Universal Journal of Environmental Research and Technology
All Rights Reserved Euresian Publication © 2013 **eISSN 2249 0256**
Available Online at: **www.environmentaljournal.org**
Volume 3, Issue 3: 337-344

Open Access **Research Article**

Water Quality Assessment of River Gomti in Lucknow

Dhananjay Kumar, Anjali Verma, Namita Dhusia and Nandkishor More*

Department of Environmental Science, BBA (A Central) University, Lucknow-226025, (U.P.), India.

***Corresponding author: nkmore2000@yahoo.com**

Abstract:

Gomti river originates from Madhoganj Tanda village in Pilibhit district, U.P. It passes through the district of Shahjahanpur, Kheri, Hardoi, Sitapur, Lucknow, Barabanki, Sultanpur, Jaunpur and ultimately merges in Ganga. The world is facing problems with a wide variety of pollutants both inorganic and organic in nautre. 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. Gomti receives huge quantities of untreated sewage, agricultural runoff, brings 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 physicochemical parameters in water of river Gomti were assessed to know about the water quality in its catchment area. Total of fifteen sampling sites were selected between Guaghat upstream and Gomti Barrage. Parameters like Temperature, Total suspended solids (TSS), Total dissolved solid (TDS), pH, Hardness, Dissolved oxygen (DO), Nitrate, Nitrite, Chlorine, Total Coliforms and some Heavy metals were determined. Changes in water quality of River Gomti due to variations in quantity of parameters were found. Heavy metals mainly Iron, Cadmium, Copper and Arsenic were noticed.

Keywords: Gomti River, Water quality, Physico-Chemical Parameters, Heavy Metals.

1.0 Introduction:

The Gomti originates from Gomat Taal which was formally known as Fulhaar Jheel near Madho Tanda, Pilibhit, India. It extends to 900 km through Uttar Pradesh and meets the Ganges River near Saidpur Kaithi in Gazipur. Its water coverage is about 22,735 square km. After travelling about 240 km Gomti enters Lucknow, where it travels for 16 km. The cities of Lucknow, Lakhimpur Kheri, Sultanpur and Jaunpur are located on the banks of the Gomti 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 populous areas (18 million approx) of Uttar Pradesh. High pollution levels in the river have negative effects on the ecosystem of the Gomti threatening its aquatic life. Before reaching in Lucknow Gomti receives waste from sugar and distillery industries of Sitapur. All industries of distillery, milk industry, vegetable oil, pouring effluent directly into Gomti and besides this domestic waste water are also discharge into the River Gomti.

According to Srivastava *et al*., (2011) drains are the main source of water pollution especially for rivers flowing within the city carry industrial effluent, domestic waste, sewage and medicinal waste results in pooring the water quality. The extent to which these drains pollute the water quality of river Gomti in Lucknow city. Study of water quality of the river Gomti 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 plasticizers, metallic wastes, suspended solids, phenols, acids, greases, salts, dyes, cyanides, DDT and some heavy metals like Cu, Cr, Cd, Hg, Pb are also discharged from industries (Namdev and Singh, 2012). Gomti is under 'assault' at various points of its journey as it meanders through the 900 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 quit 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 biomagnifications in the chain (Prasad, 2011). High concentration of all metals like Cr, Cu, Ni, Pd and Zn were noticed in River Gomti from 2006-2008 (Mishra and Mishra, 2008). Drinking water containing traces of heavy 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 bio-monitoring of rivers in Uttaranchal, in view of their 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. Investigations, monitoring of seasonal variations in the concentrations of heavy metals Pb, Fe, Zn, Mn, Cd, Co, Cu, Cr 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 feed river Alaknand Rudraprayag at Chamoli was done by Tiwari et al. (1991). Water and sediments quality of rivers Damodar and Barkar 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 (1993). Rajukar et al., (2003) investigated physicochemical and biological nature of River Unshyrpi at Shillong Meghalaya. A survey was carried out by Nanda and Tiwari (1999) to study the discharge of mining environmental impact of this river. Singh (2001) presented a report on monitoring and assessment of the Gomti river quality in Lucknow. Screening of microorganisms in river Gomti 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.

Fig. 1 **Fig. 2**

Water pollution in River Gomti

2.0 Materials and Methods:

1.1 Site Selection:

The Gomti river is tributary of Ganga River. About 240 km the Gomti enters Lucknow, through which it meanders for about 12 km. A 9 km stretch of the Gomti was selected for the study. A total of 15 sampling sites were selected namely Gaughat, Hussainabad, Gulalaghat, Kuriyghat, Pakkapul, Mohan Meakin, Mankameshwar, Daliganj, Hanuman setu, Boat club, Lakshmanmela ground, Monkey bridge, Parag, Baikunth dham and Gomti barrage.

1.2 Sample Collection:

The water sampling was done in December 2010 in between 9.00 a.m to 2.00 p.m. from both sides of river Gomti. Fourteen physicochemical parameters namely Temperature, pH, Total Hardness, D.O., Nitrate, Nitrite, TSS, TDS, Chloride, Total Coliform, Heavy metals namely Copper, Iron, Arsenic and Cadmium were analysed.

1.3 Physicochemical Analysis of Water:

1.3.1 pH: pH was determined using the standard pH meter. The pH electrode was dipped in the solution and pH was recorded after every 4 days.

1.3.2 Dissolved Oxygen (DO): Dissolved oxygen content of the water samples was measured by using Winkler's method (modified azide method). The sample was collected in 300 ml bottle and DO was fixed on site by using 1 ml each of Manganous sulphate and Alkaline-iodide-azide. The precipitate formed was dissolved 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 colour.

$$\text{DO (mg/L)} = \frac{\text{ml of titrant x N x 1000 x 8}}{\text{V2(V1 - V2)/V1}}$$

1.3.3 Chlorides: Chloride content was measured by Argentometric titration.

1.3.4 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 with0.01M EDTA till wine red solution changes to blue.

$$\text{Hardness (mg/L)} = \frac{\text{C x D x 1000}}{\text{ml of Sample}}$$

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

1.3.5 Total Suspended Solids (TSS) were estimated by gravimetric method. The evaporating dish was dried at 104±1^{0}C for 1 h and cooled in desiccators to take the weight of the dish. 25 ml of the sample was taken for the analysis in a pre-dried dish and was evaporated to dryness in an oven at 104 ±1^{0}C. The dish was cooled in desiccators and final weight was taken for the analysis of TS content.

1.3.6 Total Dissolved Solids (TDS) was also determined by estimated by Gravimetric method.

1.3.7 Nitrate: Catalodo method was used. Standard solutions were prepared by using KNO_3. Sample was added with salicylic acid, and dilute NaOH where orange-yellowish colour optical density was recorded at 410 nm.

Nitrate (mg/l) =K-factor x O. D.
K-Factor = O.D. / Concentration.

1.3.8 Nitrite: For nitrite estimation Stevens and Oaks 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 x Absorbance (O.D.)
K-Factor = Absorbance (O.D.) / Concentration.

1.3.9 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. Four Heavy metals namely Copper, Iron, Arsenic and Cadmium were detected.

3. Results and Discussion:

The water samples were analysed for physicochemical characteristics. Total of nine physicochemical parameters were analysed namely pH, Dissolved Oxygen, Chloride, Total Coliform, Total Suspended Solids, Total Dissolved Solids, Total Hardness, Nitrate and Nitrite including four heavy metals namely As, Cu, Fe and Cd (Table 1 and Table 2).

Table 1: Physicochemical Parameters of River Gomti in Lucknow. (December 15 to January 15 2011)

Sr. No	Sampling Sites	pH	TDS (mg/l)	TSS (mg/l)	DO (mg/l)	Nitrate (mg/l)
1.	Gaughat	7.55	357.5	417.5	3.3	44.795
2.	Hussainabad	7.84	404	525.5	2.3	55.065
3.	Gulalaghat	7.765	611	465	2.65	42.68
4.	Kuriyaghat	7.88	405	485.5	4	45.87
5.	Pakkapul	8.265	556.5	460	2.55	53.925
6.	Mohan Meakin	8.585	555.5	565	1.95	31.275
7.	Mankameshwar	7.54	504	494.5	2.15.	66.475
8.	Daliganj	6.88	600	557.5	2.6	77.39
9.	Hanuman setu	7.855	525	453.5	2.85	73.545
10.	Boat Club	8.475	440	537	2.55	51.33
11.	Lakshaman mela	7.51	455	538	1.7	89.805
12.	Monkey bridge	7.795	486.5	485	2.1	45.75
13.	Parag	7.885	620	678.5	1.7	57.55
14.	Bailunth Dham	7.655	417.5	469	2.05	57.205
15.	Gomti Barrage	8.28	573.5	595	2.65	64.58

Table 2: Physicochemical Parameters of River Gomti in Lucknow. (December 15 to January 15 2011)

Sr. No	Sampling Sites	Nitrite (mg/l)	Hardness (mg/l)	Chloride (mg/l)	Total Coliform
1.	Gaughat	0.55562	175.5	3.059	92.5
2.	Hussainabad	0.1305	166	7.8525	245
3.	Gulalaghat	0.09269	175.5	8.426	250
4.	Kuriyaghat	0.45935	149	25.881	1255
5.	Pakkapul	0.1239	249.5	58.175	347.5
6.	Mohan Meakin	0.26669	214.5	32.374	192.5
7.	Mankameshwar	0.3772	231	62.655	215
8.	Daliganj	0.18275	206	41.505	227.5
9.	Hanuman setu	0.1706	183.5	20.665	347.5
10.	Boat Club	0.0441	169	14.61	1275
11.	Lakshaman mela	0.68005	175	18.657	1600
12.	Monkey bridge	0.12795	140	16.486	192.5
13.	Parag	0.36455	198	2.61	245
14.	Baikaunth Dham	0.40025	179	16.2995	142.5
15.	Gomti Barrage	0.314	161	19.265	125

Table: 3 Showing Heavy Metal estimation of River Gomti in Lucknow

Sr. No	Sampling Sites	As (mg/l)	Cu (mg/l)	Fe (mg/l)	Cd (mg/l)
1.	Gaughat	0.0375	0.0145	0.665	0.0181
2.	Hussainabad	0.062	0.061	1.021	0.021
3.	Gulalaghat	0.04	0.0325	0.077	0.0199
4.	Kuriyaghat	0.029	0.018	0.725	0.0198
5.	Pakkapul	0.070	0.0315	0.92	0.021
6.	Mohan Meakin	0.046	0.017	0.85	0.0163
7.	Mankameshwar	0.049	0.0525	0.715	0.0202
8.	Daliganj	0.079	0.0195	1.075	0.023
9.	Hanuman setu	0.039	0.024	0.8015	0.0208
10.	Boat club	0.0305	0.0185	0.405	0.0242
11.	LakshmanMela ground	0.0495	0.026	0.72	0.01755
12.	Monkey Bridge	0.06	0.023	1.685	0.0197
13.	Parag	0.036	0.0255	1.485	0.0176
14.	Baikunth Dham	0.0385	0.024	1.545	0.0144
15.	Gomti baragge	0.0705	0.026	1.525	0.0223

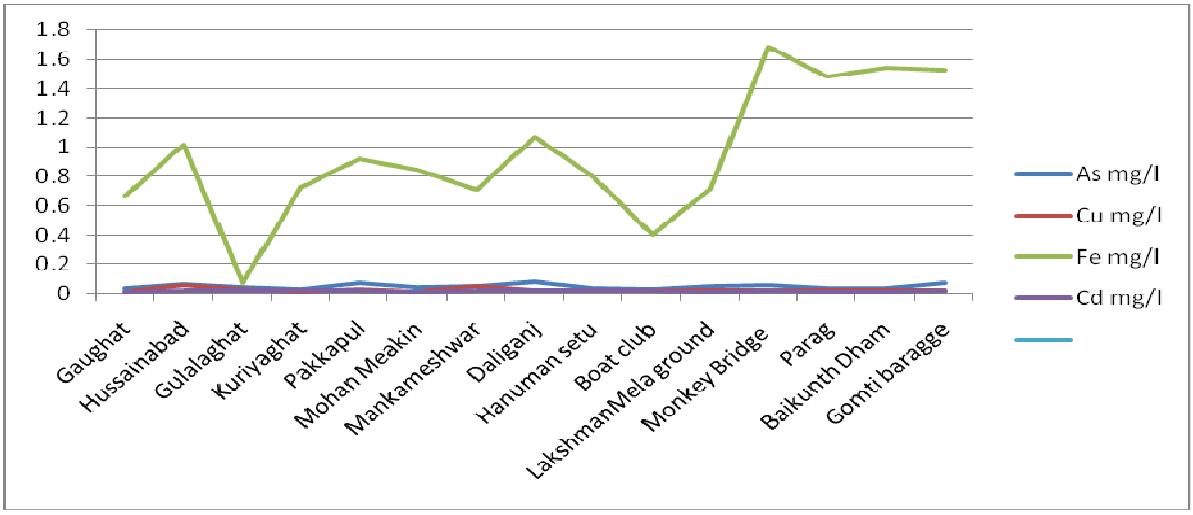

Fig a: Heavy metals at selected stations of river Gomti in Lucknow

In the present study, maximum pH value was at Mohan meakin (8.59) which was slightly higher than desirable limit and minimum value was at Daligang (6.88). 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). 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 Kuriyaghat i.e. 4 mg/l and minimum at Parag i.e. 1.7.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 Mankameshwar i.e. 62.65 and minimum at Parag 2.61 mg/l. Most of the values of the water samples were within the permissible limit except Gaughat, Laxman mela ground. The presence of faecal material from warm-blooded animals such as *Escherichia 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 coliform count was found at Laxmanmela ground i.e. 1600 MPN index/100 ml and minimum at Gaughat i.e. 92.5 MPN index/100 ml.

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 Parag at i.e. 678.5 mg/l and

minimum at site Gaughat i.e. 417.5 mg/l. The parameter was within permissible limit. The maximum desirable limit for Total Suspended Solids is 500 mg/l. The tolerance limit for Total Dissolved Solids is 500 mg/l. The maximum value of TDS analyzed at site Parag i.e.620 mg/l which was beyond the permissible limit and minimum at Gaughat 357.5 mg/l and was within permissible limit.

The maximum value of total hardness was at Pakkapul i.e.249 mg/l and minimum value at site Monkey Bridge 140 mg/l. The parameter was within permissible limit. The maximum desirable limit for Total Hardness is 300 mg/l. Health aspects of nitrate in drinking water were detected by (Adam, 1980). For drinking water the maximum desirable limit of nitrate concentration is 45 mg/l. The maximum value of the nitrate was at site Laxmanmela ground i.e. 89.80 mg/l and minimum at Mohanmeakin i.e.31.27 mg/l. Most of the values of the water samples were beyond the permissible limit except Kuriyaghat, Mohan meakin, Gulaghat and MonkeyBridge. Permissible limit of nitrate is 45 mg/l. A sensitive, spectrophotometric determination of nitrite in water and soil was done by Chatterjee *et 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 Laxman mela ground i.e. 0.68 mg/l and minimum at Boat club Gaughat i.e. 0.0441 mg/l. Most of the values of the water samples were within the permissible limit except aughat, Laxmanmela ground. Permissible limit of nitrite is 0.50 mg/l.

Increase in population, urbanisation and industrialization in the past century have resulted in increased domestic and industrial effluent 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 Hussainabad i.e. 0.61 mg/l and minimum at site Gaughat i.e.0.0145 mg/l. The concentration of copper at most of sites was within the permissible limit except Hussainabad and Mankameshwar (Fig. a). The maximum desirable limit 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 Daliganj i.e. 0.0792mg/l and minimum at site Kuriyaghat i.e. 0.029 mg/l (Fig. 3). Previous study on iron in drinking water was carried out by Jemison (1994). The permissible limit is 1.0 mg/l. Iron in natural water is controlled by both physicochemical and microbiological factors. Iron was maximum at Monkey Bridge i.e. 1.685 mg/l (Fig. 3). The maximum desirable limit for Cadmium is 0.02 mg/l. The maximum value of cadmium was at Boat club i.e.0.024 mg/l and minimum at site Baikunth Dham i.e.0.0144 mg/l (Fig. 3).

4. Conclusion:

The DO, TSS, TDS, nitrate, nitrite and other parameters at some of the sites were beyond 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 and industrial waste through several drains. The increase in value of chloride, nitrate and total hardness were also due domestic discharges. Increased concentration of heavy metal in water at Parag, Daligaj, Mohan meakin and Monkey Bridge area could be due to high discharge of water from catchment area, industries and various drains.

5. Acknowledgements:

The authors acknowledge the Head, Department of Environmental Sciences, Babasaheb Bhimrao Ambedkar (A Central) University Lucknow-226025 for providing facilities to this work. Financial support to Ms Anjali Verma in the form of PhD fellowship is gratefully acknowledged.

References:

1) Adam, J.W.H.(1980): Health aspects of nitrate in drinking-water and possible means of denitrification, Methaemoglobinaemia Nitrates in drinking water. *Environ. Health*, 86: 31.
2) Ahmed,M.K., Islam,S., Rehman,S., Haque,M.R. and Islam,M.M.(2010): Heavy Metals in water, sediment and some fishes of Buriganga River, Bangladesh. *Int. J. Env. Res*., 4,2 :321- 332.
3) Ajmal,M.R., Uddin,R., and Khan,U.K.(1988):Heavy metals in water, sediments plants and fish of Kali nadi U.P.(India). Enviro.Int.,14:515-523.
4) Apprenroth, K. J. (2007): Definition of heavy metals and their role in biological systems, Friedrich-Schiller University of Jena, Institute for General Botany and Plant Physiology, Dornburgerstr 159, 07743, Jena, Germany.
5) Bhardwaj,V., Singh,D.S and Singh,A.K.(2009): Water quality of the Chhoti Gandak River using principal component analysis, Ganga Plain, India.
6) Bhargava ,D.S.(1985) Variations in the quality in Ganga.*Efflue.and water.treat. j*.,25,2:61-5.
7) Basavaraddi, B.S., Kousar, H.and Puttaiah, E.T. (2012): Dissolved Oxygen Concentration a Remarkable Indicator of Ground Water Pollution, *Bull Env, Phar & Lif*.1, 3: 48 – 54.
8) Butu, A.W. (2013): Concentration of Metal Pollutants in River Kubanni, Zaria, Nigeria, Department of Geography Ahmadu Bello University Zaria, Nigeria, *J.Nat.Sci.Res*.,3,2.
9) Diwedi, S. (2010): Pollution Induced Structural and Physico-Chemical Changes in Algal Community: a case study of River Pandu of North India. *World Acad.of .Sci.Eng and Tech 47.*
10) Gaddamwar , A.G. (2011) *:* Analytical study of pH in rain water for the determination of polluted or unpolluted zone. *Int. J. Env.Sci*.1,6.
11) Gaur, V.K., Gupta, S.K., Pandey, S.D., Gopal,K., and Mishra, V.(2005): Distribution of Heavy Metals in sediment and water of River Gomti, *Env.Mon.Ass.,*102,1-3:419-433.
12) Gray, J. R., Douglas ,G.G ., Turcios, M. L., and Gregory , E. S. and Gregory, E.(2000) : U. S. Geological Survey Water-Resources Investigations Report 00-4191 Reston, Virginia.
13) Howaida ,A. N., Safia, M. A., Manal ,A .S. and Rawan ,G .A. ,(2013): The threats of microbial contamination and total dissolved solids in drinking water of Riyadh's rural areas, Saudi Arabia Asian Biomedicine Vol. 7 , 4: 491-498.
14) Jemison, J.M. (1994): Water Quality: Iron and Drinking Water. Cooperative Extension, University of Maine.
15) Joshi, B.K.(2007) Evaluation of Land Denudation and Rivulets Water Quality in the Gomti Basin of Indian Central Himalayas-A Case Study, G. B. Pant Institute of Himalayan Environment and Development, Kosi,Katarmal,Almora,263643.
16) Kaur, S.and Mehra,P.(2012): Assessment of heavy metals in summer & winter seasons in river yamuna segment flowing through Delhi. *India.j.Env.Eco*.,3,1:149.
17) Lepedes. (1974), Mc Gram Hill Encyclopedia of Environmental Science.
18) Mitra,A.K.(1982) Chemical characteristics of surface water at selected gauging stations in river Godavari,Krishna and Tungbhadra.*Ind.Jou of. Env Healh*.,24;165-179.
19) Mishra,S.S. and Mishra,A.(2008): Assessment of physico-chemical properties and heavy metal concentration in Gomti river. *Res. Env. Lif*., 2:55-58.
20) Namdev, D.K. and Singh, K.A.(2012): Studies on Physical Chemical Properties of water in Yamuna River at Hamirpur (U.P) with special reference to occurrence of Lead. *Int.J. Res. Tech*., 7:215-216.
21) Nanda, S.N. and Tiwari,T.N.(1999): Effect of discharge of effluents on the quality of the river Brahmani at Raurkela. *Ind . J.Env. Protec*.13,1:52-55.
22) Orathai, S., Chalong, T. and Napassorn, N. Chemical Precipitation, Water softening, Ene 806, Project Report 3, Grégoire Seyrig Wenqian Shan College of Engineering, Michigan State University.
23) Patel,M.K.and Patel ,T.K.(1993) Assessment of water quality in the river of western orrisa Part -1, River Sankh.*Ind .J. Env.Protec*.13,12:909-916.
24) Pathak,S.P.(1991):Screening of microorganisms in river Gomti water under various environmental conditions. *Journal of Applied and Natural Science.* 3 (2): 298-302.
25) Prasad, M.N.V. (2011): Emerging phytotechnologies for remediation of heavy metal contaminated/ polluted soil and water Department of Plant Sciences, School of Life Sciences University of Hyderabad, Hyderabad 500046 AP, India.

26) Prasad, M.N.V.(2004) Heavy Metal Stress in Plants. Biomolecule to Ecosystem Springer Science.
27) Rajukar,N.S., Nongbri, B. And Patwardhan, A.M. (2003) Physicochemical and biological investigation of River Unshyrpi at Shillong Meghalaya.*Ind.J. Env.Health*. 45:83-92.
28) Robson, A.A., Simone, P.A., Benedict, C., Okeke,B., Flávio,A.O., Camargo,A. and Fátima, M., B. (2010) :Characterization of copper biosorption and bioreduction by copper resistant bacteria isolated from a vineyard soil. 19th *World Congress of Soil Science*, Soil Solutions for a Changing World.
29) Semwal, N. and Akolkar, P. (2006): Water quality assessment of sacred Himalayan rivers of Uttaranchal. *Curr. Sci*., 91,4
30) Sharma,B.S. AND Agrawal,A.(1999) Assessment of water quality of river Yamuna at Agra. *Poll.Res.* 18, 1:109- 110.
31) Sharma,B.S.(1999) : A study of water quality of river Yamuna at Agra.*Ind.J.Env.Protac.* 19,6:440-441.
32) Singh,C., S.J., Kumar, V., Chandra, R. and Kumar, N. Screening out of coliform bacteria from different location of Gomti river in Lucknow, *Afri J Mic Res,* 7, 29: 3762-3771.
33) Singh, D., Ranjana, P.K. and Rwat, N.S. (1993) Water and sediments quality of rivers Damodar and Barkar with respect to heavy metals distribution*. Ind.J.Env.Protec*. 13,8.
34) Singh, K.P. (2001) Report on monitoring and assessment of the Gomti river quality. Industrial Toxicological Research Centre, Lucknow.
35) Srivastava,S., Srivastava,A., Negi,M.P.S. and Tandon , P.K.(2011): Evaluation of effect of drains on water quality of river Gomti in Lucknow city using multivariate statistical techniques,*Int. J.Env.Sci.,* 2:1.
36) Sukumar ,C., Ajai, K. P., and Gupta ,V.K. (2012) : A Sensitive Spectrophotometric Determination of Nitrite in Water and Soil. *J. Chin. Chem. Soci*. *51*: 195-198.
37) Tiwari, N.C, Sagar, Gyan,T,Dinesh. And Singh ,H.R.(1991): Monitoring of water pollution in snowfeed river Alaknand Rudraprayag at Chmoli. *Env . Eco.* 9,1:202-206.
38) Trivedi,R.K. (2000 Pollution and Biomonitoring of India rivers, First Edition, Ashish Piblishing House, New Delhi, 1-29.
39) Vinodhini, R. and Narayanan, M. (2008): Bioaccumulation of heavy metals in organs of fresh water fish. *Int. J. Env. Sci. Tech.,* 5 2: 179-182.
40) Yadav, S., Firdaus,T., Kumar, A, Alauddin, S. (2012) Spectrophotometric study of Iron, Nitrate and Phosphate in the River Gomti of Jaunpur City, *Int.j. Sci. Res.,* 1:6