ANNALS OF PLANT SCIENCES
ISSN: 2287-688X
OPEN ACCESS
www.annalsofplantsciences.com

ORIGINAL RESEARCH ARTICLE

Assessment of water quality in the river gomati at Jaunpur (U.P.), India.

Veer Pratap Singh[1], A.K. Singh Raghuvanshi[1], Prashant Singh[2]*, Santosh Kumar Singh[1], Ajoy Kumar Singh[1]
[1]Department of Botany, T.D.P.G. College, Jaunpur- 222002 (U.P.), India.
[2]Department of Botany, Udai Pratap College, (Autonomous) Varanasi - 221002, (U.P.), India.

Received: February 27, 2016; **Revised:** March 11, 2016; **Accepted:** March 17, 2016.

Abstract: The River Gomati is popularly known as "Aadi-Ganga". Gomati River is an important tributary of river Ganga and perennial river of Awadh plains. The river Gomati originates from Gomat Taal near Madhoganj Tanda village in Pilibhit district (U.P.), run across the major part of U.P. covering nine districts of Shahjahanpur, Lakhimpurkheri, Hardoi, Sitapur, Lucknow, Barabanki, Sultanpur, Jaunpur and ultimately merges in Ganga river, near Saidpur Kaithi in Varanasi. The world is facing problems with a wide variety of pollutants both inorganic and organic in nature. Healthy soil, clean water and air are the soul of life. Often soil, water and air are no longer clean and pure, but pose human health risks. The river Gomati receives huge quantities of untreated sewage agricultural runoff, brings a lot of pesticides, fertilizer, street washouts bringing oil, asphalt, sediment and many types of heavy metals. From industrial effluents to domestic discharge, the river becomes more of a flowing dumping yard. The physico-chemical parameters in water of river Gomati were assessed to know about the water quality in its catchment area. Total of four sampling sites were selected between Gokul ghat upstream and Ramghat downstream. Physico-chemical parameters like pH, Temperature, Total dissolved solid (TDS), Total suspended solid (TSS), Hardness, Dissolved oxygen (DO), Nitrate, Nitrite, Chloride, Total Coliforms and some heavy metals were determined. Changes in water quality of river Gomati due to variations in quantity of parameters were found. Heavy metals mainly Copper, Iron, Zinc, Lead, Arsenic, Cadmium and Nickel were noticed.

Key words: Water quality; Gomati River; Physico-chemical parameters; Heavy metals; Jaunpur; India

Introduction

The River Gomati originates from Gomat Taal which was formally known as Fulhaar Jheel near Madhoganj Tanda village in Pilibhit district (U.P.). It extends to 940 km through Uttar Pradesh and meets the Ganga River near Saidpur Kaithi in Varanasi. Its water coverage is about 22,735 Square Km. The cities of Lucknow, Lakhimpurkheri, Sultanpur and Jaunpur are located on the banks of the river Gomati and are the most prominent of the 15 towns located in its catchment area. Its flow mainly depends upon occurrence of rain and therefore the flow in river is very lenient during monsoon. The river collects large amounts of human and industrial pollutants as it flows through the highly popular areas (18 million approx.) of Uttar Pradesh. High pollution levels in the river have negative effects on the ecosystem of the river Gomati threatening its aquatic life. Municipal and domestic waste and sewage water are also discharge into the river Gomati.

According to Srivastava *et al.,* (2011) drains are the main source of water pollution especially for rivers flowing within the city carry industrial effluents, municipal and domestic waste, sewage and medicinal waste results in pooring the water quality. The extent to which these drains pollute the water quality of the river Gomati in Jaunpur city. Study of water quality of the river Gomati of Jaunpur city was carried out by Yadav *et al.,* (2012).

The water pollutants include sewage, variety of both organic and inorganic pollutants including oils, greases, plastics, metallic wastes, suspended solids, phenols, acids, salts, dyes, cyanides, DDT and some heavy metals like Cu, Cr, Cd, Hg, Pb are also discharged from industries (Namdev and Singh, 2012). Gomati is under 'assault' at various points of its journey as it meanders through the 940 km stretch of rich alluvial plains of Uttar Pradesh. According to study carried out by several researchers on some of the important rivers, it has been observed that in recent years, the water of most of rivers is polluted. Many sources of heavy metals including tannery, sugar, beverages, paints, chemicals, fertilizers, batteries, automobiles, factories, food processing units, cement thermal power plants, petroleum refineries and sewage disposal water. Heavy metals reveals a huge amount of problems having high density but physical properties are quite meaningless (Appenroth 2007). Heavy metals causes environmental pollution and are phytotoxic in nature (Prasad, 2004). Heavy metals have specific gravity 5 (Lepedes, 1974). The contamination of the environment with toxic metals has become a worldwide problem, affecting crop yields, soil biomass and fertility, contributing for the bioaccumulation and biomagnification in the chain. (Prasad, 2011). High concentration of all metals like Cr, Cu, Ni, Pb and Zn were noticed in river Gomati from 2006-2008 (Mishra and Mishra, 2008). Drinking water containing traces of heavy

Corresponding Author
Prashant Singh,
Udai Pratap College,
(Autonomous) Varanasi - 221002,
(U.P.), India.

metals and is dangerous for health. Fresh water fishes also get affected due to bioaccumulation of heavy metals (Vinodhini and Narayanan, 2008).

Heavy metals are carcinogenic to humans. Higher concentration of metal in water and sediment during rainy season could be due to the industrial, agricultural or domestic runoff coming into the river (Gaur *et al.,* 2005). River water quality monitoring is necessary especially where the water serves as drinking water sources are threatened by pollution resulting from various human activities along the river course (Ahmad *et al.,* 2010). Water quality assessment based on biomonitoring of rivers in Uttaranchal, in view of the religious importance and ecological sustainability was carried out by Semwal and Akolkar (2006). Some algae can be used as bioindicators of water pollution (Dwivedi, 2010). Study carried out by Joshi (2007) indicated that surface water and land resources management plan should be carried out for conservation of precious water. Investigation, monitoring of seasonal variations in the concentrations of heavy metals Pb, Fe, Zn, Cd, Co, Cu, Cr, As, and Ni in the Yamuna river water flowing through Delhi was carried out by Kaur and Mehra (2012). Ajmal *et al.,* (1988) studied about the detrimental effects of heavy metals measured copper and cadmium levels in the water, sediments organic detritus and in the aquatic environment. All the industries consume huge quantity of water (Mitra, 1982). Trivedi (2000) studied about the pollution and biomonitoring of Indian rivers. Several other researchers have also studied on water quality of rivers in India (Bhargava, 1985) and about variations in the quality in river Ganga. Assessment of water quality of river Yamuna at Agra was carried out by Sharma and Agrawal (1999). Monitoring of water pollution in snow fed river Alaknanda Rudraprayag at Chamoli was done by Tiwari *et al.,* (1991). Water and sediments quality of rivers Damodar and Barakar with respect to heavy metals distribution was reported by Singh *et al.,* (1993). Assessment of water quality of western Orrisa was carried out by Patel and Patel (1933). Rajukar *et al.,* (2003) investigated physico-chemical and biological nature of River Unshyrpi at Shillong Meghalaya. A survey was carried out by Nanda and Tiwari (1919) to study the discharge of mining environmental impact of this river. Singh (2001) presented a report on monitoring and assessment of the Gomati river quality in Lucknow. Screening of microorganisms in river Gomati water was made by (Pathak, 1991) under various environmental conditions. Objectives of the present investigation were to evaluate water quality trend over a period of time, water uses to understand the environmental fate of different pollutants and to facilitate the identification of emerging issues with future priorities. Overall aim of the study was to check the water quality parameters and their role in causing water pollution.

Figure 1: Water pollution in Gomati River at Jaunpur

Figure 1a: Selected Sampling sites of river Gomati with Gokul ghat (S_1), Jogiyapur (Shiv) ghat (S_2), Miyapur ghat (S_3) and Ramghat (S_4).

Materials and Methods

Gomati River

The river Gomati is tributary of Ganga River. The river Gomati, ranks third position in eastern U.P. of India among the holiest river Ganga near Kaithi of district Varanasi over 940 km Journey with water restoring area of nearly 30,437 km^2, on its way it is joined by many small seasonal and perennial rivers polluted at several stretchers by different industries.

Site Selection

Four sampling sites were selected all along the 5 km route of the river in Jaunpur city from Gokul ghat to Ramghat. Five major drainage channels and several open drains are adding effluents and domestic wastes into the river which enhance the pollution load in river water and aquatic flora and fauna. Selected sampling sites were Gokul ghat (S_1), Jogiyapur (Shiv) ghat (S_2), Miyapur ghat (S_3) and Ramghat (S_4) respectively.

Sample Collection

The water sampling was done in 2010-2011 in between 9.00 a.m. to 2.00 p.m. from both sides of river Gomati. Sixteen physico-chemical parameters namely pH, Total Hardness, D.O., Nitrate, Nitrite, TSS, TDS, Chloride, Total Colliform and Heavy metals namely Cu, Fe, Zn, Pb, As, Cd and Ni were analyzed.

Physico-chemical analysis of water

1. **pH:** pH was determined using the standard pH meter. The pH electrode was dipped in the solution and pH was recorded after every four days.

2. **Total Dissolved Solids (TDS):** TDS were also estimated by gravimetric method.

3. **Total suspended solids (TSS):** TSS was estimated by gravimetric method. The evaporating dish was dried at 104 $\pm$ 1^{0}C for 1 hrs and cooled in desiccators to take the weight of the dish. 25 ml of the sample was taken for the analysis in a predried dish and was evaporated to dryness in an oven at 104 $\pm$ 1^{0}C. The dish was cooled in desiccators and final weight was taken for the analysis of TS content.

4. **Dissolved Oxygen (DO):** Dissolved oxygen content of the water samples was measured by using Winkler's method. The sample was collected in 300 ml bottle and D.O. was fixed in site by using 1 ml each of manganous sulphate and Alkaline-iodide-azide. The precipitate formed was disolved in laboratory by using sulphuric acid and titrated with sodium thiosulphate using starch as an indicator. The end point of titration was blue to straw pale colours.

$$DO(mg/l) = \frac{ml\ of\ titrant \times N \times 1000 \times 8}{V_2(V_1 - V_2)/V_1}$$

5. **Nitrate:** Catalodo method was used. Standard solution were prepared by using KNo_3. Sample was added with salicyclic acid and dilute NaoH where orange-yellowish colour optical density was recorded at 410 nm.

Nitrate (mg/l) = K - factor × Absorbance (O.D.)

K- factor = O.D./Concentration.

6. **Nitrite:** For nitrite estimation stevens and Oak method was used. The standard solutions were prepared by using $NaNo_2$. 1 ml of 1% sulphanilamide and 1 ml of 0.02% NEDA were added after to obtain pink colour and absorbance was recorded at 540 nm.

Nitrite (mg/l) = K- factor × Absorbance (O.D.)

K- factor = Absorbance (OD)/Concentration

7. **Hardness:** The total hardness of the water samples was determined by EDTA titration method where 50 ml of well mixed sample was mixed with 1-2 ml buffer of pH 10 and a pinch of Eriochrome black-T indicator. The contents were then titrated with 0.01 M EDTA till wine red solution changes to blue.

$$\text{Hardness (mg/l)} = \frac{C \times D \times 1000}{ml\ of\ sample}$$

Where-
C = ml of EDTA for titration
D = mg of $CaCO_3$ equivalent to 1 ml of EDTA.

Heavy Metal Analysis

100 ml of water sample was mixed with conc. nitric acid (10 ml) then cooled and filtered through whatman 42 filter paper. Seven Heavy metals namely Copper, Iron, Zinc, Lead, Arsenic, Cadmium and Nickel were detected and determined by method prescribed in APHA (1989).

Results and Discussion

The water samples were analysed for physico-chemical characteristics total of nine physico-chemical parameters were analyzed namely pH, Dissolved oxygen (DO), Chloride, Total suspended solids, Total dissolved solids, Total Hardness, Nitrate Nitrite and Total Coliform including seven heavy metals namely, Cu, Fe, Zn, Pb, As, Cd and Ni (Table 1 and Table 2).

In the present study, maximum pH value was at Gokul ghat (8.2), which was slightly higher than desirable limit and minimum value was at Ramghat (6.9). pH was within permissible limit at all stations. Analytical study of pH in rain water for the determination of polluted or unpolluted zone was also done by Gaddamwar (2011).

Table 1: Physico-Chemical parameters of river Gomati at Jaunpur (2010-2011).

Sampling sites	pH	;	TSS	DO	te	Nitrite	Hardness	Chloride	Total Colliform
1. Gokul ghat	8.2	357	395	7.9	1.95	0.345	166.0	32.030	192
2. Jogiyapur ghat	7.2	611	500	3.6	3.45	0.569	249.5	46.321	693
3. Miyapur ghat	7.5	555	476	4.4	3.85	0.432	206.3	51.739	732
4. Ram ghat	6.9	486	4.03	5.3	1.33	0.129	179.0	68.625	551

Table 2: Estimation of heavy metals in river Gomati at Jaunpur (2010-2011)

Sampling sites	Cu	Fe	Zn	Pb	As	Cd	Ni
1. Gokul ghat	0.019	1.15	0.18	0.53	0.037	0.0031	0.715
2. Jogiyapur ghat	0.038	1.98	0.32	0.62	0.054	0.0041	1.118
3. Miyapur ghat	0.032	2.26	0.44	0.92	0.071	0.0048	1.356
4. Ram ghat	0.042	1.80	0.21	0.82	0.068	0.0043	1.256

pH of the water is the measure of the H^+ ion activity of the water system. It indicates whether the water is acidic, neutral or alkaline in nature. Dissolved oxygen concentration is a remarkable indicator of water pollution (Basavaraddi *et al.,* 2012). Fish and other aquatic animals depend upon DO, which dependent on the water temperature. The maximum DO in water was observed at Gokul ghat (7.9 mg/l) and was minimum at jogiyapur ghat (3.6 mg/l).

The maximum desirable limit for chlorides is 250 mg/l with relaxation up to 1000 mg/l. The maximum value of the chloride was recorded at site Ram ghat (68.625 mg/l) and was minimum at Gokul ghat (32.030 mg/l). The presence of faecal material from warm-blooded animals such as Eschorichia coli or klebsiella pneumonae are the indicator of potential danger of health risks those faecal possess (Singh *et al.,* 2013). The maximum number of total colliform count were found at Miyapur ghat (732 MPN index/100 ml) and minimum at Gokul ghat (192 MPN index/ 100ml).

Suspended sediment concentration (SSC) and Total suspended solids (TSS) are predominantly used to quantify concentrations of suspended solid phase material in surface waters (Grey *et al.,* 2000). The maximum value was at Jogiyapur ghat (500 mg/l) and was minimum at site Gokul ghat (395 mg/l). The parameter (TSS) was within permissible limit at all sites. The maximum desirable limit for Total suspended solids is 500 mg/l. The maximum value of TDS analyzed at site Jogiyapur ghat (611 mg/l) which was beyond the permissible limit and was minimum at Gokul ghat (357 mg/l) and was within permissible limit.

The maximum value of Total hardness was at Jogiyapur ghat (249.5 mg/l) and was minimum at site Gokul ghat (166 mg/l). The parameter (Total Hardness) was within permissible limit at all sites. The maximum desirable limit for total hardness is 300 mg/l. Health aspects of nitrate in drinking water were detected by (Adam, 1980). The maximum value of the nitrate was at site Miyapur (3.85 mg/l) and was minimum at site Ram ghat (1.33 mg/l). Most of the values of the water samples were within the permissible limit. A sensitive spectrophotometric determination of nitrite in water and soil was done by Chatterjee at al., (2004). For drinking water the maximum desirable limit of nitrite concentration is 0.50 mg/l. The maximum value of the nitrite was at site Jogiyapur ghat (0.569 mg/l) and was minimum at Ram ghat (0.129 mg/l). Most of the values of the water samples were within the permissible limit except Jogiyapur ghat. The permissible limit of nitrite is 0.50 mg/l.

Increase in population, urbanization and industrialization in the past century have resulted in increased domestic sewage, municipal sewage and industrial effluents being discharged into the aquatic system (Ajmal *et al.,* 1988). Further, dust input in water increases the heavy metal concentration in river line system. High amount of untreated sewage coming from city also increase load of metals. The maximum value of copper was at site Ram ghat (0.042 mg/l) and was minimum at site Gokul ghat (0.019 mg/l). The concentration of copper at all sites was within the permissible limit. The maximum desirable limit of copper is 0.05 mg/l. Arsenic contaminated in water is major factor of human health risk.

The problem can be solved or relieved by supplying clean water (Sukreeyapongse *et al.,* 2007). The maximum desirable limit for arsenic is 0.05 mg/l. The maximum value of arsenic was at Miyapur ghat (0.71 mg/l) and was minimum at site Gokul ghat (0.037 mg/l). Most of the values of water samples were beyond the permissible limit except Gokul ghat. Previous study on iron in drinking water was carried out by Jemison (1994). The permissible limit of iron is 1.0 mg/l. Iron in natural water is controlled by both physico-chemical and microbiological factors.

The maximum value of Iron was at site Miyapur ghat (2.26 mg/l) and was minimum at site Gokul ghat (1.15 mg/l). The parameters were beyond the permissible limit at all sites. The maximum desirable limit for cadmium is 0.02 mg/l. The maximum value of cadmium was at site Miyapur ghat (0.0048 mg/l) and was minimum at site Gokul ghat (0.0031 mg/l). The parameter was within permissible limit at all sites. The maximum values of Zinc (0.44 mg/l), Lead (0.92 mg/l) and Nickel (1.356 mg/l) was at site Miyapur ghat and the minimum values of Zinc (0.18 mg/l), Lead (0.53 mg/l) and Nickel (0.715 mg/l) was at site Gokul ghat.

Conclusion

The DO, TDS, TSS, nitrate, nitrite and other parameters at some of the sites were beyond the permissible limit, water was polluted and is not suitable for beneficial uses without conventional treatments. The river is highly polluted due to discharge of domestic, municipal and industrial waste through several drains. The increase in value of chloride, nitrate and total hardness were also due to domestic and municipal waste discharges. Increased concentration of heavy metals in water at site Jogiyapur ghat and Miyapur ghat due to domestic waste, municipal waste and industrial effluents.

Acknowledgement

The authors are grateful to Principal, T.D.P.G. College, Jaunpur (V.B.S. Purvanchal University) and Principal Udai Pratap (Autonomous) College, Varanasi for encouragement and facilities provided during research work.

References

1. APHA, Standard methods for the examination of water and waste water. 17th Ed., Washington, D.C (1985).

2. Singh, Juhi and Mishra, R.N., Studies on the mobility of the heavy metals in the river Ganga at Varanasi. *J. Purv. Acad. Sci*., 13 (B) (2007): 53-56.

3. Whitton, B.A. Biological monitoring of heavy metals in flowing water INSA *Symp. Biomonitoring Stat Environ.* (1985): 50-55.

4. Ahmad, M.K., Islam, S., Rehman, S., Haque, M.R. and Islam, M.M., Heavy metals in water, sediments and some fishes Buriganga river, Bangladesh. Int. J. Env.Res.(2010) 4(2) : 321 - 332.

5. Bharadwaj, V., Singh, D.S. and Singh, A.K., Water quality of the chhoti Gandak River using Principal component analysis, Ganga plain, India, (2009).

6. Bhargava, D.S., Variations in the quality in Ganga. Efflu. and water treat. J. (1985) 25(2): 61-51.

7. Dwivedi, S., Pollution induced structural and Physico-chemical Changes in Algae Community: a case study of River Pandu of North India. World Acad. of Sci. Eng. and Tech. (2010) 47.

8. Gaddamwar, A.G., Analytical study of pH in rain water for the determination of polluted or unpolluted zone.Int. J. Env. Sci. (2011) 1(6).

9. Gaur, V.K., Gupta, S.K., Pandey S.D., Gopal K., and Mishra, V., Distribution of heavy metals in sediment and water of river Gomati Env. Mon. Ass., (2005) 102 (1-3): 419 - 433.

10. Kaur, S. and Mehra, P., Assessment of heavy metals in summer and winter seasons in river Yamuna segment flowing through Delhi. India J. Env. Eco., (2012) 3(1) : 149.

11. Mitra, A.K., Chemical characteristics of Surface water at selected gauging stations in river Godavari, Krishna and Tungbhadra. Ind.of Env. Health., (1982) 24, 165-179.

12. Mishra, S.S. and Mishra, A., Assessment of physico-chemical properties and heavy metal concentration in Gomati River. Res. Env. Lif. (2008) 2 : 55-58.

13. Namdev, D.K. and Singh, K.A, Studies on physico-chemical properties of water in Yamuna river at Hamirpur (U.P.) with Special reference to occurrence of Lead. Int. J. Res. Tech. (2012) 7:215-216.

14. Nanda, S.N. and Tiwari, T.N., Effect of discharge of effluents on the quality of the river Brahmani at Raurkela. Ind. J. Env. Protec. (1999) 13(1): 52-55.

15. Patel, M.K. and Patel, T.K., Assessment of water quality in the river of western Orrisa part-1, River Sankh. India J. Env. Protec; (1993) 13(12):909 - 916.

16. Pathak, S.P., Screening of microorganisms in river Gomati water under various environmental conditions. Journal of Applied and Natural Science, (1991) 3(2): 298-302.

17. Semwal, N. and Akolkar, P., Water quality assessment of sacred Himalayan rivers of Uttaranchal. Curr. Sci. (2006) 91(4).

18. Sharma, B.S. and Agrawal, A., Assessment of water quality of river Yamuna at Agra. Poll. Res. (1999) 18 (1): 109 - 110.

19. Sharma, B.S., A study of water quality of river Yamuna at Agra. Ind. J. Env. Protec. (1999) 19 (6): 440-441.

20. Singh, D., Ranjana, P.K. and Rawat, N.S., Water and Sediments Quality of rivers Damodar and Barkar with respect to heavy metals. distination. Ind. J. Env. Protec. (1993) 138.

21. Singh, K.P., Report on monitoring and assessment of the Gomati river quality. Industrial Toxicological Research Centre, Lucknow (2001).

22. Srivastava, S., Srivastava, A., Negi, M.P.S. and Tandon, P.K., Evaluation of effect of drains on water quality of river Gomati in Lucknow city using multivariate statistical techniques. Int. J. Env. Sci., (2011) 2 (1).

23. Singh, A., Srivastava, A. and Pandey, A.K., Impact of pollution on plankton productivity of river Gomati at Jaunpur (U.P.) Environ. Ecol. (2010) 28 (1): 95-97.

24. Ali, Nafasat., Akhtar, M. and Pandey, A.K., Studies on the role of metallic pollution in river in ecosystem. Asian J. Env. Sci. (2009) 4(1): 92-94.

25. Singh, N.B., Pandey, Shivani and Ali, S.N., Heavy metal content in Gomati river water, Sediment and hydrobiota in Jaunpur (U.P.). Asian J. Env. Sci., (2010) 5(1): 53-57.

Cite this article as:
Veer Pratap Singh, A. K. Singh, Raghuvanshi, Prashant Singh, Santosh Kumar Singh, Ajoy Kumar Singh. Assessment of water quality in the river gomati at Jaunpur (U.P.), India. *Annals of Plant Sciences* 5.3 (2016): 1312-1317.

Source of support: Nil
Conflict of interest: None Declared