IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Seasonal variation in water quality of River Gandak, Bihar, India

[1]Atul Kumar Sinha, [2]S.K.Sinha
[1]Assitant Professor, [2]Associate Professor
University Department of Geology
Binod Bihari Mahto Koyalanchal University, Dhanbad

Abstract: The study explains water quality of River Gandak, Bihar, India. Seasonal changes in the water quality of the river observed during Monsoon, several water quality parameters show considerable changes due to increased run- off from the catchment and other seasonal factors. A few parameters responsible for temporal variation in water quality of the river Gandak was rendered by these parameters. Water temperature, pH, turbidity, electrical conductivity,sulphate, phosphate,free CO_2, total iron,total alkalinity, total hardness, nitrogen-nitrite, nitrogen-nitrate, carbonate, bi-carbonate,total dissolved solids, total suspended solids, calcium, magnesium, sodium, potassium, chloride, dissolved oxygen(DO), biological oxygen demand(BOD),chemical oxygen demand(COD). The seasonal changes in water quality of the river where due to seasonal effects and catchment characteristics.

Keywords: ***River water quality, river Gandak, Seasonal variation, free CO_2, BOD, COD***

Introduction:

Water quality monitoring and assessment is the foundation of water quality management; thus, there has been an increasing demand for monitoring water quality of many rivers by regular management of various water quality variables(Bartram and Balance 1996; Hirsch et al. 1991). Rivers serve as the most important freshwater resource for human being storing about 2,000 km^3 water globally(Oki and Kanae 2006). They present a continuously renewable physical resources used for domestic, industrial and agricultural purposes, as means for waste disposal, transportation, getting food resources and recreational activities(Boon et al. 1992). Besidesthere human influences, river water quality is also affected wide range of natural influences viz. geological, hydrological and climatic factors (Bartram and Balance, 1996). The quality of water identified in terms of its physical, chemical and biological parameters (Sargaonkar and Despande,2003). Has become of public interest in the world because not only developed countries but also developing countries suffers the impact of pollution due to disordered economic growth associated with exploration of virgin natural resources (Shiferaw and Bantilan, 2004). In India, several studies have documented physico-chemical, biological and toxicological aspects of the water and sediments of Ganga river (Singh and Singh 2007; Mukherjee et al. 1993, Singh et al. 2002; Kumari et al. 2001). Water quality is highly variable which occur not only with regards to their spatial distribution but also over time. Temporal variations in precipitation, surface run off, interflow, groundwater flow, and pumped in and outflows have strong effect on river discharge and subsequently on the concentration of pollutants in river water (Vega et al. 1998). Assessment of seasonal changes in surface water quality is an important aspects for evaluating temporal variations of river pollution due to natural or anthropogenic inputs of point and nonpoint sources (Ouyang et al. 2006). In view of spatial and temporal variation in hydrochemistry of rivers, regular monitoring programmes are required for reliable estimate of water quality (Chapman and Kimstach 1992). The river Gandak (Narayani in Nepal) river flows southeast.TheGandakriver rises at 7620 m in Tibet near Nepal boarder having total basin areas 46,300 km^2 is in India (Rao1995). The river joins the Ganga near Patna from north. Sampling was done near a small town Hajipur having population about 2.0 lakhs. River water receives seawage discharge of the town and run off from the agricultural fields on both the banks. The sampling site was located at mid-stream KonharaGhat approximately 1.5 km from Hajipur town. A crematorium Ghat is situated 200 m above the sampling site.

The river was approximately 400 m wide at this site. The right and left banks were used for cultivation of vegetables and banana. Fishing was also very common at this site.

In the study, we assessed the water quality of Gandak to answer three questions;

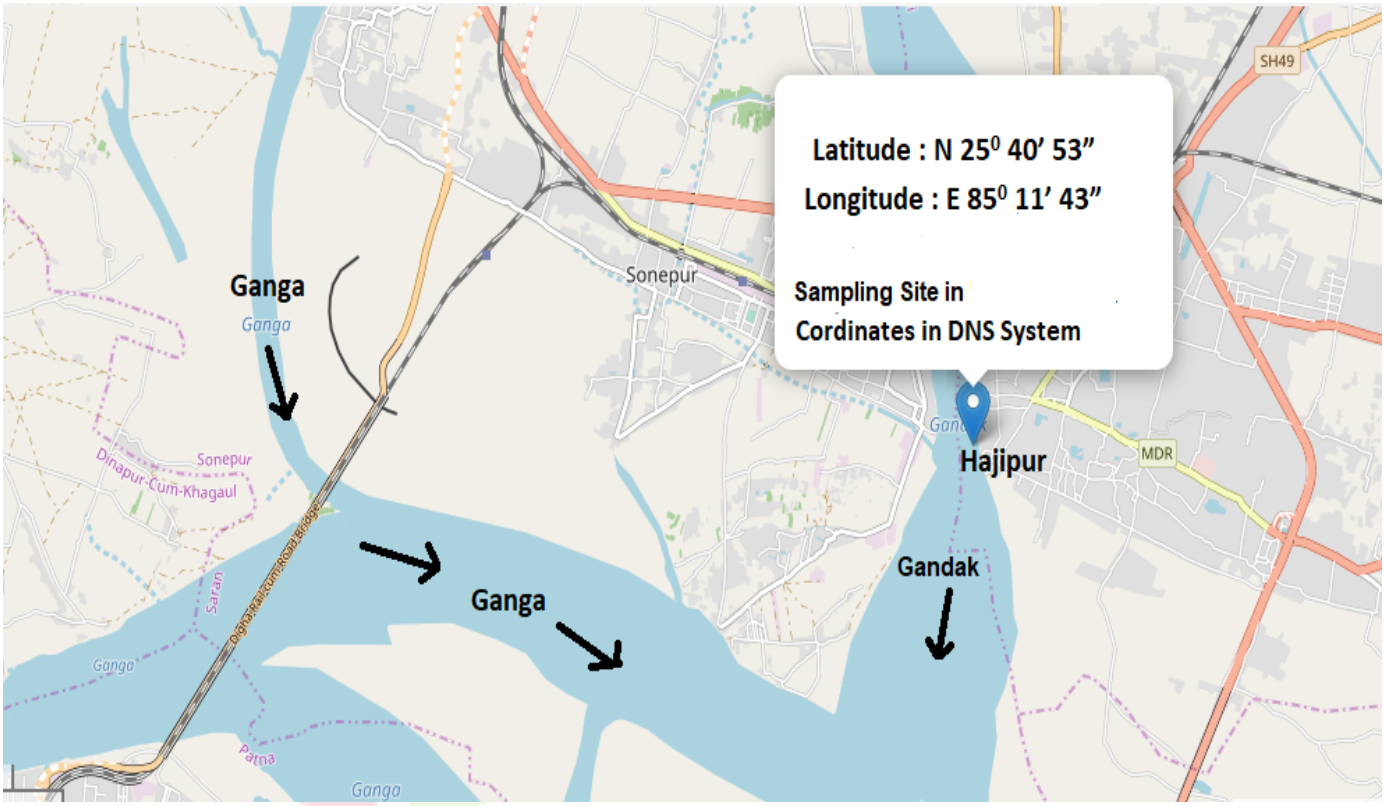
I. What was the status of water quality of the river Gandak?
II. Which parameters were responsible for much of the seasonal variation in river water quality?
III. Did the water quality witness seasonal changes?

Material and Methods:

Study Area: The study area lies in Hajipur townof Bihar with population over 2 lakhs. The average annual rain fall over the middle plains is 104 cm mostly by south-west Monsoon during July to September (Krishna-Murti et al. 1991). The Gandakreceives untreated sewage of the town at this sampling site.

Sampling Sites:

The seasonal variation in water quality of river Gandak at Hajipur town was assessed based on data January 2007 to December 2009. Water samples were collected only in a month.



Sampling Site on Gandak river

Geographical coordinates:

Latitude : N 25^0 40' 53"
Longitude : E 85^0 11' 43"

Water sampling and analysis:

Sampling strategy for monitoring of river water quality was designed to generate significant in information on water quality of the river and also the impact point source of pollution on mid-stream water quality. River water samples were collected every month on 13th day at mid-point of the river sampling sites. Water sample were collected from a depth of 25-30 cm. Collection, preservation and transportation of water samples to the laboratory were as per standard methods (APHA 1998).

All together 24 parameters Water temperature, pH, turbidity, electrical conductivity,sulphate, phosphate, free CO_2, total alkalinity, total hardness, total iron, nitrogen-nitrite, nitrogen nitrate carbonate, bi-carbonate, total dissolved solids, total suspended solids, calcium, magnesium, sodium, potassium, chloride, dissolved oxygen(DO), biological oxygen demand(BOD),chemical oxygen demand(COD) were determined. We used mercury thermometer with 0.1^0C graduation to measure water temperature on the spot. Electrical conductivity and pH were also recorded on the spot using portable tester (Eutech instruments, Malayasia). Dissolved oxygen measure on site employed modified Winkler's method, total alkalinity (TA) was measured on the site following acid titrimetric method using H_2SO_4 as titrant and methyl orange as an indicator. Free CO_2 was also determined by EDTA titrimetric method. Sodium, potassium were estimated using flame photometer, chloride by

argentometric method. Sulphate by turbidimetric method, phosphate by stannous chloride method and COD by open reflux method nitrate was estimated by phenol disulphonic acid method (Trevedi and Goel 1986). All the water quality parameters were expressed in milligram per litre, except pH, EC (µS cm^{-1}), temperature (^{0}C).

Data Analysis:

Monthly values were pooled to get seasonal water quality. Season were categorized into three groups: - summer (March to June), monsoon (July to October), winter (November to February). The physical and chemical property were evaluated using central tendency (mean) and dispersion (standard deviation).

Table 1 Seasonal variation in Water Quality of Gandak River during 2007-2009 (Values are expressed in Mean ± SD)

Parameter	*GandakMid Stream*		
	Winter	**Summer**	**Monsoon**
Water Temp.(°C)	19.17 ± 3.33	27.42 ± 3.57	28.17 ± 2.16
pH	8.36 ± 0.08	8.35 ± 0.09	8.16 ± 0.1
EC(µS/cm)	277.51 ± 42.43	252 ± 48.18	205 ± 20
Turbidity (N.T.U)	18.75 ± 72.95	94.16 ± 78.87	132.6 ± 70.3
Total Hardness (mg/L)	149.66 ± 26.18	131.25 ± 12.25	108 ± 33.3
Calcium (mg/l)	37.37 ± 5.16	32.99 ± 4.48	36.03 ± 13.36
Magnesium (mg/l)	13.78 ± 4.70	13.16 ± 3.74	9.13 ± 2.76
Sodium (mg/l)	12.68 ± 3.42	11.86 ± 5.55	5.53 ± 1.43
Potassium (mg/l)	6.03 ± 0.37	5.87 ± 1.13	6.1 ± 0.93
Chloride (mg/l)	5.60 ± 0.76	5.71 ± 1.75	3.96 ± 0.07
Phosphate (mg/l)	0.09±0.05	0.15 ± 0.1	0.275± .148
Sulphate (mg/l)	29.44 ±	17.64 ±2.45	13.93 ± 3.66
Total Iron (mg/l)	9.77 ± 6.18	10.5 ± 6.03	24.4 ± 8.8
Dissolved Oxygen (mg/l)	8.08 ± 1.03	6.74 ± 1.04	6.1 ± 0.06
Biological Oxygen Demand (mg/l)	1.28 ± 0.27	1.48 ± 0.29	1.3 ± 0.2
Chemical Oxygen Demand (mg/l)	9.12 ± 3.10	11.12 ± 3.88	16.26 ± 2.33
Methyl Alkalinity (mg/l)	122.33 ± 11.22	93.66 ± 13.59	107.3 ± 5.66
Total Dissolved Solid (mg/l)	178.83 ± 40.9	198.41 ± 55.37	320.6 ± 250.3
Total Suspended Solid (mg/l)	319.91±303.09	324.16 ±	942.6 ± 439.6
Carbonate (mg/l)	8.36 ± 1.71	7.65 ± 2.62	3.0 ± 0.09
Bicarbonate (mg/l)	116.75 ± 12.09	92.5 ± 13.41	11.12 ± 10
Nitrite –Nitrogen (mg/l)	0.02 ± 0.02	0.02±0.02	0.05±0.03
Nitrate-Nitrogen (mg/l)	0.018 ±0.1	0.17 ± 0.14	0.46 ± 0.1
Free CO2 (mg/l)	2.34 ± 0.0	1.29 ± .0	5.03 ± 1.68

Result and Discussion:

In general, the seasonal variations are mainly by the changes in water volume during monsoon. The river receives silts and debris from the catchments during monsoon which increases turbidity, suspended solid and chemical oxygen demand, while the large volume of runoff water dilutes the ionic components of the river. Lower value of dissolved oxygen (DO) during monsoon be due to turbid water resulting into less penetration of light in the water to subsequent decreasing photo synthesis activity, higher rate of bacterial decomposition of organic matter and hence, more demand of oxygen for their metabolic activities. High dissolved oxygen (DO) in winter is because of greater dissolution of oxygen in water at lower temperature. Moreover, photosynthetic activities gets inhanced due to better illumination there by releasing oxygen into water (Ravindra et al. 2003). Variables which are influenced primarily by the effect of rain fall run off can be considered as extrinsic variables while variables influenced by river volume during dry season are considered intrinsic variables and would be expected to exhibit a significant inverse correlation with river volume (Wright 1982). Similar trends of variables have been observed in the Gandak. Since most of the water quality parameters did not very significantly at sites pooled data were used for analysis. Since monsoon season scored positive on this, which separated this season from the other two, it can be clearly interpreted that monsoon was characterized by high turbidity and total alkalinity. Summer season scored positive on this it can be interpreted that this was characterized by high water temperature and sulphate based on data analysis, it is suggested that temperature, total alkalinity, turbidity and sulphate

were the most crucial parameters for temporal variation of water quality of river Gandak. The pH value obtained in Gandak river water suggest that alkalinity is imparted primarily due to bicarbonates (Meybeck et al. 1992). Which can be contributed by carbonate weathering in the catchment area. Turbidity, sulphate and phosphate are also seasonally contributed from the catchment. This is case of the GandakRiver, the season variations are attributed to catchment characteristics and anthropogenic pollution due to discharge of waste water is a regular source throughout the year. High turbidity is the characteristics feature of monsoon due to increased suspended solids contributed with rain water from catchment area and source of high phosphate might be the agricultural runoff. Low temperature in winter is well known season phenomena. Analysis of the data shows contribution of anthropogenic pollution to this river. It means anthropogenic pollution is a regular source throughout the year (Singh et al. 2004, 2005).

Graphical Representation of parameters

Fig 1. Trends of Seasonal Variation in Water Temperature (ºC) at Study Site (Gandak River)

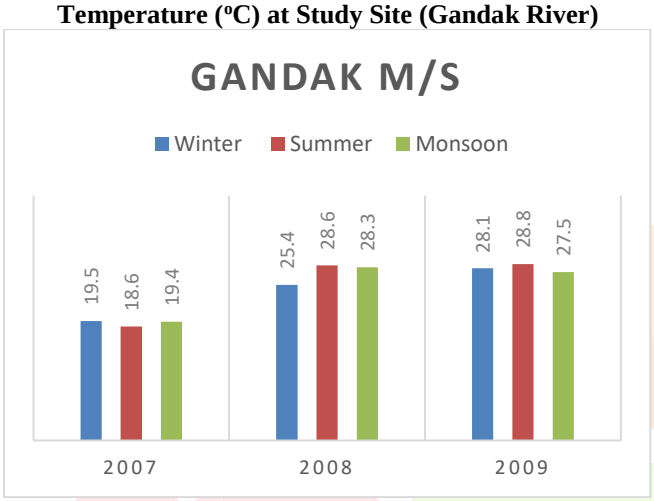


Fig 2. Trends of Seasonal Variation in pH at Study Site (Gandak River)

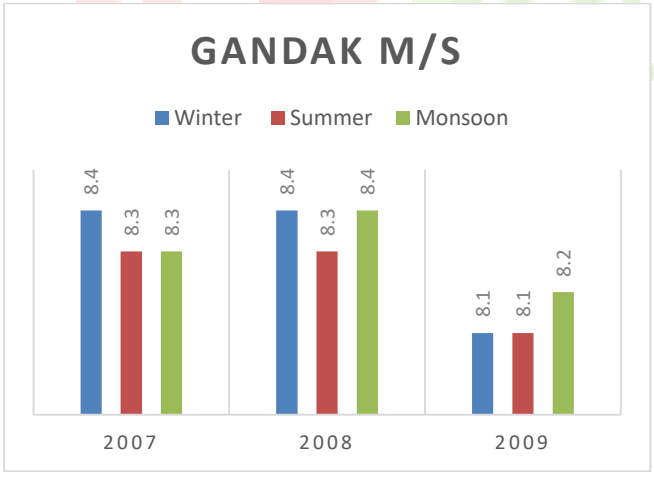


Fig 3. Trends of Seasonal Variation in Electrical Conductivity (µS/cm) at Study Site (Gandak River)

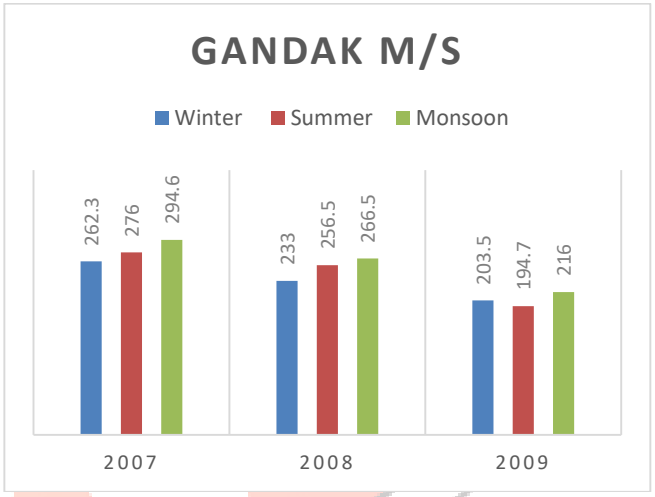


Fig 4. Trends of Seasonal Variation of Turbidity (N.T.U) at Study Site (Gandak River)

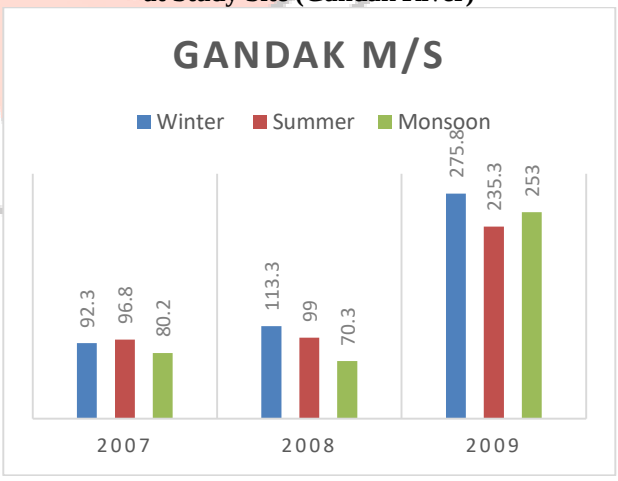


Fig 5. Trends of Seasonal Variation of Total Hardness (mg/L) at Study Site (Gandak River)

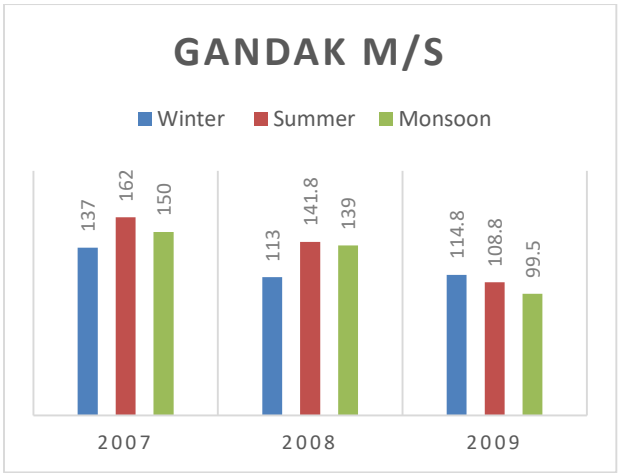


Fig 6. Trends of Seasonal Variation of Calcium (mg/l) at Study Site (Gandak River)

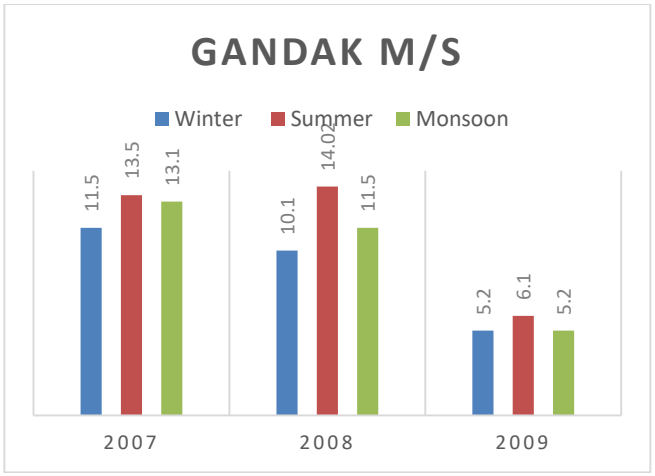


Fig 9. Trends of Seasonal Variation of Potassium (mg/l) at Study Site (Gandak River)

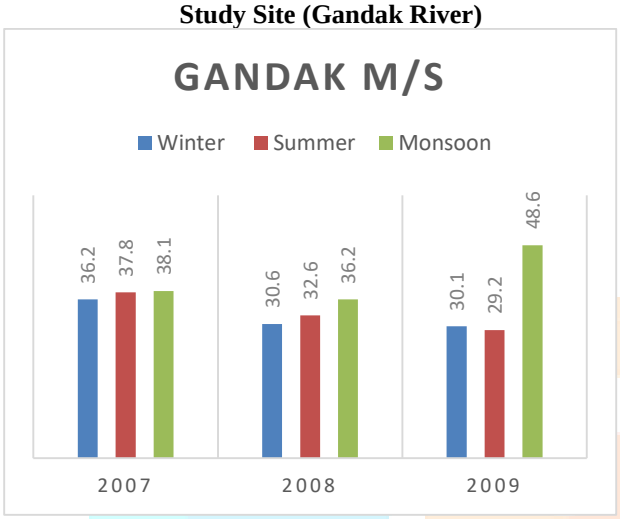


Fig 7. Trends of Seasonal Variation of Magnesium (mg/l) at Study Site (Gandak River)

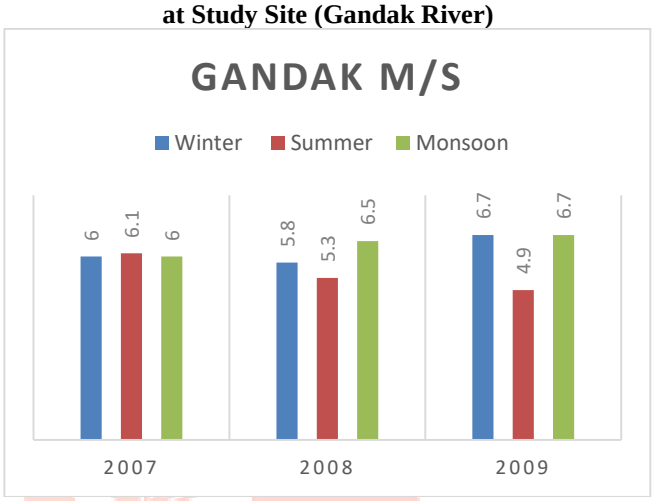


Fig 10. Trends of Seasonal Variation of Chloride (mg/l) at Study Site (Gandak River)

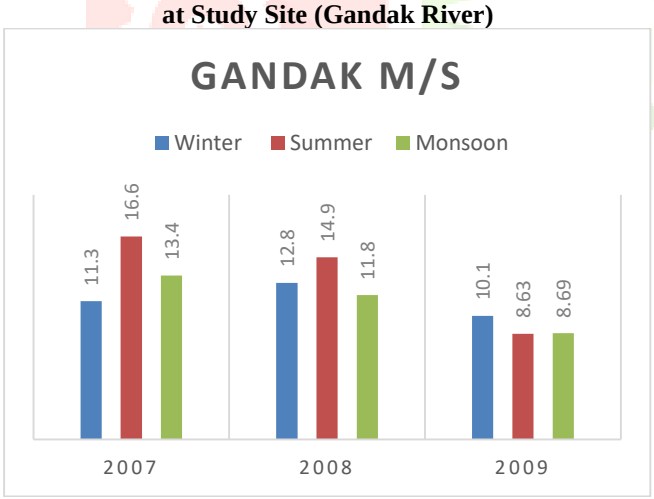


Fig 8. Trends of Seasonal Variation of Sodium (mg/l) at Study Site (Gandak River)

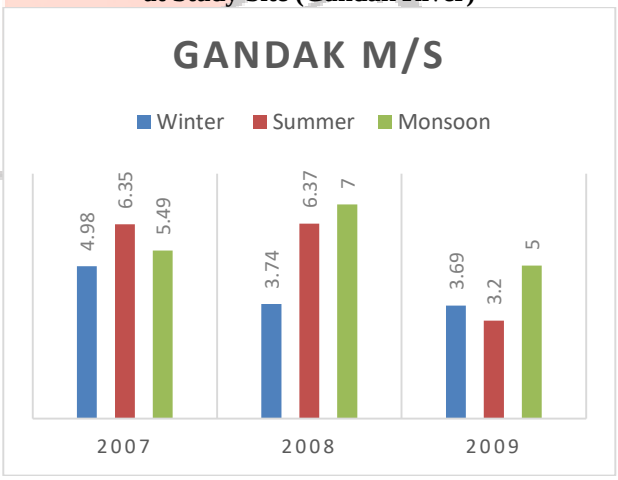


Fig 11. Trends of Seasonal Variation of Phosphate (mg/l) at Study Site (Gandak River)

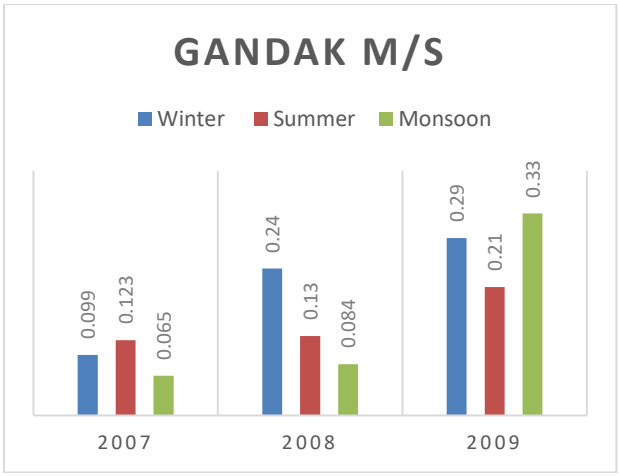


Fig 12. Trends of Seasonal Variation of Sulphate (mg/l) at Study Site (Gandak River)

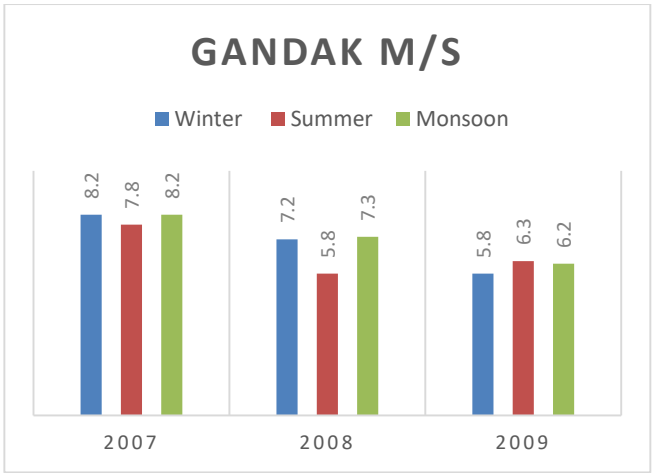


Fig 15. Trends of Seasonal Variation of Biological Oxygen Demand (mg/l) at Study Site (Gandak River)

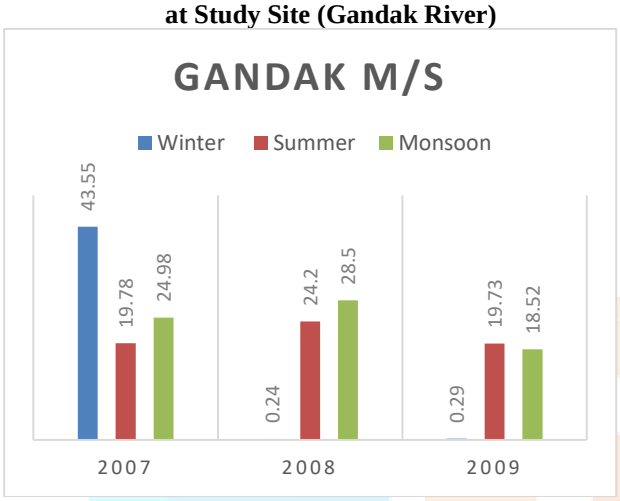


Fig 13. Trends of Seasonal Variation of Total Iron (mg/l) at Study Site (Gandak River)

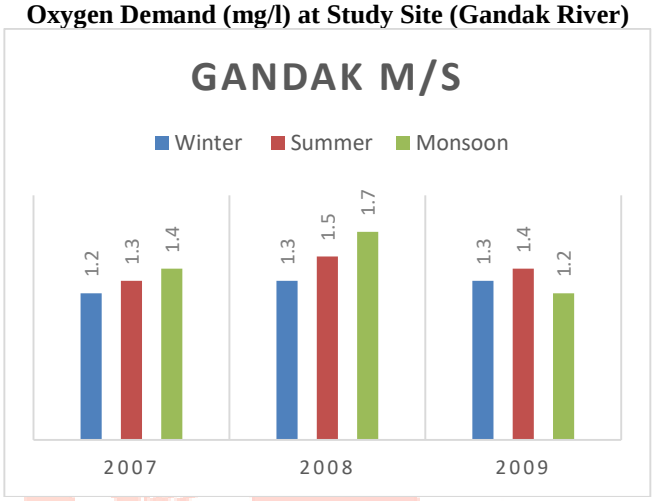


Fig 16. Trends of Seasonal Variation of Chemical Oxygen Demand (mg/l) at Study Site (Gandak River)

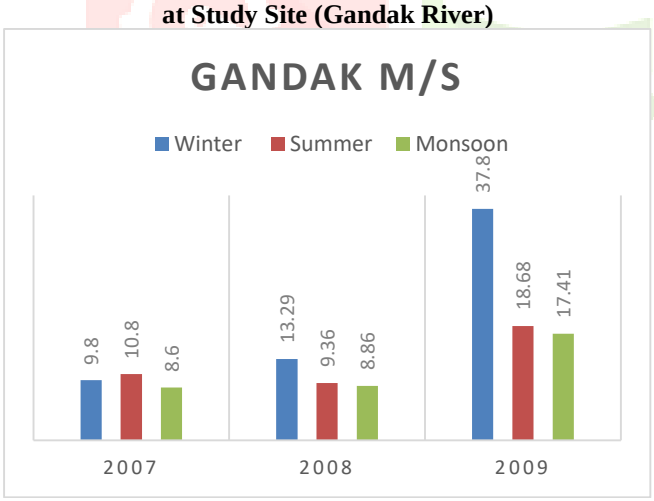


Fig 14. Trends of Seasonal Variation of Dissolved Oxygen (mg/l) at Study Site (Gandak River)

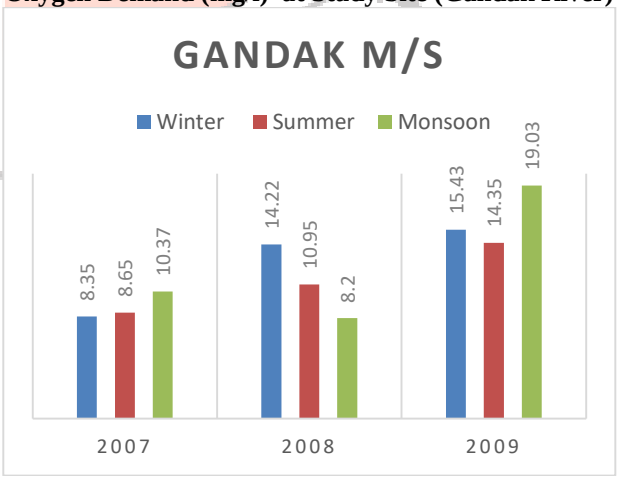


Fig 17. Trends of Seasonal Variation of Methyl Alkalinity (mg/l) Study Site (Gandak River)

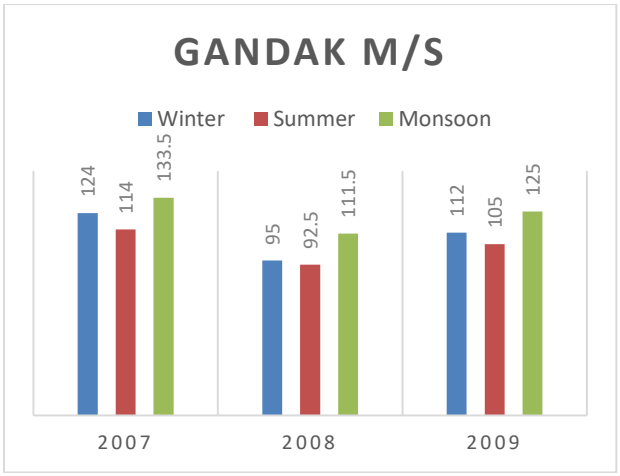


Fig 18. Trends of Seasonal Variation of Total Dissolved Solid (mg/l) at Study Site (Gandak River)

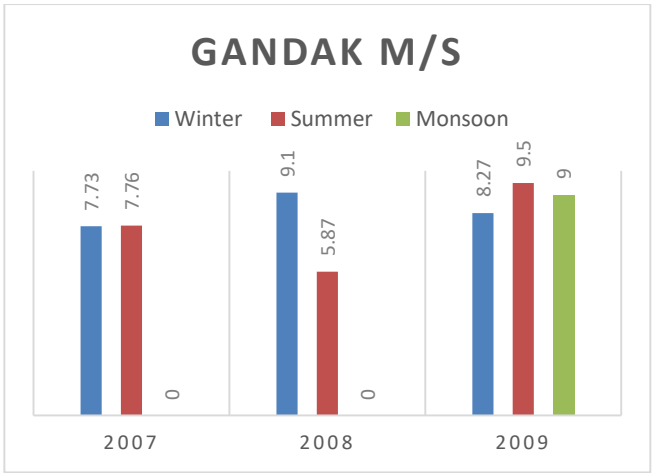


Fig 21. Trends of Seasonal Variation Bicarbonate (mg/l) at Study Site (Gandak River)

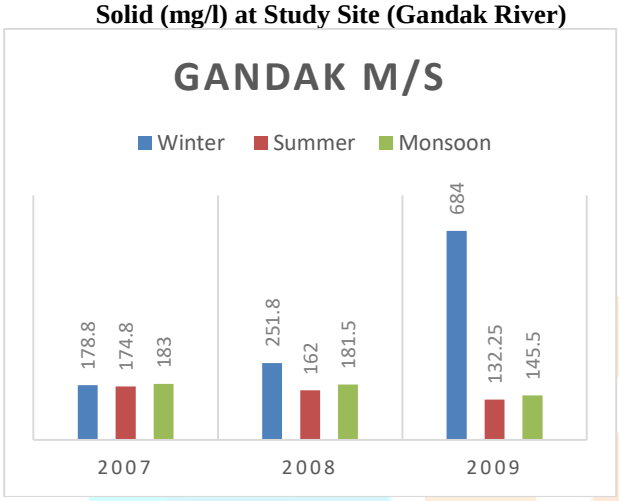


Fig 19. Trends of Seasonal Variation of Total Suspended Solid (mg/l) at Study Site (Gandak River)

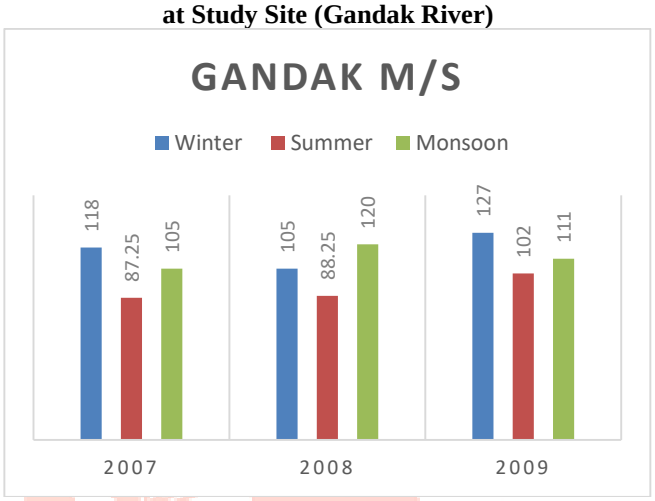


Fig 22. Trends of Seasonal Variation Nitrite –Nitrogen (mg/l) at Study Site (Gandak River)

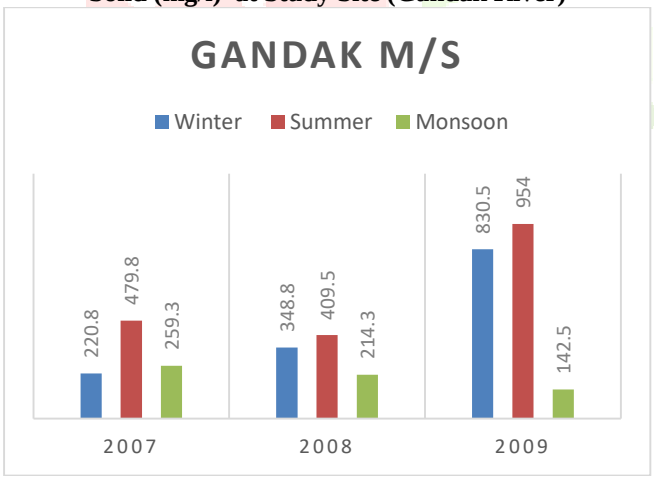


Fig 20. Trends of Seasonal Variation of Carbonate (mg/l) at Study Site (Gandak River)

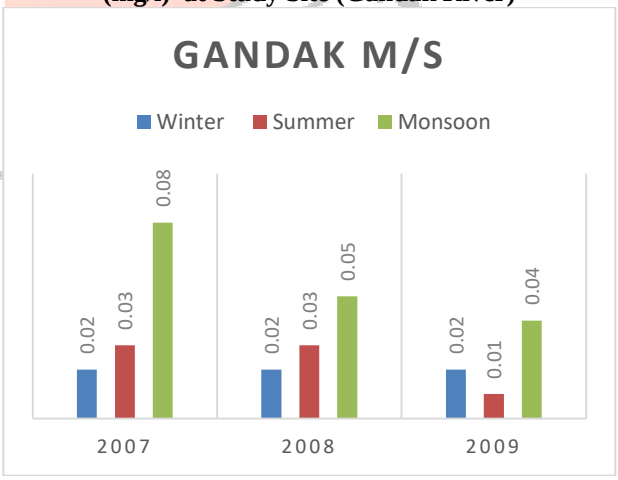


Fig 23. Trends of Seasonal Variation Nitrate-Nitrogen (mg/l) at Study Site (Gandak River)

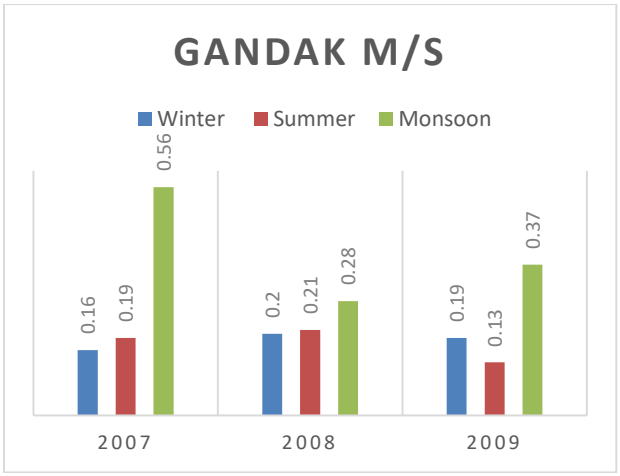
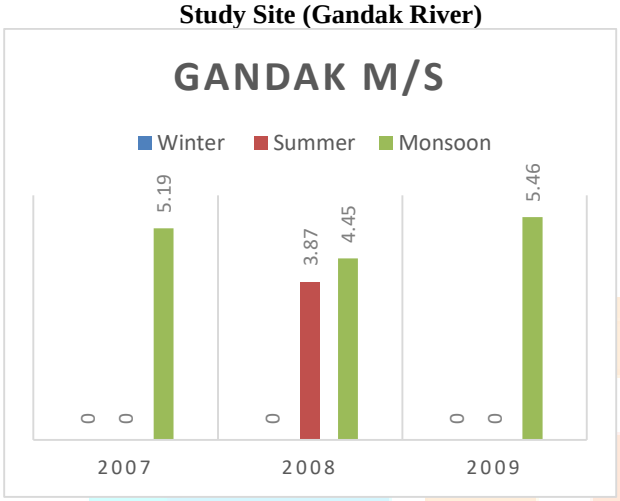


Fig 24. Trends of Seasonal Variation Free CO_2 (mg/l) at Study Site (Gandak River)



Conclusion:

The study shows that water quality of the river Gandak was influenced by seasons. The season change in water quality of the river Gandak were imparted mainly due to the catchment characteristics and season effects. It also reflected that the anthropogenic activities influenced water quality of the river round the year.

Acknowledgements:

Financial supports of National River conservation Directorate, Ministry of Environment and Forests,Government of India is duly acknowledged. The members of Environmental Biology Laboratory,Department of Geology,Patna University extended help in sample collection and analysis.

References:

APHA(1998).Standard methods for the examination of water and wastewater(20th ed.)Washington, DC: American Public Health Association, American water works Association and Water works Association and water Pollution Control Federation.

Bartram, J., & Balance, R. Water quality monitoring—a practical guide to the design and implementation of freshwater quality studies and monitoring programmes.Geneva: UNEP and WHO.

Boon, J., Calow,P&Petts,G.E (1992). River conservation and management.Chichester: Willey.

Chapman, D., &Kimstach, V. (1992). The selection of Water Quality variables. Water quality assessment. Londod:Chapman&Hall.

CPCB. (2005). Water quality criteria. New Delhi; Central Pollution Pontrol Board.

Hirsch, R.M.,Alexander,R.B.,&Smith,R.A.(1991). Selection of methods for the detection and estimation of trends in water quality. Water resources research, 27(5), 803-813.

Krishna Murti, C.R.,Bilgrammi,K,S,Das,T.M., &Mathur,R.P(1991). The Ganga: A scientific study. New Delhi: Ministry of Environment and Forests, Government of India, Published for the Ganga Project Directorate.
Kumari, A.,Sinha ,R.k.,&Gopal,k.(2001). Concentration of HCHs in the sediments samples from the river Ganga in Bihar, India. Research journal of Chemistry and environment, 5(1), 73-74.

Meybeck,M.,Friedrich, G.,Thomas, R.,&Chapman,D.(1992).Rivers, in water quality assessment. London: Chapman & Hall.

Mukherjee,D.,Chattopadhaya,M.,&Lahiri,S,C.(1993).Water quality of the river Ganga(The Ganges) and some of its physicochemical properties. Environmentalist, 13,199-210.

Oki, T., &Kanae, S (2006). Global hydrological cycles and world water resources. Science, 313(5790), 1068-1072.

Ouyang, Y., Nkedi-Kizza, P., Wu, Q.T.,Shinde, D., & Huang, C. H. (2006). Assessment of seasonal variations in surface water quality. Water research, 40(20), 3800-3810.

Rao,K.L.(1995) India's water wealth:ItsAssessment,uses and projection.Reprinted,Orient Longman Limited, New Delhi.

Ravindra, K., Ameena, Meenakshi, Monika, Rani, and Kaushik, A. (2003). Seasonal variations in physico-chemical characteristics of River Yamuna in Haryana and its ecological best designated use. Journal of environmental monitoring, 5, 419-426.

Sargonkar, R., & Deshpande, V. (2003). Development of an overall index of pollution for surface water based on a general classification scheme in Indian context. Environmental Monitoring and Assessment, 89, 43-67.

Shiferaw, B., &Bantilan, S. (2004). Agriculture, rural poverty and natural resources management in less favored environments: Revisiting challenges and conceptual issues. Journal of food & Agricultural & Environmental, 2(1), 328-339.

Singh, M., Muller, G., & Singh, I.B. (2002). Heavy metals in freshly deposited stream sediments of rivers associated with urbanization of Ganga plain, India .Water, Air, Soil Pollution, 141, 35-54

Singh, K.P., Malik, A., Mohan, D., & Sinha, S. (2004). Multivariate statistical and temporal variations in water quality of Gomati River (India) - a case study. Water quality assessment and apportionment of pollution sources of Gomati River (India) a case study. .Water Research, 38(18), 3980-3992

Singh,K.P.,Malik, A.,& Sinha's.(2005).Water quality assessment and apportionment of pollution sources of Gomati river(India) using multivariate statistical technique, a case study .Analytica chemical acta,538,355-374

Singh, K.P., Malik, A., Singh, V.K., basant, N., & Sinha, S. (2006). Multi-way modeling of hydro-chemical data of an alluvial river system- A case study. . AnalyticaChemicaActa, 571,248-259.

Singh, M., & Singh, A.K. (2007). Bibliography of environmental studies in natural characteristics and anthropogenic influences on the Assessment, 129,421-432.

Singh, A., Ghosh, S., & Sharma, P. (2007). Water quality management of a stretch of river Yamuna: An interactive fuzzy multi-objective approach. Water Resources Management, 21(2), 515-532.

Singh,J., Agrawal, D.K., &Panwar, S. (2008). Seasonal Variations in Different Physico-Chemical characteristics of Yamuna river water quality in Proposed Lakhwar hydropower project influence area. International Journal of Applied Environmental Sciences, 2(1).107-117.

Trivedi,R.K.andGoel,P.K.(1986). Chemical and Biological method water
Pollution studies.Environ.publs. Karad,India.

Vega, M., Pardo, R., Barrado, E., &Deban, L., (1998). Assessment of seasonal and polluting effects on the quality of river water by exploratory data analysis. Water Research, 32, 3581-3592.

Wright, R. (1982). Seasonal variation in water quality of a West African River (R. Jong in Sierra Leone). Revue d'hydrobiologietropicale, 15(3), 193-199.