Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 9, Issue, 7(A), pp. 27707-27710, July, 2018

ISSN: 0976-3031

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

EVALUATION OF PHYSICO-CHEMICAL PARAMETERS AND FEW HEAVY METAL CONTAMINATION OF RIVER GANGA AT VARANASI UP, INDIA

Pushpa Kumari[1]., Kriteshwar Prasad[2] and Prakriti Verma[3]*

[1,2]Department of Geology, Patna University Patna, Bihar
[3]Department of Zoology, Patna University Patna, Bihar

DOI: http://dx.doi.org/10.24327/ijrsr.2018.0907.2315

ARTICLE INFO

Article History:

Received 12th April, 2018
Received in revised form 23rd May, 2018
Accepted 7th June, 2018
Published online 28th July, 2018

Key Words:

Ganga river water, physico-chemical parameter, heavy metal, toxicity

ABSTRACT

Investigations were carried out to evaluate the physico chemical parameters and heavy metal content in the Ganga river water at Varanasi. Six sampling station were selected along a seven km long stretch between Assi to Varuna. The sub surface water sample collected from the six sites from up stream and down stream was analyzed for physico chemical parameters and heavy metal analysis. The concentration of cadmium (Cd), copper (Cu), Iron (Fe) and nickel (Ni) were determined using Atomic Absorption Spectrophotometer (Perkin-Elmer Analyst 200). The levels of the heavy metals were compared with WHO 1993 and previous research. The data revealed the increased trend of heavy metals in the river water from all the sampling sites at Varanasi in comparison to the previous studies. Highest concentration of Cd, Cu, Ni and Fe in the river water showed the trend: Fe>Ni>Cu>Cd. Concentration of all the heavy metals was high in down-stream sampling sites can be positively correlated with the physicochemical parameters. However, the concentration of these heavy metals in water remained below permissible limit but its increasing trend may lead to potential health risk in long run. So far the physico-chemical characteristics were concerned; the river water appeared to be fit for bathing purpose. However, pollutants in the form of heavy metals were found to be more than the previous studies.

INTRODUCTION

The river Ganga is the holy and one of the most utilized river and called life line of north India. The basin of river Ganga is the India's largest river basin which covers 26 percent of the countries landmass and supports approximately 43 percent of its population. It is one of the most utilized rivers in the world. It has played an important role in the development of Indian civilization and economy due to availability of water throughout the year (Sing & Singh. 2014). Increased urbanization and industrialization in the basin, has resulted in polluting the river, since the river has been the preferred waste disposal site for industrial and domestic effluents (Fostner & Whittmann 1981; Modak *et al.* 1992). The Ganga basin is the most heavily populated river basin in the world, with over 400 million people and a population density of about 1,000 inhabitants per square mile (390/km^2). It was ranked among the five most polluted river of the world in 2017 (Rai, B. 2013). The Ganga Action Plan was launched in 1986 and re launched in 2009 by Government of India with the objective to improve the water quality of the river to acceptable standards by preventing pollution from reaching it. But, despite programmes, at various lines the Ganga still runs polluted (Rai, B. 2013). Many a literature is available to illustrate that pollution is increasing even in the stretches which are considered clean (Gupta *et al*, 2006, Das S. 2011, Jain *et al.* 2007). During recent year, anthropogenic activities have dramatically increased the atmospheric, aquatic and sediment deposition of pollutant elements even in areas far away from direct humans influence (Verma P., and Chand G. B. 2007: Altered Biochemical Profile of Carbohydrate, Protein and Triglycerides in Clarias batrachus and Heteropneustes fossilis due to rogor and Endosulfan toxicity. J. Ecophysiol Occup. Hlth. The Academy of Environmental Biology, India..Vol (7) 2007, 63-68.; Pandey & Pandey, 2005; Kumari, 2013, 2014). Traces of fertilizers, pesticides and heavy metals are dissolve in the nearest river water due to leaching from the agricultural and industrial, run off Heavy metals are known to have serious health implications including carcinogenesis induced tumor promotion (Schwartz 1994). The deposition of heavy metals in water bodies can double increase the human intake through food chain as well as through drinking water. The river Ganga rises in the Gangotri glacier in the Himalaya Mountain at an

Corresponding author:* **Prakriti Verma
Department of Zoology, Patna University Patna, Bihar

elevation of 7138 m, above mean sea level. It enters the plain at Haridwar over UP, Bihar and West Bengal and receives a wide array of chemical constituents including toxicants from a variety of natural and anthropogenic sources (Kar *et al* 2008). The present study was an attempt to investigate the relationship between the concentration of few heavy metals and water quality assessment in River Ganga at Varanasi. The city of Varanasi is located on the left bank of Ganga in the North-Eastern part of India and it is one of the biggest and oldest cities of state of Uttar Pradesh. The city is located at 25^0 to 2^0 16'N latitude and $82^0$5 to 83^0E latitude. Due to the religious significance the Ganga stretch along Varanasi pertaining biggest problem that about 60000 pilgrims take a dip in the river daily. About 84 ghats serve as laundries, 40000 bodies are cremated every year generating 15000 ash tones of per month. Also there are 23 large and medium scale industries in and around city till 1997. The industrial effluences from the industries ultimately find their way into the Ganga (Anonymous; 2000)

MATERIALS & METHODS

Study Area – Varanasi is a religious city situated on the left bank of the Ganga River in its middle stretch in the North Eastern part of India. The city extends from Assi to Varuna seven km long river faces. The study was performed during 2009 year at selected sites located from upstream and downstream of Varanasi city.

Upstream

1. Ramnagar – Right Bank 3/4: N 25^0 16' 57" Latitude and E 83^0 00' 48" longitude.
2. Ramnagar Midstream (1/2: N 25^0 16' 57" Latitude and E 83^0 00' 43" longitude.
3. Ramnagar Left Bank (1/4): N 25^0 16' 54" Latitude and E 83^0 00' 39" longitude.

Downstream

1. Downstream Varuna – Righat Bank (3/4) : N 25^0 19' 33" Latitude and E 83^0 02' 57" longitude.
2. Downstream Varuna – Midstream (1/2) : N 25^0 19' 42" Latitude and E 83^0 62' 5" longitude.
3. Downstream Varuna – Left Bank (1/4) : N 25^0 19' 47" Latitude and E 83^0 02' 44" longitude

METHODOLOGY

Water samples were collected at a depth of 30 cm below water surface in polyethylene jerricanes for physico-chemical analysis. Water samples for heavy metals were collected in wide mouth acid washed, polyethylene reagent bottles of capacity 1 litre in which 2 ml of concentrated HNO_3 acid was added and preserved in ice box at 4 C and transported for analysis to the laboratory. Standard methods (APHA, 1998) and Zwart and Trivedi (1995) were followed for sample collection, preservation and transportation.

Table 1 Physico-chemical characteristics of water samples of the River Ganga at Varanasi during 2009

		U/S Ramnagar Bridge			D/S Varuna-Ganga confluence		
Parameters	**Unit**	**Right Bank**	**Mid stream**	**Left Bank**	**Right Bank**	**Mid stream**	**Left Bank**
Temp.(Water)	^{O}C	30.5	30.5	30.5	30.5	30.5	30.5
pH	-	8.3	8.3	8.3	8.2	8.2	8.0
P.Alkalinity	mg/L	3.6	3	3.2	3.4	2	Nil
Free CO_2	mg/L	Nil	Nil	Nil	Nil	Nil	4.58
M. Alkalinity	mg/L	130	132	132	130	130	160
CO_3^{--}	mg/L	7.2	6	6.4	6.8	4	Nil
HCO_3^-	mg/L	123	126	126	123	126	160
Cl^-	mg/L	15.89	16.79	14.98	15.89	15.89	18.16
NO_3^-	mg/L	0.549	0.609	0.673	0.737	0.532	0.035
T. Hardness	mg/L	110	117	117	117	119	135
Ca^{++}	mg/L	25.05	25.88	27.55	26.72	25.88	27.55
Mg^{++}	mg/L	11.64	12.64	11.64	12.14	13.16	16.2
SO_4^{--}	mg/L	19.99	18.78	17.68	19.00	17.90	16.25
PO_4^{---}	mg/L	0.055	0.05	0.076	0.056	0.058	0.131
D.O.	mg/L	5.64	5.08	5.8	4.84	4.59	4.19
BOD	mg/L	1.61	1.37	1.77	1.45	1.37	2.09
COD	mg/L	11.1	9.62	9.32	8.66	9.32	11.99
Na^+	mg/L	38.6	37.8	37.1	38.1	37.3	44.3
K^+	mg/L	7.9	8.2	7.9	8.1	8	9.5
TDS	mg/L	161	161	164	167	164	177

Table 2 Concentrations of heavy metals in water samples of the river Ganga at Varanasi during August 2009

Sl.No.		**Metal Concentration (mg/l)mean±S.D**							
	Water Sample's Details	**Cd**		**Cu**		**Fe**		**Ni**	
		2001	**2009**	**2001**	**2009**	**2001**	**2009**	**2001**	**2009**
1	Ramnagar - RB	0.0043± 0.0002	NT	0.0008±0.0021	0.0168±0.0023	1.485±0.002	41.80±0.015	0.015±0.008	0.065±0.002
2	Ramnagar - MS	0.071±0.0026	NT	NT	0.0246±0.001	NT	18.36±0.010	0.0012±0.0012	0.064±0.0005
3	Ramnagar - LB	NT	0.012±0.001	0.0012±0.0001	0.102±0.003	2.525±0.001	23.16±0.016	0.0056±0.0002	0.0875±0.0016
4	D/S Varuna - RB	NT	0.013±0.001	NT	0.056±0.002	NT	26.04±0.25	NT	0.116±0.001
5	D/S Varuna - MS	0.008±0.0015	0.016±0.003	NT	0.040±0.001	NT	21.55±0.0017	NT	0.084±0.002
6	D/S Varuna - LB	NT	0.028±0.001	NT	0.085±0.0035	NT	64.24±0.020	NT	0.104±0.002

***NT= Not Traceable**

The samples analyzed for respective heavy metals by Atomic Absorption Spectrophotometer (Perkin-Elmer Aanalyst 200). Water temperature, Ph, electoral conductivity, alkalinity, Free CO2, and dissolved Oxygen were analyzed with the help of Fielg analysis kit on sampling spot. While rest of the physico chemical parameter and heavy metal analysis were done in laboratory using standard methods (APHA, 1998) and Zwart and Trivedi (1995) within the prescribed duration.

RESULTS AND DISCUSSION

The data on Physico chemical characteristic and four heavy metal concentrations are presented in Table-1&Table-2 respectively.

The study enlightens the physic-chemical parameters and few heavy metal contaminations in the Ganga river water at Varanasi during 2009 and compared with others. The study reveals the physic-chemical characteristic was quite variable. The conductivity value indicating more quantities of inorganic salts in the river, the pH were towards alkaline range indicates that the river water is in the initial stage of pollution. However, among heavy metals the range of Cadmium was present in the river water at left bank of upstream site (0.012±0.001 mg/l) and right bank as well as left bank of the downstream site (0.013±0.001 mg/l) and (0.028±0.001 mg/l) respectively. However, it was absent at the right bank and mid bank of the upstream of the river. The maximum concentration of Cd was on the left bank of the river at downstream site where as it was absent during 2001 at same site, (Sinha 2004). The World production of Cd is about 21000 tons/yr which is mainly used in metal plating, electroplating, as pigments and as stabilizers for plastics. Mine drainage, sewage sludge applied to land and phosphate fertilizers are also significant sources of Cd (Mason, 2002). Cadmium is highly toxic to life in general and human health in particular. The effects of acute Cd poisoning in humans are very serious. Among them are high blood pressure, kidney damage and destruction of red blood cells. The sources of Cd in the Ganga at Varanasi may be from the agricultural runoff and small scale industries like metal plating, electroplating etc. The maximum concentration of Cd on the left bank at the downstream site reflects contribution of Cd through the Varuna River which carries city sewage, storm water of the city, and agricultural runoff especially during the flood season in the month of August. Moreover, as the river gets wider in the downstream of Varanasi area, where, chances of deposition of the metal on the left bank are much more.

Copper occurs in the Earth's crust at an average concentration of approximately 50 mg/kg, principally as sulfide, both as the simple sulfide and numerous sulfide minerals. Estimates of the total anthropogenic discharge of copper to surface water range from 35 x 10^3 to 90 x 10^3 metric tons/yr (Cordero, 1988). The primary sources include domestic waste water, manufacturing processes involving metals, steam electrical production, and the dumping of sewage sludge. Atmospheric deposition, of which approximately 56% comes from anthropogenic emissions (Nriagu 1989), is another major source to water. Maximum Copper (0.102±0.003mg/l) was present in the river water at the left bank of Ramnagar site followed by left bank at downstream site (0.085±0.0035). It appears the Cu content in water at upstream site is from other sources including run offs and not from the city of Varanasi as Cu in the water in 2001 was found to be almost absent. The 2001 data is of the month of June when there was no discharge of run offs from the catchment because Cu has a strong affinity for clays, iron and manganese oxides, and carbonate materials, residues are often elevated in sediments. In some freshwaters, more than 90% of total Cu may be bound to humic acids (Mantoura *et al* 1978). These complexes are often quite stable. Cu has strong affinity for hydrous iron and manganese oxides, carbonate materials, clays, and organic matter in bottom sediments. Binding to particulates such as clay results in significant downstream transport of copper. Depending on river and environmental conditions, from 10% to 95% of total Cu was transported by this mechanism.

With an average abundance of 5% by dry weight, iron is the fourth most abundant element in the Earth's crust. It is an essential trace element, required by both animals and plants. At upstream site the concentration of Iron was maximum at right bank (41.80±0.015 mg/l) followed by left bank and mid stream (23.16±0.016 and 18.36±0.010 mg/l) respectively. At downstream site a steep rise up to 64.24±0.020mg/l was observed whereas it was completely absent during 2001 (Sinha 2004). Although iron is of little direct toxicologic significance, it often controls the concentration of other elements, including toxic heavy metals, in surface waters. Total environmental flux of iron is enormous. Approximately 9.9x 10^8 metric tons are transported annually by rivers (Westall and Stumm, 1980). Iron is routinely detected in municipal wastes, particularly where iron and steel are manufactured. Concentration of over 50 mg/l, and as low as 0.004 mg/l, have been reported from some rivers (De Santo, 1991).

In the present study the Ganga River at Varanasi has enough volume and flow not to allow anoxic condition at water sediments interface. Out of six water samples iron was detected in all samples being the maximum at downstream Varuna confluence (left bank) while the minimum was 18.36 ±0.010mg/l in midstream sample of Ramnagar. The main source of iron in Ganga at Varanasi appears to be the Varuna which is highly polluted.

The maximum concentration of Ni in the river water was 0.116 ±0.001mg/l at downstream site at the right bank of the river followed by 0.104 mg/l at the left bank of the river at the downstream site. The range of the Ni content in the water was 0.65±0.002 mg/l at right bank at Ramnagar site to 0.116 ±0.001mg/l at Right bank of downstream site.

CONCLUSION

Heavy metals content in the river water was assessed besides the physico-chemical characteristics of the river water. So far the physico-chemical characteristics were concerned; the river water appeared to be fit for bathing purposes. However, pollutants in the form of heavy metals were found to be more than the previous study of 2001. It appears that besides the city of Varanasi, iron flows to the river from other sources upstream of the city; nevertheless city's contribution of iron cannot be ignored. From the study it appears that the major source of heavy metal pollution in the Ganga at Varanasi is the discharge of the Varuna River which contains city sewage, small scale industrial effluent and run off from the catchment. However, the Ganga flowing through the city of Kanpur receives industrial effluents from here also carries heavy metal load especially those of chromium up to Varanasi. The study also revealed that concentration of heavy metals is increasing with passage of time as it was noticed that the 2009 contents of the heavy metals were higher that those of 2001. Based on the above noted findings it can be concluded, that heavy metal load in the Ganga at Varanasi is increasing and major source is the city itself. There is a serious need to collect the effluents of the small scale industries separately and treat the same before discharging the same to the Ganga.

Acknowledgements

Authors are thankful to the Head of the Dept. of Geology for providing infrastructural facilities and Prof. R.K.Sinha Dept. of Zoology for data analysis and consistence support during sampling.

Reference

Anonymous. (2000): A Report on state of Environment – Varanasi. Central Pollution Control Board, New Delhi, pp. 318.

APHA, (1998): *Standard Methods for the Examination of Water and Waste Water* (20^{th} ed.), American Public Health Association, American Water Works Association and Water Pollution Control Federation, Washington.

Cordero, R. (1988): Metal bulletin prices and Data 1986. Metal Bulletin Book, Survey, Engaland. Pp. 375.

Das, Subhajyoti. (2011): "Cleaning of river Ganga "Journal of Geological Society of India., Vol-78,pp.124-130

De Santo, R. S. (1991): *Inorganic contaminants of surface water: Research and monitoring priorities.* Springer – Verlag Inc., New York. pp.334.

Kar D.P. Sur, S.K. Mandal, T. Saha & R.K. Kole. (2008): Assessment of heavy metal pollution in surface water. *International Journal of Environmental Science and Technology* 5: 119-124

Kumari Pushpa. (2014): Contamination of ater due to heavy metals in river ganga Varanasi U.P. India. Natural Science Today Vol.19 No-19 pp.92-99

Kumari Pushpa. (2013): Geochemical study of the river Ganga at Varanasi (U.P.) India with special reference to some heavy metals. *Adv. Bio. Res*. 31(1&2) pp.131-139

Modak,D.P. Singh,K.P., Chandra. H.Ray P.K.(1992): Mobile and bound form of trace metals in sediments of the lower Ganges, Water Res.,26(11),1541-1548

Mantoura, R. F. C., Dickson, A. and Riley, J. P. (1978): The complexation of metal with humic material in Natural waters. *Estuarine and coastal Marine Science.* 6: 387-408.

Mason, C. F. (2002): *Biology of Freshwater Pollution* (4^{th} ed.) Prentice Hall, Essex, pp. 387.

Mishra, V. (2005):. The Ganga at Varanasi and travel to stop her abuse. *Current Science*, 89(5): 755 – 763.

Nriagu, J. O. and Pacyna, J. M. (1988): Quantitative assessment of worldwide contamination of air, water and soil by trace metal. *Nature*. 333: 134-139.

Nriagu, J.O. (1989): A global Assessment of natural sources of worldwide contamination of air, water and soil by trace metal. *Nature* – 333 : 134-139.

Pandey, U & J. Pandey (2005): The influences of catchment modifications of two fresh water lakes of Uaipur. PP. 256-262. In: K.K.S. Bhatia & S.D. Khobragade (eds.) urban lakes in India: conservation management and Rejuvenation (Part-1).

Pandey J, Subhashis K, Pandey Richa (2010): Heavy metal contamination of Ganga river at Varanasi in relation to atmospheric deposition. *J. Tropical ecology* 51 (25); 365-373.

Rai Basant (2013): Pollution conservation of ganga river in modern India. *International Journal of Scientific and Research Publication*, Volume 3 issue 4, pp. 1-4.

Rai. Basant . (2014): Pollution and Conservation of Ganga River in Modern India. *International Journal of Scientific and Research Publications*. Vol. 4, pp. 2250-3153

Schwartz, J. (1994): Air pollution and daily mortality: A review and metal analysis. *Environmental Research* 64: 26-35.

Singh, P., U. K. Haritashya, K. S. Ramasastri, & N. Kumar, (2005): 'Prevailing weather conditions during summer seasons around Gangotri glacier. *Current. Science*. 88(5):753-760.

Sinha, R.K. (2004): Monitoring of Heavy Metal load in the river Ganga at Varanasi (April 2001 – September, 2002). Final Technical report submitted to national river conservation directorate. *Ministry of environment and forests, Government of India*. Pp. 37; table 198, figures 11.

Singh K.H and Singh N.B. (2014): Evaluation of heavy metals loading of river Ganga in Gajipur(U.P) India, *International Journal of Chemical Science*: 12(1),191-198

Trivedy, R. K. and Goel, P. K. (1986): *Chemical and Biological Methods for Water Pollution Studies*. Environmental Publication, Karad, pp. 247.

U.Fostner and G.T.W.Whittmann.(1981): Metal pollution in the Aquatic Environment, Springer Verlag Berlin, Heidelberg N.Y.pp.486

Westall, J. and Stumm, W. I. (1980): The Hydrosphere. In: *The handbook of Environkmental chemistry*, (Ed. O. Hutzinger): Springer–Verlag, NewYork. pp.17-49.

Zwart, D. De. and Trivedi, R. C. (1995): Manual on Integrated Water Quality Evaluation (RIVM Project Report No. 802023). Central Pollution Control Board, New Delhi. pp. 318.

How to cite this article:

Pushpa Kumari *et al*.2018, Evaluation of Physico-Chemical Parameters And Few Heavy Metal Contamination of River Ganga At Varanasi Up, India. *Int J Recent Sci Res.* 9(7), pp. 27707-27710.

DOI: http://dx.doi.org/10.24327/ijrsr.2018.0907.2315

****