reviews in Environmental Science and Bio/Technology*. 2013 Dec;12(4):335-53.
8. Holdgate MW. A perspective of environmental pollution. Cambridge University Press; 1979 May 17.
9. Malik, D., Singh, S., Thakur, J., Singh, R.K., Kaur, A. and Nijhawan, S., 2014. Heavy metal pollution of the Yamuna River: An Introspection. *Int. J. Curr. Microbiol. App. Sci*, *3*(10), pp.856-863.
10. Odobašić, A., Šestan, I. and Begić, S., 2019. Biosensors for determination of heavy metals in waters. *Biosensors for environmental monitoring*, DOI: 10.5772/intechopen.84139
11. Pal, R., Dubey, R.K., Dubey, S.K. and Singh, A.K., 2017. Assessment of heavy metal pollution through index analysis for Yamuna water in Agra region, India. *Int. J. Curr. Microbiol. App. Sci*, *6*(12), pp.1491-1498.
12. Prasad, S., Saluja, R., Joshi, V. and Garg, J.K., 2020. Heavy metal pollution in surface water of the Upper Ganga River, India: human health risk assessment. *Environmental Monitoring and Assessment*, *192*(11), pp.1-15.
13. Sehgal, M., Garg, A., Suresh, R. and Dagar, P., 2012. Heavy metal contamination in the Delhi segment of Yamuna basin. *Environmental monitoring and assessment*, *184*(2), pp.1181-1196.
14. Singh, R., Gautam, N., Mishra, A. and Gupta, R., 2011. Heavy metals and living systems: An overview. *Indian journal of pharmacology*, *43*(3), p.246.
15. Pal R, Dubey RK, Dubey SK, Singh AK. Assessment of heavy metal pollution through index analysis for Yamuna water in Agra region, India. *Int. J. Curr. Microbiol. App. Sci*. 2017;6(12):1491-8.

16. Yi, Y., Yang, Z. and Zhang, S., 2011. Ecological risk assessment of heavy metals in sediment and human health risk assessment of heavy metals in fishes in the middle and lower reaches of the Yangtze River basin. *Environmental pollution*, *159*(10), pp.2575-2585.
17. Ahmed, M.K., Shaheen, N., Islam, M.S., Habibullah-al-Mamun, M., Islam, S., Mohiduzzaman, M. and Bhattacharjee, L., 2015. Dietary intake of trace elements from highly consumed cultured fish (Labeo rohita, Pangasius pangasius and Oreochromis mossambicus) and human health risk implications in Bangladesh. *Chemosphere*, *128*, pp.284-292.
18. Ojekunle OZ, Ojekunle OV, Adeyemi AA, Taiwo AG, Sangowusi OR, Taiwo AM, Adekitan AA. Evaluation of surface water quality indices and ecological risk assessment for heavy metals in scrap yard neighbourhood. *Springer Plus*. 2016 Dec;5(1):1-6.
19. Asim M, Nageswara Rao K. Assessment of heavy metal pollution in Yamuna River, Delhi-NCR, using heavy metal pollution index and GIS. *Environmental Monitoring and Assessment*. 2021 Feb; 193(2):1-6.
20. Prasad S, Saluja R, Joshi V, Garg JK. Heavy metal pollution in surface water of the Upper Ganga River, India: human health risk assessment. *Environmental Monitoring and Assessment*. 2020 Nov; 192(11):1-5.