ANALYTICAL AND STATISTICAL ANALYSIS OF RIVER GOMATI IN LUCKNOW (UP) INDIA

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Abstract : In this research work 14 physical and chemical parameter which are generally found in water such as pH,TotalHardness,Carbonate,Bicarbonates,ElectricalConductivity,Chloride,Fluoride,Phosphate,Sulphate, Nitrate, Potassium, Calcium and Magnesium were analyzed to determine current status and water quality of river Gomati with the help of analytical and statical analysis. In this study it was concluded that except some of the analyzed parameters, maximum parameters were found to be within permissible limit prescribed by BIS and the parameter which were found above permissible limit were Ph maximum level 8.9 at Daliganj ,Total Hardness (TH) maximum concentration 345 mg/l at Pakka Pull and Magnisium (Mg) the maximum concentration of magnesium was monitored at Pakka Pull 51.6 mg/l and minimum at Ghaila Setu 30 mg/l. 8 parameters out of 11 parameters are showing high variance level in comparison with BIS limit. this shows that the condition of Gomati river water from last 12 years was not so good and getting degraded day by day due to lack of preventive measures that should be taken for controlling river water pollution and negligence of the rules made by the authorities. It leads to health issues increasing day by day as well as degrading and creating imbalance in the aquatic life system also.

***IndexTerms - BIS, Dispersion Analysis, Analytical Analysis, Water* Quality -**

I. INTRODUCTION

The river Gomati originates from Gomati Taal which was formally known as Fulhaar Jheel near Madho Tanda Pilibhit, India. It extends to 900km through Uttar Pradesh and meets the Ganga river near Saidpur , Kaithi in Gazipur it water coverage is about 22735 sq. kilometer. The cities of Lucknow, Lakhimpur Kheri ,Sultanpur and Jaunpur are located at the bank of Gomati are most prominent of the town located in its catchment area (Kumar et al 2013). Its flow mainly depends upon occurrence of rain and therefore the flow in river is very lenient during monsoon the river collects domestic and industrial wastes from various sources as it flows from highly populated area of Uttar Pradesh high pollution level have negative impact on the ecosystem destroying aquatic life.

II. Before reaching Lucknow Gomati receives waste from sugar and distillery industries of Sitapur all industries out flow their effluent directly in river Gomati (Singh 2001).

III. The Gomati receives high pollution load from different point and non- point sources .it receives untreated raw waste water and industrial effluent through its five major tributaries and 40 drains in Lucknow (UPPCB, 2013).

IV. Domestic sources are washing of clothes and animals. the quantity of domestic sewage and industrial waste produced in Lucknow reported by UPPCB 2015 is about 325mld .only one treatment plant was located at Gaughat to receive the sewage from Sarkata Pata and Nagaria as well as from Gaughat have 42 MLD capacities constructed under Gomati action plan for sewage treatment and therefore large quantity of sewage is discharged directly without treatment into various places through sewage pumping stations (Shrivastava et al. 2015).

The water quality affected both by biological and chemical contaminants lead to very dangerous effects on living organisms consuming polluted water. Therefore it is necessary to monitor the river water quality to determine the level of pollution so that necessary treatment would be given for to make water safe for consumption for all living beings and to save aquatic life also.

Water quality monitoring (WQM) is of particular importance in environmental monitoring. Every living creature needs water to survive (WHO, 2011). About 71% of the earth surface is covered with water, whereas 24% is made up of land mass (Alkandari et al. 2011)

Therefore in this research work the main objective is to analyze the level of some of the important physical and chemical parameter which are generally found in natural raw water such as Ph , Conductivity, Carbonate (CO_3), Bicarbonate (HCO_3),Total Hardness (TH), Calcium(Ca) ,Magnesium(Mg), Sodium(Na),Chloride(Cl),Nitrate Nitrogen(NO_3),Phosphate(PO_3), Potassium(K),Sulphate (SO_4),Conductivity.

II. DETAIL OF STUDY AREA

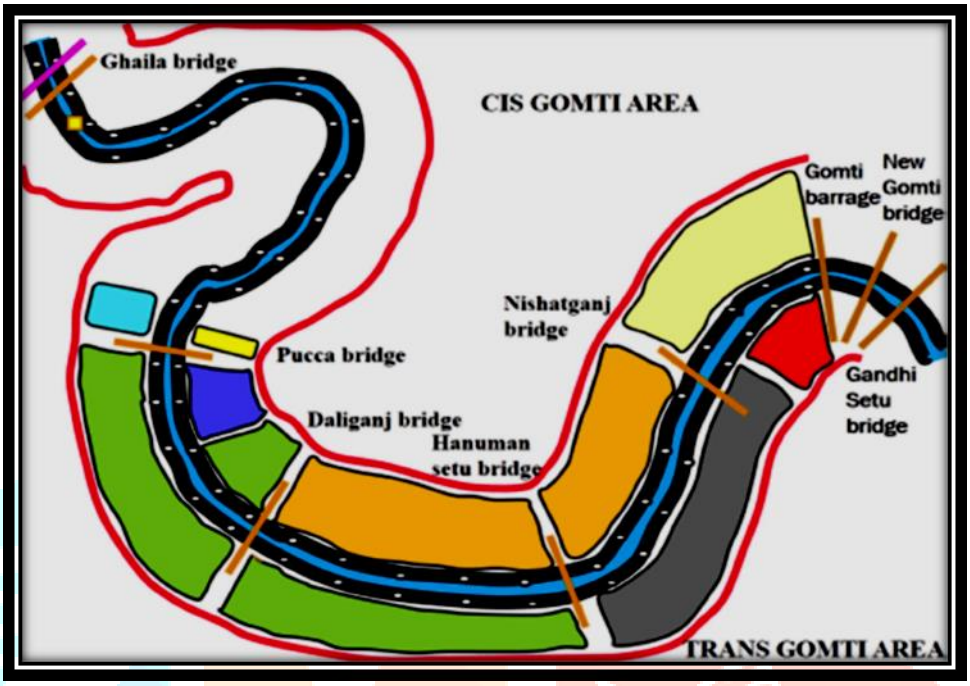
In this study Gomati river stretch is selected for study from four different locations in Lucknow district, the detail about it is given as under.

S1) Ghaila Setu Boating Point -Latitude**: N** 26 Degree 52 Minutes 21.13 Second Longitude: **E** 80 Degree 51 Minutes 20.76 Second. This point is very clean than other three points less polluted than other three locations due to lack of waste into river.

S2) Hanuman Setu-Latitude: N 26.8605 51minutes and 37.76 Second and Longitude 80.9378 Degree 56 Minutes and 15.3S 5 Seconds. Hanuman Setu bridge It was constructed on the river Gomati near hanuman temple so many people came there for bathing and worshipping and throwing various kind of waste.

S3) Daligunj – Latitude: N 26 Degree 52 Minutes 732 Second And Longitude E 80 Degree 55 Minutes 37.46 Second. In this area river water is getting depleted and more polluted than other three sites

S4) Pakka Pull - Latitude: N 26.872838 Degree 52 Minutes 22.22 Second Longitude: **E** 80.9164 Degree 54 minutes 58 .19 second. It is also a bridge constructed over Gomati River. Here washer men used to wash clothes and river was so much polluted here due to excess nutrient Supplied through detergents and human waste.



Sources : Uttar Pradesh Pollution Control Board

Figure 1.1 Showing sampling sites on river Gomati in Lucknow Uttar Pradesh

III.RESEARCH METHODOLOGY

3. MATERIAL AND METHOD

The Gomati river water samples were analyzed for 14 parameters in the analytical laboratory of central ground water board Lucknow .Various physical and chemical parameters like temperature ,ph,EC,CO_3^{--},HCO_3^-,CL^-,F,NO_3^-,SO_4^{--},TH, Ca^{++},Mg^{++},Na^+,K^+,PO_4.have been monitored for 4 different sites of river Gomati .

3.1. SAMPLING AND ANALYTICAL ANALYSIS

Sample Collection Procedure:

1) Plastic bottles of 1 liter capacity with stopper were used for collecting samples .

2) Each bottle was washed with 2% nitric acid and then rinsed three times with distilled water

3) Then kept in clean place for preservation.

Sampling Technique:

Grab sampling:-Discrete grab sample is one that is taken at a selected location, depth and time and then analyzed for the constituent of interest.

4) Discrete grab sampling was adopted for taking raw water sample from river Gomati from four sampling point. Usually grab sampling was done for unstable parameters in this sampling method sample was taken from one point.

5) The bottles were filled leaving no air space and then the bottles were sealed to prevent any leakage.

6) Each container was clearly marked with the name and date of sampling.

Methods:

Standard method prescribed by APHA was used for the analytical analysis for accurate results of experiments the various method used are given below: Electrometric method was used for measuring ph Conductivity sensor is used for measuring Electrical Conductivity , EDTA titration was used for measuring TH ,starch iodide test was done for measuring chloride, titration was used for measuring carbonate and bicarbonate, UV Spectrophotometer is used to measure SO_4 in water, flame emission photometer was used to determine sodium and potassium concentration in water selective electrode method was used to determine fluoride in water, stannous chloride method was used to determine phosphate in water, titration was used to determine magnesium concentration in water.

S. No	Substance Or (Desirable Limit)	Unit Of Measurement	Requirement(Desirable Limit) As Per BIS 10500:2012
1	Ph		6.5-8.5
2	TH	mg/L	300
3	K	mg/L	100
4	CO_3	mg/L	-
5	HCO_3	mg/L	-
6	Ca	mg/L	75
7	Na	mg/L	200
8	Cl	mg/L	250
9	F	mg/L	1
10	Mg	mg/L	30
11	PO_4	mg/L	-
12	NO_3	mg/L	45
13	EC	µs/Cm	-
14	SO_4	mg/L	200

(Table No. 3.1) Drinking Water Standards as per BIS 10500: 2012 guidelines.

STATICAL ANALYSIS

Statical tool were used to determine mean and the dispersion analysis of the11 parameters of river Gomati from past 12 years time period. For variance range formula was used which is given below

Range= maximum value- minimum value

Mean values of Previous data (sources: UPPCB) of summer season (pre monsoon period

Parameter	Ca mg/l	CL mg/l	CO_3 mg/l	F mg/l	HCO_3 mg/l	K mg/l	Mg mg/l	Na mg/l	NO_3 mg/l	PO_4 mg/l	SO_4 mg/l
BIS limit	75	250	-	1.5	-	100	30	200	45	-	200
Year											
1997	40.85	29.96	0	0.28	323	6.92	85	23	-	0.36	0
1998	40.85	40.94	0	0.27	292	9.26	27	15	-	0.26	0
1999	42.6	35.45	0	0.41	315	11.6	21	12	-	0.37	2.64
2000	37	25.62	0	0.11	252	8.97	15	9.72	-	0.1	10.64
2001	40.75	27.09	0	5.7	252	6.05	18	10.35	-	0.18	0
2002	42.95	30.04	0	0.32	150	6.34	20.88	9.6	-	0.18	0
2003	39.15	28.01	0	0.11	234	6.14	21.68	11.5	-	0	9.72
2004	49.3	398.44	0	0.71	254	8.09	29.49	17.37	-	0.18	0
2005	50.07	28.01	0	0.2	254	10.04	37	18.17		0.24	8.04
2006	34	12	0	0.44	200	7.4	22	24.1	1.31	0.11	28
2007	49	29.9	6.4	0.38	241	8.5	27	26.8	1.77	0.11	27
2008	57	29.9	0	0.77	207	11.5	32.7	26.6	1.56	0.1	26.7

(Table No. 3.2)

IV. RESULTS AND DISCUSSION

4.1 Results 14 Physiochemical Parameter Of the river Gomati were monitored from different sites during pre-monsoon period 6/05/2018 in analytical lab of Central Ground Water board with standard method recommended by (**APHA 2012**) .The concentration of pH , EC, CO_3, HCO_3,Cl,F, , NO_3 ,SO_4 ,TH ,Ca_2 ,Mg+ ,Na+ ,K+ and PO_4 are graphically presented and disused below :

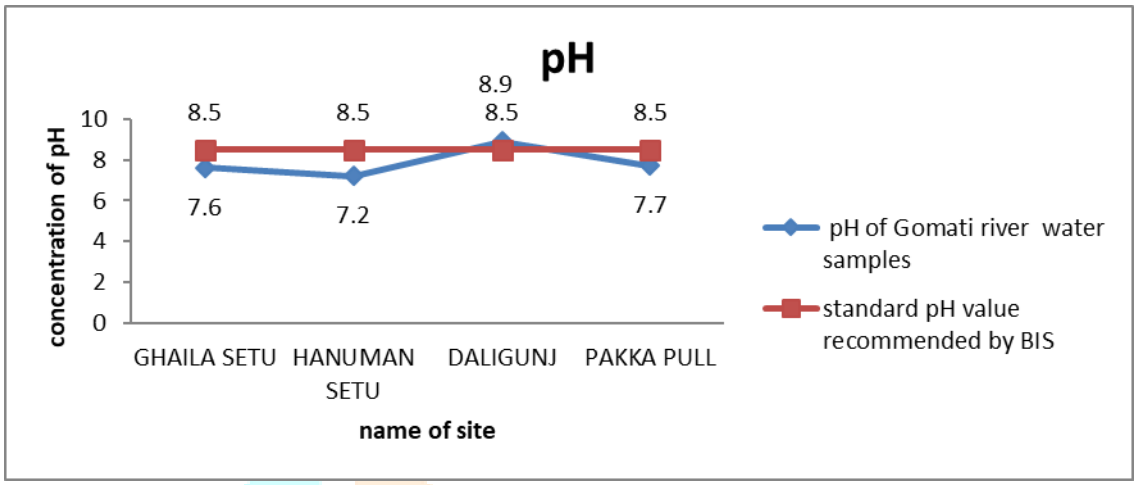


Figure no. 4.1

1)pH-In this study it was observed that the maxi pH of river Gomati was monitored at Daligunj 8.95 which is beyond the permissible limit prescribed by BIS and minimum at Ghaila Setu point 7.7 .High pH level indicates oxygen depletion as well as high alkalinity and presence of carbonate in water. Ph at other location are within permissible limit as per WHO and BIS prescribed limit analytical study of pH in Gomati river was also done by (Kumar et al in 2013)

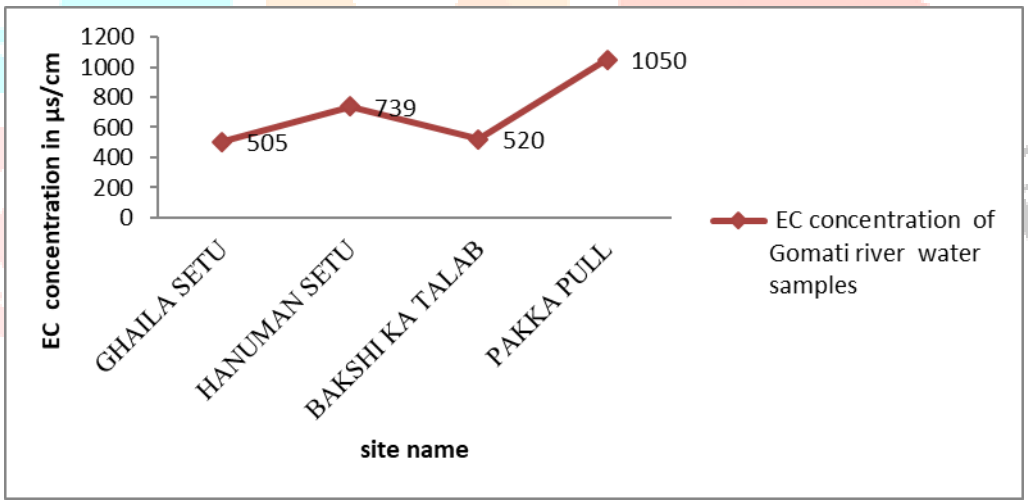


Figure no. 4.2

2) ELECTRICAL CONDUCTIVITY-In this study maximum conductivity was observed at Pakka Pull with level 1050 µs/cm and minimum at Daligunj with level 520 µs/cm .BIS have not recommended any permissible limit for electrical conductivity.
Electrical conductivity of water is a measure of water ability to conduct electricity. The elements whose ionic form contribute to these measure are calcium, magnesium, potassium, bicarbonate, sulphate and chloride. High conductivity indicates presence of high level action and anion in the water. Pure water have low conductivity due to lower concentration of action and anion.

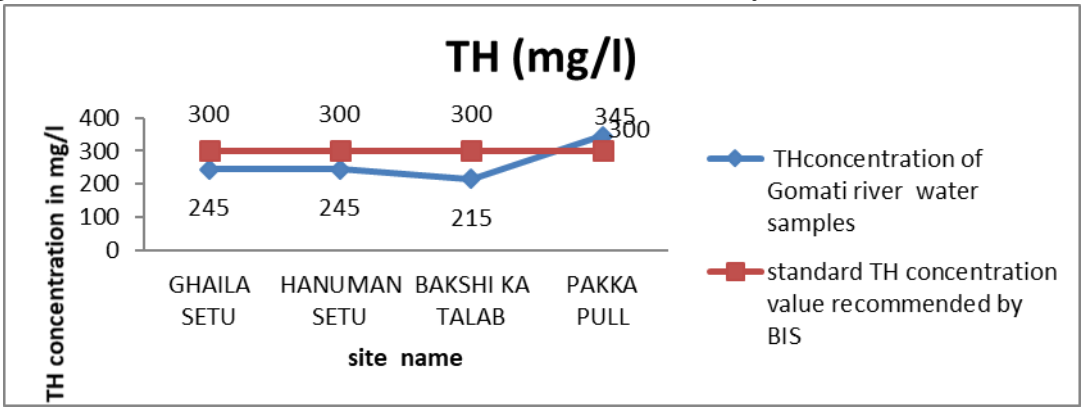


Figure no. 4.3

3) TOTAL HARDNESS- The maxi permissible limit for TH is 300mg/l as per BIS standards for drinking water. The maximum value for hardness was monitored at Pakka Pull 349mg/l which was above permissible limit of BIS and minimum at Ghaila RSAC boating point 245 in previous study done. In pervious study done by (Kumar et al 2013) was maxi at Pakka Pull and at other locations TH is below permissible limit.

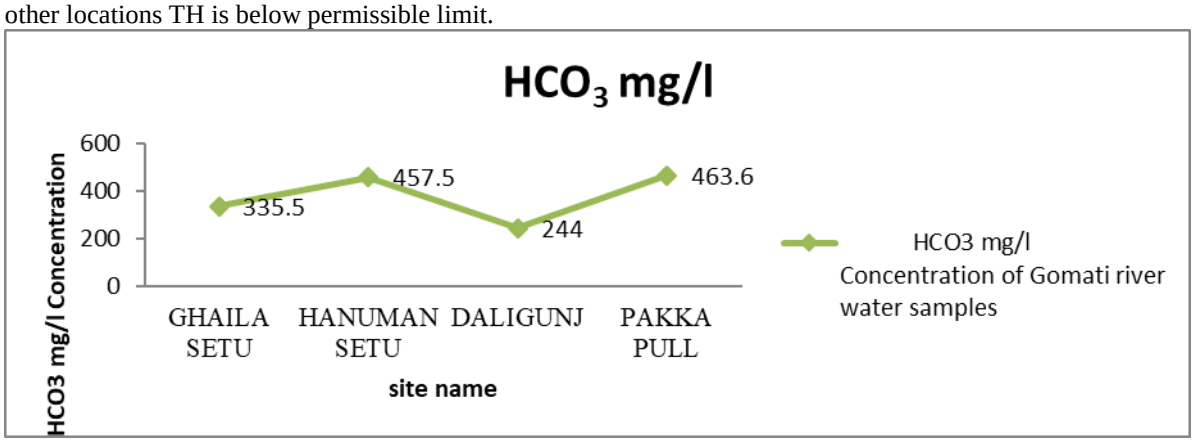


Figure no. 4.4

4) BICARBONATE-Alkalinity of water is used as to know the ability of water to neutralize acid.the maxi value for carbonate alkalinity was monitored at bakashi ka talab at other location the carbonate alkalinity was absent. The maxi value for bicarbonate alkalinity was monitored at Pakka Pull 463.6mg/L and Minimum at Daligunj 244mg/L.

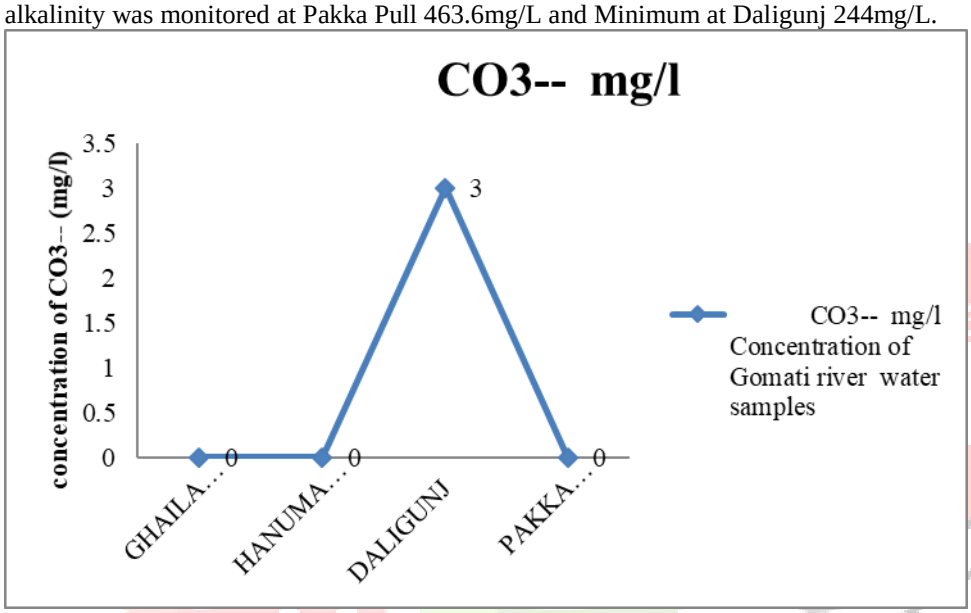


Figure no. 4.5

5) CARBONATE- In the present study carbonate was analyzed at Daligunj. And at other sites carbonate was absent.

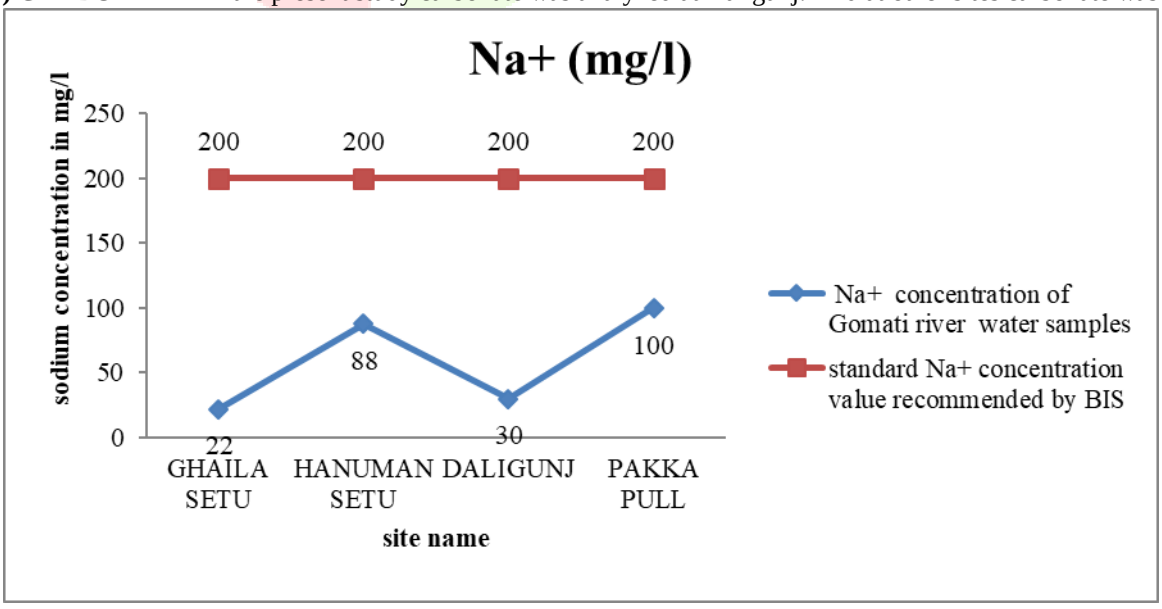


Figure no. 4.6

6) SODIUM- The sodium ranked sixteenth among the element in order of abundance and is present most natural water as per APHA the level of sodium may vary from less than 1mg Na/l to more than 500mg Na/L to more than 500 mg/l Na. High concentration of sodium generally found in hard water and brines

The maximum value for sodium was monitored at Pakka Pull 4.348mg/l and minimum at RSAC boating point 0.957mg/l.The permissible limit for concentration of sodium in raw water recommended by BIS is 200mg/l but has not any ad verse impact on health. In this study the sodium concentration at all site was within permissible limit.

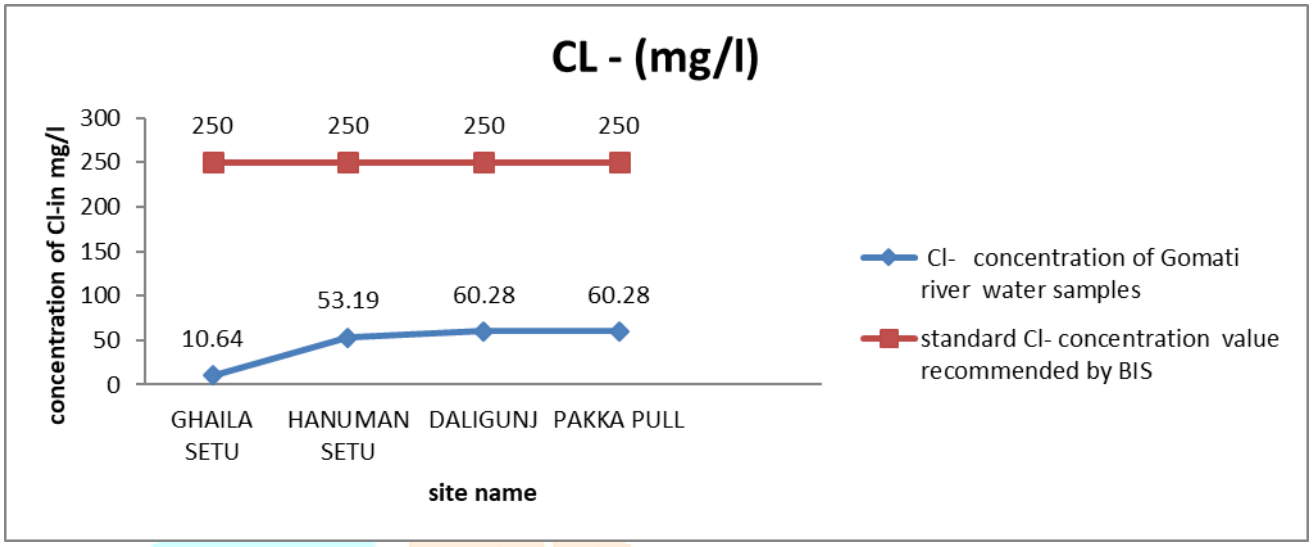


Figure no. 4.7

7) CHLORIDE- In this study the maxi chloride concentration 60.28mg/l was monitored at Daligunj bridge and minimum concentration 10.64 mg/l at Ghalia Setu RSAC boating point which were within permissible limit of BIS standards.

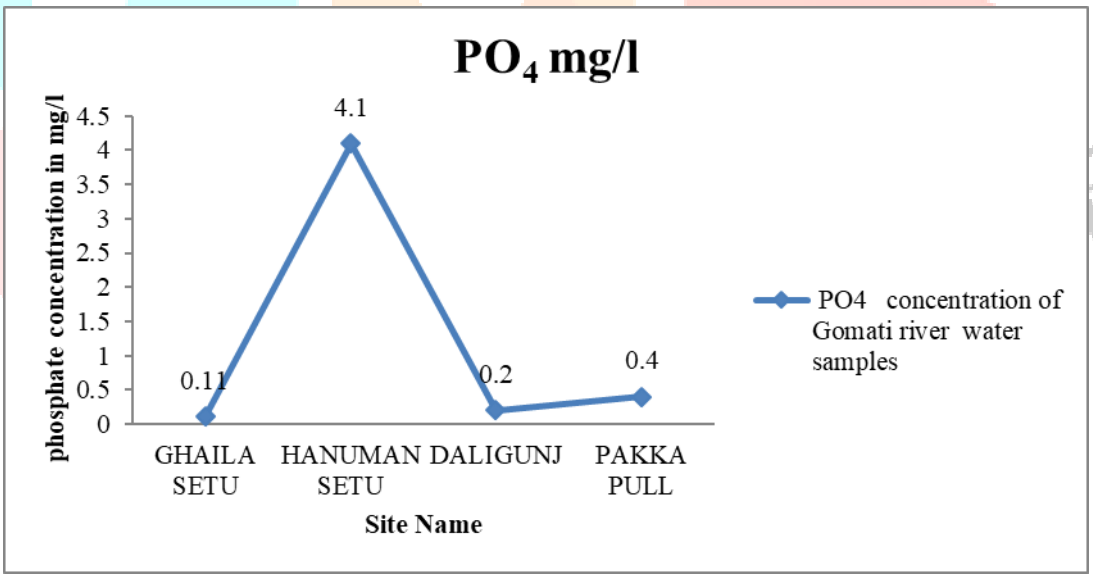


Figure no. 4.8

6) PHOSPHATE-Phosphorus occurs in river water and in waste water naturally and due to anthropogenic activity in the form of various kinds of phosphates these are commonly known as orthophosphate and total phosphate .The various forms of phosphate come into river bodies through effluent and polluted water from a variety of sources. Large quantities of same compound may be added when water is used for laundering since the material are major constituent of many commercial and cleaning preparation. Phosphate in large quantities in water in river water indicates pollution through industrial waste and sewage. .In the present study the graph indicate maximum phosphate concentration at Hanuman Setu 4.1 mg/l and minimum 0.11mg/l at Daligunj.The permissible limit for PO_4 has not been prescribed by BIS but according to UPHAS guidelines maxi phosphate concentration in water should be below 0.1 mg/l.

Otherwise it would be responsible for depletion of oxygen concentration due to excess of nutrient in water eutrophication process exceeds in which it will consume oxygen for their growth causing trouble for other aquatic living organisms in water.

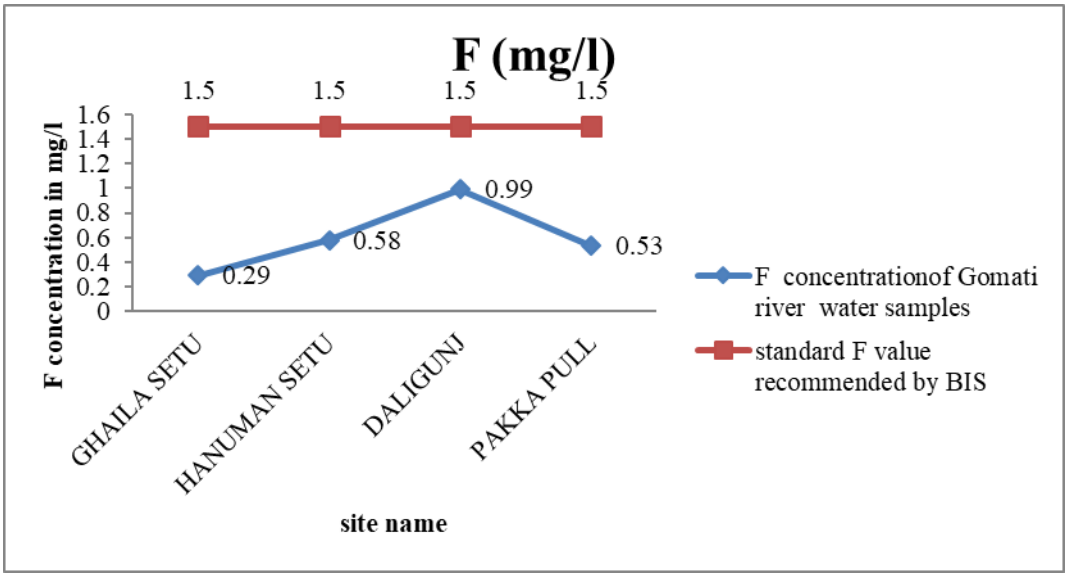


Figure no. 4.9

9) FLUORIDE- Fluorides ions have important significance in potable water. High level of fluorides causes dental fluorosis in which disfiguration of teeth occurs on the other hand its too low level causes Dental caries.(APHA)

Hence it is necessary to maintain concentration of fluoride b/w 0.8mg/l to 1.5mg/l ion potable water as recommended by BIS.In this study the maximum concentration of fluoride was monitored 0.99mg/l at Daligunj and minimum 0.29mg/l at Ghaila Setu RSAC boating point, which is below the minimum prescribed limit given by BIS only at this point. At other locations quantity of fluoride are within permissible limit.

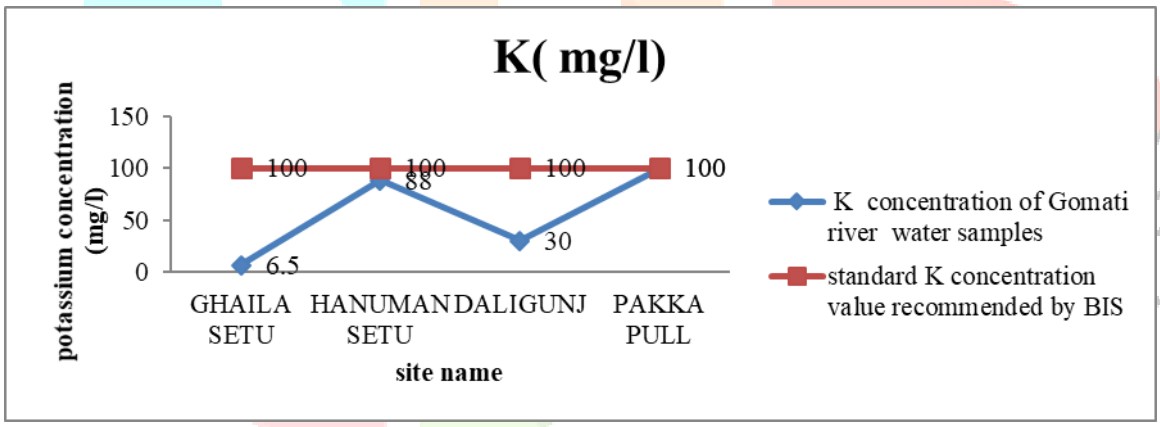


Figure no. 4.10

10) POTASSIUM- Potassium ranks seventh among the element in order of abundance, potassium is an essential element in both plant and human nutrition and occur in groundwater as a result of mineral dissociation.

Permissible limit:-Its concentration in most drinking water seldom reduces 100mg/l as per (APHA) guidelines. In this study the maxi concentration of potassium was 100 mg/l at Pakka Pull and minimum concentration was 6.5 mg/l at Ghaila Setu which are within permissible limit of BIS.

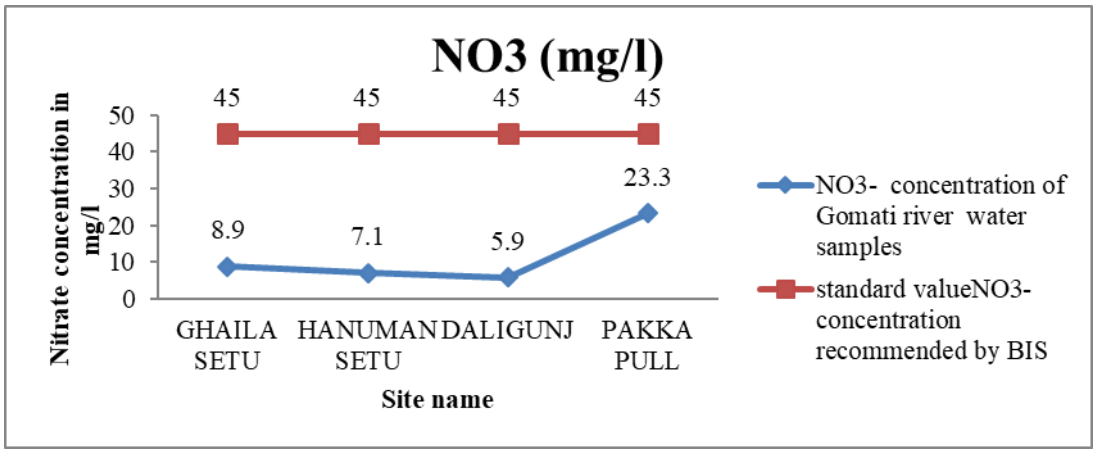


Figure no. 4.11

NITRATE-For drinking water the permissible limit for nitrate is 45mg/l as per BIS standard and 20mg/l as per WHO standard.

In present study maxi value for nitrate was monitored at Pakka Pull 23.3 mg/l and minimum at 1.2 Ghalia Setu RSAC boating point. The value is found above permissible limit at one point only. Other three values are within permissible limit.

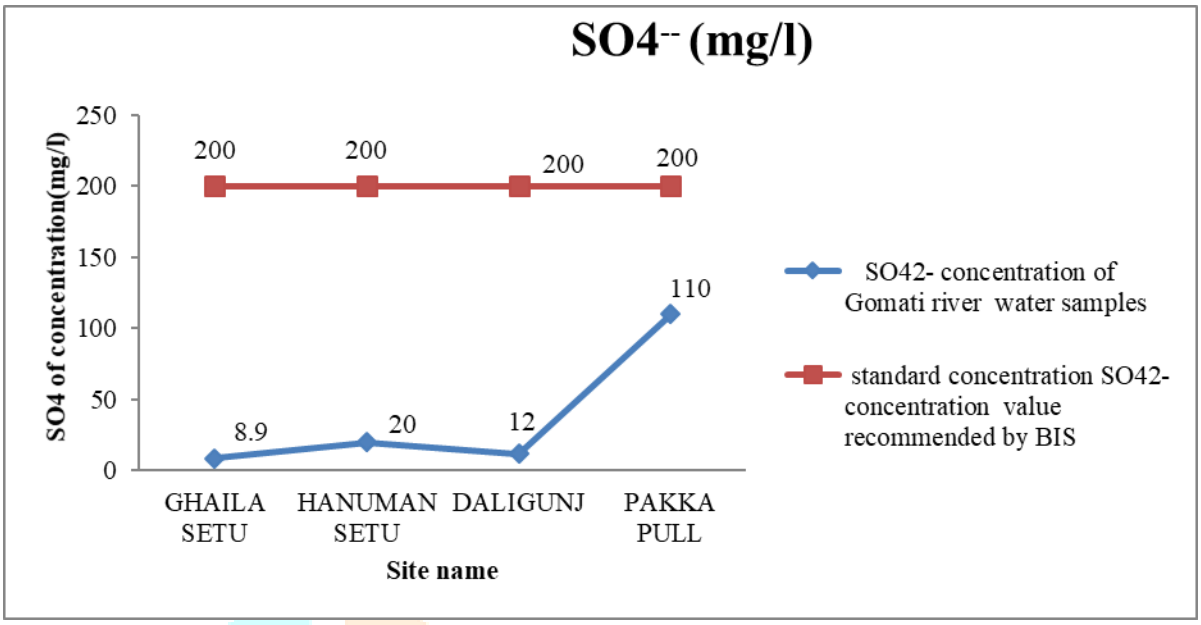


Figure no. 4.12

12) SULPHATE-The maximum concentration of Sulphate was detected at Pakka Pull and minimum concentration was detected at RSAC Ghaila boating point, High value of Sulphate show domestic waste presence of and it will cause gastrointestinal disorders if consumed by humans beings (WHO) and as per BIS and WHO limit of SO_4 in water should not exceed 200mg/l.The concentration at all sites are within permissible limit.

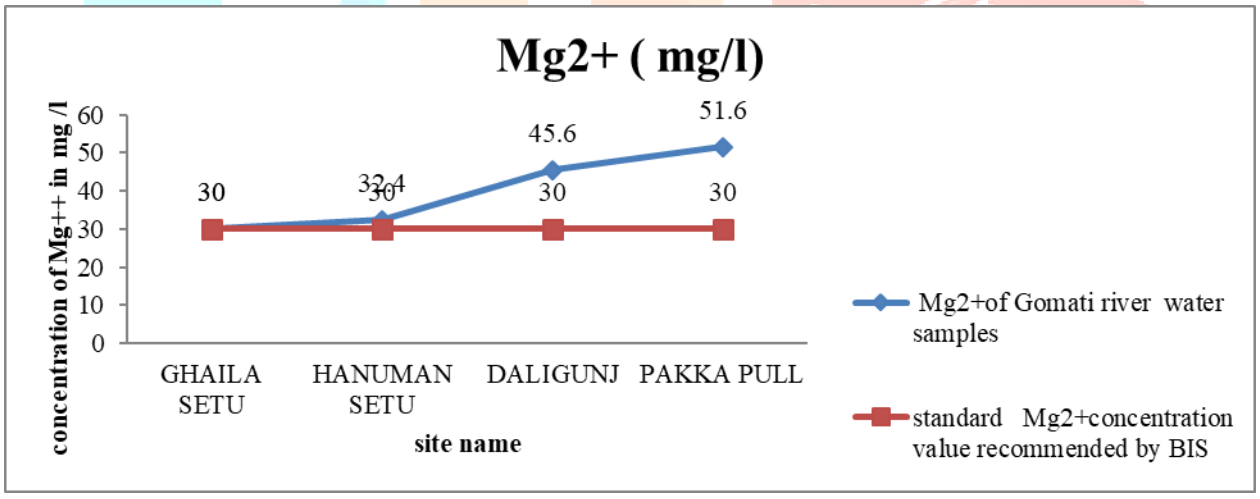


Figure no. 4.13

13) MAGNESIUM - The maximum desirable concentration of Magnesium prescribed by BIS is 30 mg/l.In this study the maximum concentration of magnesium was monitored at Pakka Pull 51.6 mg/l and minimum at Ghaila Setu 30 mg/l.It was observed that the concentration at Pakka Pull, Hanuman Setu and Daligunj is above the maximum permissible limit prescribed by BIS.

High concentration of magnesium indicates hardness of water it may cause a change in bowel habits (Diarrhea) its presence may be due to presence of dolomite mineral containing magnesium. As Per WHO Report (UNICEF/WHO, 2008).

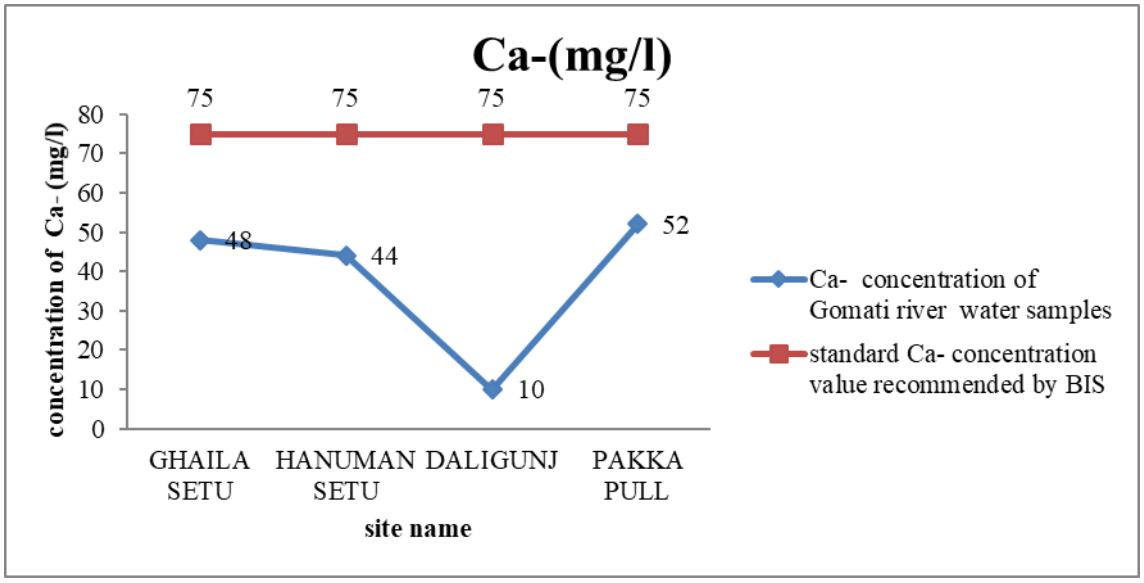
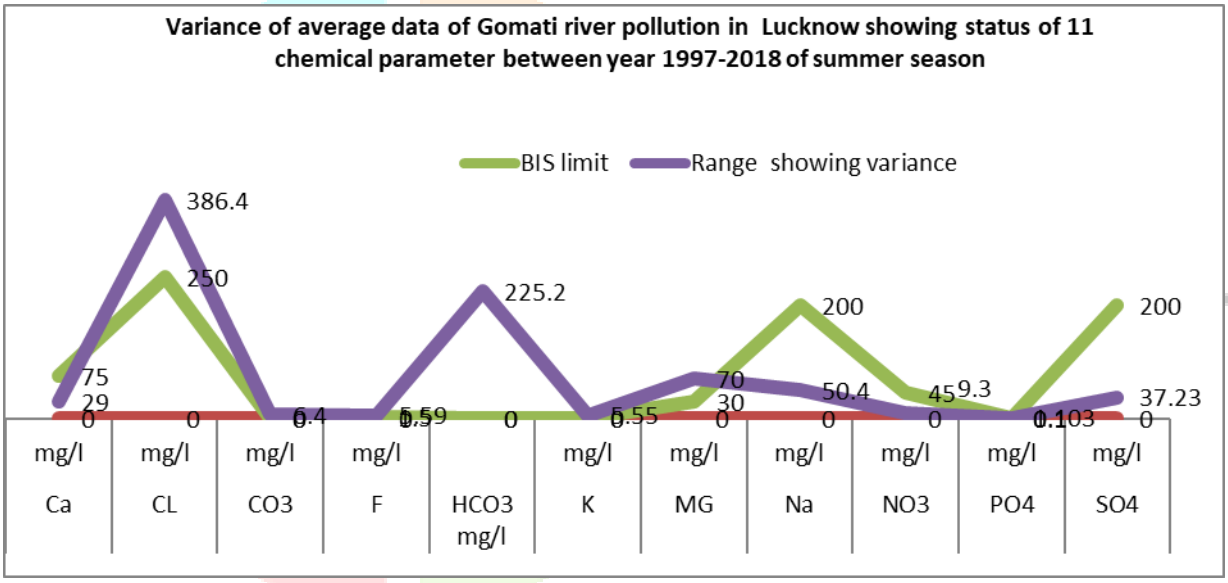


Figure no. 4.14

14) CALCIUM- In the present study It is observed that the maximum concentration of Calcium 52mg/l monitored at Pakka Pull and minimum concentration 10 mg/l at Daliganj.The maxi permissible limit for Calcium prescribed by WHO is 75 mg/l.In this study calcium at all four sites are within permissible limit.



Result of Statical analysis of previous data with the help of statical tool is given below:

Figure no 4.15

Self-analyzed mean value data of 2018	**28**	**46**	**0**	**0.59**	**10.375**	**39**	**60**	**1.203**	**37.225**		
Parameter	Ca mg/l	CL mg/l	CO_3 mg/l	F mg/l	HCO_3 mg/l	K mg/l	Mg mg/l	Na mg/l	NO_3 mg/l	PO_4 mg/l	SO_4 mg/l
BIS limit	75	250	-	1.5	-	100	30	200	45	-	200

Table no 4.1

Statically analysis of water quality based on previous 12 year data with the help of dispersion analysis to analyses variation in parameter with increase in time is shown in the graph. The data of 2008 collected from a study conducted by UPPCB in summer with the average data of 2018 analyzed in this study.

It was shown in the graph that Calcium, Chloride, Fluoride, Carbonate, Nitrate and Phosphate and Magnesium and Sulphate were above the permissible limit.

Calcium- High level of calcium indicates hardness of water.

Impact on human being:-Hard water is not easy to digest it may cause laxative effect on human being result into Diarrhea.

Chloride- High level of chloride indicates leaching of marine sedimentary deposit pollution through industrial effluent from paper ,pulp and textile industries or sea brines and also through domestic wastes and sewage from sewer line.

Impact on human being: - The high chloride concentration may cause various stomach disorders.

Fluoride:-The increase in fluoride concentration indicates presence of high level of fluorine mineral in river water due to insoluble fluorides such as fluorspar CaF_2, cryolite and fluoroapatite $3Ca_3(PO_4)_2.CaF_2$).

Impact on human being:- lower concentration of fluoride lesser than 1mg/l in water may cause dental caries (tooth decay due to cavity formation)optimum concentration. are 0.7 to 12mg/l as per (BIS) the permissible limit of fluoride in water is 1.5 mg/l.

Carbonate:-Presences of carbonate indicates high value of ph above 8.3 or more. It also indicates hardness of water.

Impact on human being:-There is not any negative impact of presence of carbonate in water on human being.

Nitrate:-Presence of nitrate indicates fully oxidized organic matter and presence of sewage with presence and absence of bacteria causing blue baby disease if present in high concentration.

Impact on human being:- The presence of too much nitrate in water may adversely affect the health of infant causing a disease called blue baby disease. Children suffering from this disease may vomit; their skin color may become dark and may die in extreme cases.

Phosphate:- The various forms of phosphate come into river bodies through effluent and polluted water from a variety of sources. Large quantities of same compound may be added when water is used for laundering since the material are major constituent of many commercial and cleaning preparation.

Phosphate in large quantities in water in fresh water indicates pollution through sewage and industrial waste.

Impact on human being: - High level of phosphate in water causes respiratory diseases such as breathing problems and also urinary infection such as kidney failures. (Nyamangara et al.2013).

Magnesium: - High concentration of magnesium indicates hardness of water due to presence of dolomite mineral containing magnesium as per WHO report (UNICEF/WHO, 2008)

Impact on human being:-It may cause a change in bowel habits (Diarrhea) its presence may be due to presence of dolomite mineral containing magnesium as per WHO report (UNICEF/WHO, 2008)

Sulphate:- High value of Sulphate indicate presence domestic waste in large quantity.

Impact on human being: - It may cause laxative effect on human body and Diarrhea.

Conclusion:

In this study it was concluded that except some of the analyzed parameters., maximum parameters were found to be within permissible limit prescribed by BIS (2012) and the parameter which were found above permissible limit were Ph 8.9 at Daliganj, Total hardness (TH) maxi concentration 345 mg/l at Pakka Pull and the maximum concentration of magnesium was monitored at Pakka Pull 51.6 mg/l and minimum at Ghaila Setu 30 mg/l. This indicates high level of detergent, and soap used for washing clothes are present in river water which have negative health impact on the consumers and on comparative analysis of variance of previous data and current data of river Gomati with BIS standard limit. 8 parameters out of 11 parameters are showing high variance level in comparison with BIS limit. this shows that the condition of Gomati river water from last 1 decades was not so good and getting degraded day by day due to lack of preventive measures that should be taken for controlling river water pollution and negligency of the rules made by the authorities. It leads to health issues increasing day by day as well as degrading and creating imbalance in the aquatic life system also.

Recommendation:

1) This study shows that there is high level of variations in parameter of river Gomati from last 14 years. Therefore it is recommended that the domestic waste and sewage should not disposed into river without giving conventional treatments to the effluents. Industrial or domestic waste should be given proper treatment on the basis of analyzed data.

Acknowledgement:

I would like to thanks Mr Anupam Kumar Gautam and Dr. Ajay Bharti (HOD) for guiding me from beginning for this research work and Dr. Ram Prakash in Central Ground Water Board Lucknow UP for providing me analytical lab facilities for conducting water analysis because of whom this project has been completed.

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