

Water Quality Assessment of River Ganga Health Hazard Identification and Control

Singh Rajesh¹, Bahukhandi Kanchan², Mondal Prasanjeet³ Singh Satendra⁴

¹ National Institute of Hydrology, Roorkee, Uttarakhand, India

² University of Petroleum and Energy Studies, Dehradun, Uttarakhand, India

³ University of Petroleum and Energy Studies, Dehradun, Uttarakhand, India

⁴ University of Petroleum and Energy Studies, Dehradun, Uttarakhand, India

Abstract- The present project 'Water Quality Assessment of river Ganga Health Hazard Identification and control' includes tests for, pH value, Electrical Conductivity, Total Dissolve Solid, Hardness, Alkalinity, Chloride, Nitrate, Sulphate, Iron, Sodium, Potassium, Calcium and Magnesium. Result was compared with drinking water standard prescribed by BIS 10500-2012 and all parameters satisfied the prescribed limit given in BIS standard for drinking water. Water Quality of river Ganga from Gangotri to Haridwar is found Pollution free. Spatial variation in river water quality is shown by Quality Contour Map by using Surfer Software 9.0 version. Maximum water quality deviation from mean value is observed at Haridwar which shows the adverse impact of Industrialization, Urbanisation and Rapid growth of population on the river water quality.

Index Terms- water quality, IS: 10500, Electrical Conductivity, Total Dissolve Solid, Hardness, Alkalinity, Chloride, Nitrate, Sulphate, Iron, Sodium, Potassium, Calcium, Magnesium, Surfer 9.0.

I. INTRODUCTION

The River Ganga is a perennial river originating from the Himalayas and flowing through many states before its confluence with Bay of Bengal. The Ganga basin accounts for a little more than one-fourth (26.3%) of the country's total geographical area and is the biggest river basin in India. Ganga plain is one of the most densely populated regions of the world, due to its availability of water, fertile soil and suitable landscapes.

The Ganga has been worshipped by Indians from time immemorial and the practice still continues. The water of the Ganga was considered to be holy, having powers to rid us from all our sins it is also used for various purposes such as drinking, bathing, power generation, recreation, community water supply, irrigation etc. This water is being polluted by indiscriminate disposal of sewage, industrial waste and human activities which affect quality of river water. The increased anthropogenic

activities (Praveen et al. 2012) large scale deforestation and over grazing in the watershed areas of river basins is having adverse impact on river water quality and is affecting the flora and fauna (Joshi et al. 2009). It is a fact that good water quality produces healthier humans. Freshwater scarcity ranks among the most urgent environmental challenges of this century. To water resources management and pollution mitigation plan it is essential to have relevant information on water quality status and trend to describe overall water quality conditions. Therefore it is necessary to monitor and assess the water quality of River Ganga.

It is of utmost importance that the River Ganga be restored to its past glory. It is an urgent need to improve its water quality; this can be achieved by regular monitoring and assessment of water quality. A conscious effort towards reversing the current trends of deterioration of water quality of Ganga is the need of the hour. However, the ability to properly track progress toward minimizing impacts on natural environments and improving access of humans to safe water depends on the availability of data that document trends. As such assessing of water quality of River Ganga is a necessary activity at all governing levels: local, national. Keeping these facts in mind current study focused on assessments including approaches to their identification, analysis and resolution of current water quality status and trends of river Ganga from Gangotri to Haridwar.

II. MATERIAL AND METHODS

A total number of 23 samples were collected of river Ganga from approximate length of 254 Km starting from Gangotri to Bishanpur (Haridwar) and analysed. The samples were collected during winter period with their GPS coordinates during December 2014 and preserved by adding an appropriate reagent (Jain and Bhatia, 1988; APHA, 1992) Full care has been taken to ensure obtaining a sample that is truly representative. Further, the integrity of the sample was maintained from the time of collection to the time of analysis. Descriptions of River water sampling location along with their GPS coordinates are given in

Table 2.1 and these location are also shown in satellite map fig 2.1

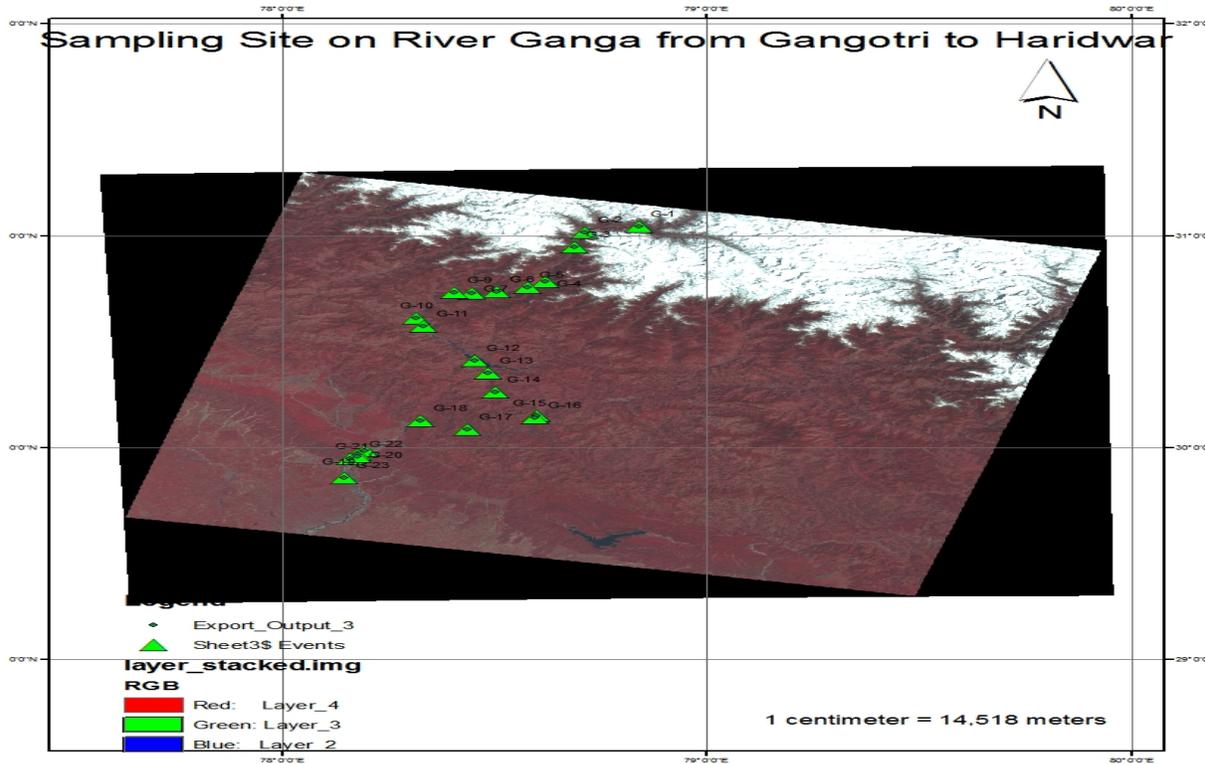


Fig 2.1 Sampling site on satellite map of river Ganga

Table-2.1 Sampling Sites-

Code	Location	Long.	Lat.	Hight (m)	Distance(Km)
G-1	Jangla Bridge	78.84065833	31.0433278	2585	0
G-2	Jhala Bridge	78.71349861	31.0159611	2378	26.490613
G-3	Dabrani Bridge	78.68833889	30.9462333	1966	34.699657
G-4	UK Laghu Vidhut Pariyojna	78.61881389	30.7853278	1430	54.332124
G-5	Nalluna Senj	78.578	30.756875	1320	54.332124
G-6	After Heena Power Station	78.50666667	30.7362603	1208	66.772303
G-7	u/s Uttarkashi	78.44674722	30.7295	1076	75.606229
G-8	d/s Uttarkashi	78.43944444	30.7258333	1106	76.264219
G-9	Badethi Chungi	78.43944444	30.7303528	1053	79.404703
G-10	Dharashu	78.31622222	30.6106639	815	99.205983
G-11	Chinyalisaur	78.332475	30.5745333	790	103.34455
G-12	Tehri Reservoir (Koti colony)	78.45367778	30.4123139	792	125.445578
G-13	Zero Bridge Tehri	78.48515	30.3527278	561.95	133.415968
G-14	Downstream of Koteswar PP	78.50085556	30.2625472	518	144.180048
G-15	Bhagirathi Devprayag	78.59858611	30.1510139	462	160.430282
G-16	Ganga Devprayag	78.59638611	30.1407139	365.48	161.979644
G-17	Lakundi Shiv Chula	78.435275	30.0858028	321	187.707604
G-18	Lakhman Chula Rishikesh	78.32709167	30.126375	312	205.295911

G-19	Saptrishi Ashram	78.19606389	29.9871056	243.308	226.962528
G-20	Bhimgowada Barrage	78.17639444	29.9698833	242.42	229.997382
G-21	Khadkhadi	78.16209167	29.947425	236.59	232.421654
G-22	Gujrawala Bhawan	78.17800833	29.9573194	234	242.092785
G-23	Bisanpur village	78.14702222	29.8577361	217.5	254.712282

Software Arc GIS 9.3 and Surfer 9 are used for Showing the study area and sampling location and plotting the Water Quality Parameter status graph and their trend respectively. Water sample analysis was performed as per standard method (Jain and Bhatia, 1988; APHA, 1992) at National Institute of Hydrology, Roorkee laboratory (An ISO 9001-2008 Certified)

The details of analytical method and equipment used in the study are described in Table 6. Ionic balance was calculated, the error in the ionic balance for majority of the samples was within 5%. The total number of selected parameters is thirteen for assessing water quality of river Ganga.

Table 2.2 Details of the analytical method and equipment used in the study

Parameter	Method	Instrumentation and Apparatus
pH	Electrometric	pH Meter
Conductivity	Electrometric	Conductivity Meter
TDS	Electrometric	Conductivity Meter/TDS Meter
Alkalinity	Titration by H ₂ SO ₄	-
Hardness	Titration by EDTA	-
Chloride	Titration by AgNO ₃	-
Sulphate	Turbidimetric	Turbidity Meter
Nitrate	Ultraviolet Screening	UV-VIS Spectrophotometer
Sodium	Flame Emission	Flame Photometer
Potassium	Flame Emission	Flame Photometer
Calcium	Titration by EDTA	-
Magnesium	Titration by EDTA	-
Iron	Spectrophotometric	Spectrophotometer

III. ANALYSES AND INTERPRETATION OF DATA

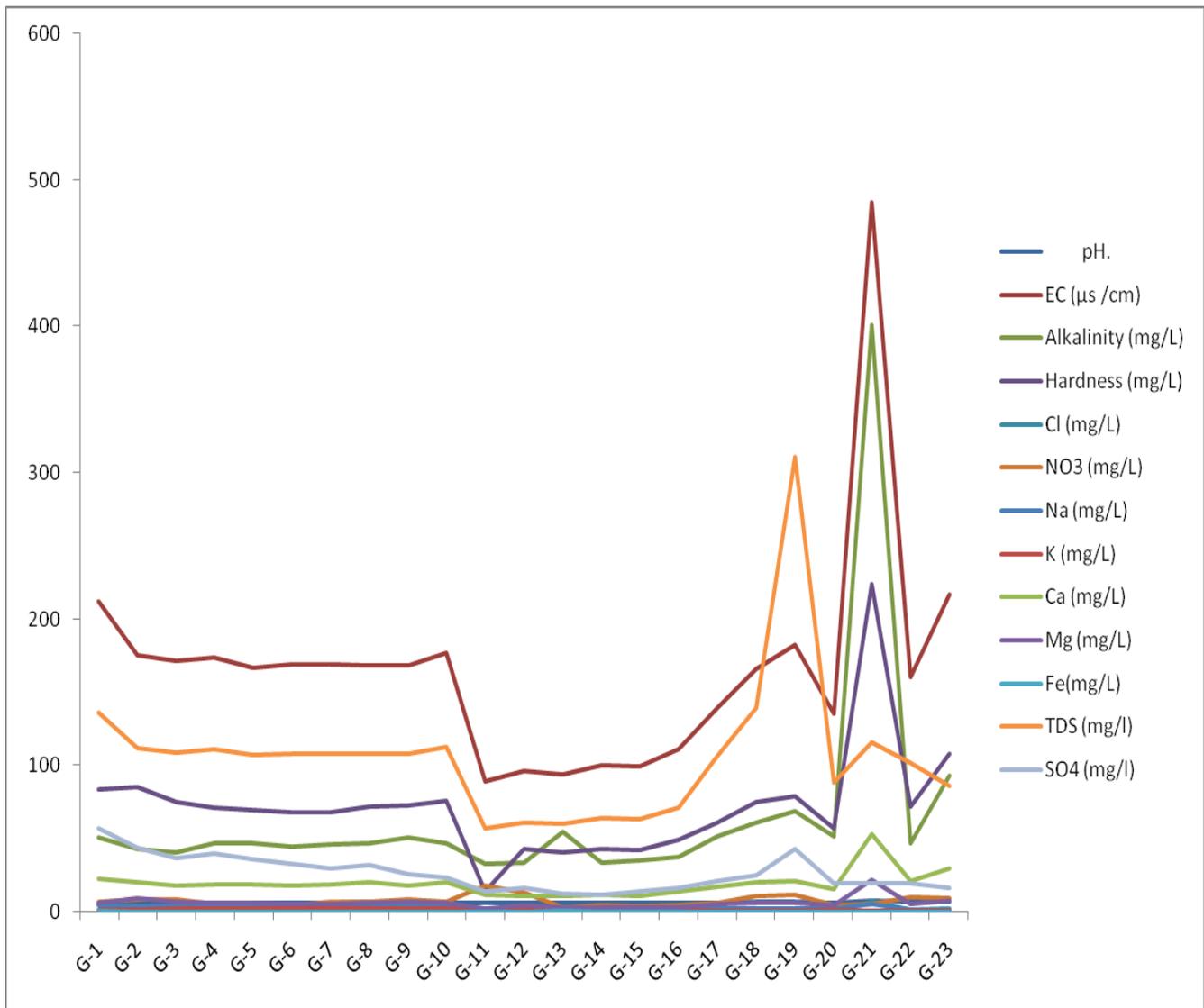
The samples were analyzed for assessment of water quality as per standard methods (APHA, 1999). The parameters such as pH, Conductivity, TDS, Alkalinity, Hardness, Chloride, Sulphate, Nitrate, Sodium, Potassium, Calcium, Magnesium, and Iron for samples from River Ganga were analyzed and the results are given in Table 3.1. Water quality status of River Ganga from Gangotri to Haridwar in terms of selected 13 parameters is found within specified limit as prescribed by BIS 2012 (Table 3.2). A close examination clearly indicates that all parameter are complying with the standards (BIS 10500). However the Quality of Water is spatially varying in nature from Gangotri to Haridwar. But it can be concluded that River Ganga in Uttarakhand is relatively clean and complying with the criteria. It has been observed that at Bisanpur and Khadkhadi, deviation from mean values is more for maximum nos of parameter. After deep analysis of all possible causes it is found that the discharge from Jagjeet-Pur, Sewage treatment plant is the most probable cause of the deviation. Jagjeet-pur STP, received entire sewerage of haridwar city which is nearly 55-60 MLD but installed treatment capacity is only 45 MLD. Remaining (60-45=15) MLD sewage water directly being discharged into the river Ganga. Results of all parameters at all the location are shown in table 3.2

Table-3.1 Compliance of River Water Quality with BIS Standard

Parameters	Acceptable Limit	Allowable Limit	Water Quality of River Ganga
pH	6.5-8.5	No Relaxation	Within Limit
Conductivity	-	1,500 $\mu\text{s/cm}$ (WHO)	Within Limit
TDS	500	2000	Within Limit
Alkalinity	200	600	Within Limit
Hardness	200	600	Within Limit
Chloride	250	1000	Within Limit
Sulphate	200	400	Within Limit
Nitrate	45	No Relaxation	Within Limit
Sodium	200 (WHO)	-	Within Limit
Potassium	10 (WHO)	-	Within Limit
Calcium	75	200	Within Limit
Magnesium	30	100	Within Limit
Iron	0.3	No Relaxation	Within Limit

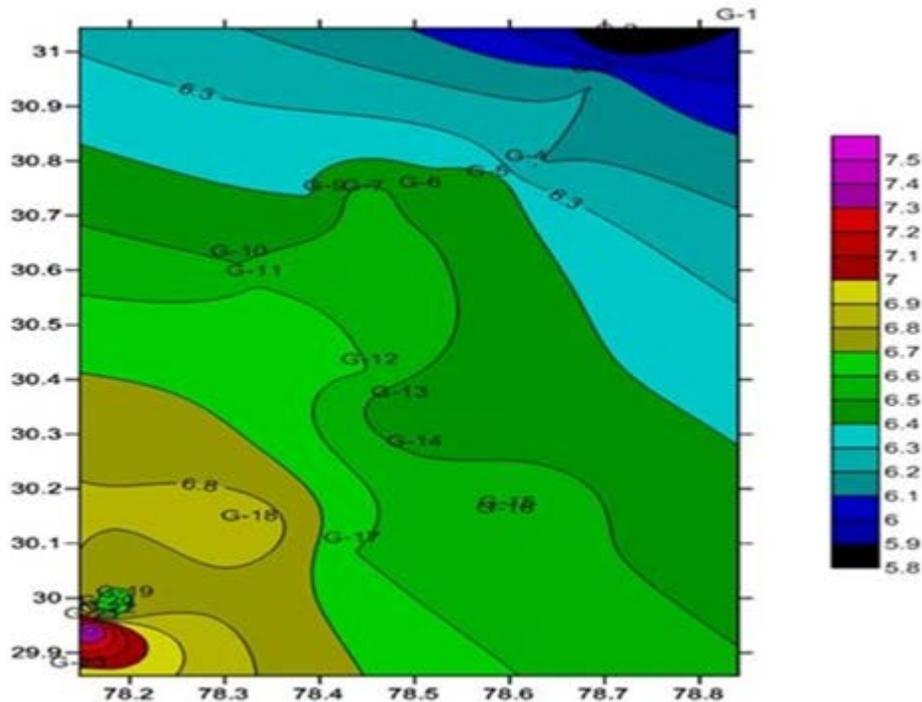
Table 3.2 Physico-chemical characterization of River Ganga Samples

Sample Code	Location	pH.	EC (µs/cm)	Alkalinity (mg/L)	Hardness (mg/L)	Cl (mg/L)	NO3 (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	Fe (mg/L)	TDS (mg/l)	SO4 (mg/l)
G-1	Jangla Bridge	5.9	212	51	84	0.2	7	4.4	1.6	23	6	0.5	136	57
G-2	Jhala Bridge	5.8	175	43	85	4.2	8.8	3.9	1.6	20	9	0.17	112	44
G-3	Dabrani Bridge	6.2	171	41	75	0.8	8.4	3.9	1.7	18	7	0.16	109	37
G-4	UK Laghu Vidhut Pariyojna	6.2	174	47	71	0.8	5.3	5.1	1.9	19	6	0.21	111	40
G-5	Nalluna Senj	6.5	167	47	70	1.4	1.3	4.8	1.9	19	6	0.06	107	36
G-6	After Heena Power Station	6.4	169	45	68	0.4	4.8	5.1	1.9	18	5	0.08	108	33
G-7	u/s Uttarkashi	6.6	169	46	68	2.2	6.6	4.8	2	19	5	0.07	108	30
G-8	d/s Uttarkashi	6.7	168	47	72	1.8	6.6	4.7	2	20	6	0.06	108	32
G-9	Badethi Chungi	6.4	168	51	73	1.2	8.8	4.3	1.8	18	7	0.07	108	26
G-10	Dharashu	6.5	177	47	76	2	7	4.5	1.7	20	6	0.09	113	24
G-11	Chinyalisaur	6.6	89	33	14	0.2	18	1.7	1.1	12	2	0.15	57	14
G-12	Tehri Reservoir (Koti colony)	6.6	96	34	43	0	13	1.7	1.3	11	4	0.18	61	17
G-13	Zero Bridge Tehri	6.4	94	55	41	1.2	3.1	1.8	1.1	11	3	0.27	60	13
G-14	Downstream of Koteswar PP	6.5	100	34	43	1.4		1.7	1.1	12	3	0.06	64	12
G-15	Bhagirathi Devprayag	6.6	99	35	42	0.4	4	1.6	1	11	3	0.08	63	14
G-16	Ganga Devprayag	6.5	111	38	49	1.2	4.8	2	1	14	3	0.1	71	17
G-17	Lakundi Shiv Chula	6.6	139	52	61	2.4	5.7	1.6	0.8	17	5	0.1	106	21
G-18	Lakhman Chula Rishikesh	6.9	166	61	75	2.4	11	1.7	0.8	20	6	0.07	139	25
G-19	Saptrishi Ashram	6.7	182	69	79	2.4	12	1.6	0.7	21	6	0.19	311	43
G-20	Bhingowada Barrage	6.5	135	52	57	0	4.8	1.7	0.9	16	4	0.1	88	20
G-21	Khadkhadi	7.5	485	401	224	7.4	5.3	5	0.5	53	22	0.02	116	20
G-22	Gujrawala Bhawan	7	160	47	72	2	9.7	1.2	0.7	21	5	0.08	102	20
G-23	Bisanpur village	6.9	217	93	108	2.2	9.2	1.4	0.5	30	8	0.02	86	17



pH- As it is clear from the above graph that pH Values at the entire length of river are within specified limit (The pH of most natural waters ranges between 6.5 and 8.5). However it has been observed (see graph) that pH values at Jangla Bridge, Jhala Bridge, Debrani Bridge, UK Laghuvidut pariyojna and at Naluna

Senj are less than 6.5 due to dissolution of carbon dioxide and low alkalinity. On the other hand pH at Khadkhadi is maximum (but within the limit).For better understanding of spatial variation in pH concentration pH contour map is given here-



Explanation-It is clearly shown in contour map that pH Values is increasing as we moves downstream from Gangotri. Highest pH is shown near Haridwar.

Electrical Conductivity- Electrical Conductivity is within limit in entire course of river however its values are spatially varies .Electrical conductivity at Khadkhadi is found maximum but within limit. However from Chinyalisur to Lakhundi Shiv-Chula electrical conductivity are observed below mean values. But overall Electrical Conductivity is within limit and showing good health of River. Conductivity is within limit and showing good health of river.

Alkalinity- Alkalinity has crossed the Acceptable limit at Khadkhadi (401 mg/l), otherwise concentration of alkalinity in entire length of river is almost uniform and within the permissible limit.

Hardness- Hardness values are found to be within specified limit along the entire length of River Ganga (from Gangotri to Haridwar) highest alkalinity is observed at Khadkhadi (224mg/l) and minimum at Chinyalisaur.

Chloride- Chloride content in River Ganga is found within prescribed limit, which shows that river is healthy. Maximum chloride concentration is found at Khadkhadi (7.4mg/l) and minimum at Tehri Reservoir.

Nitrate- Nitrate concentration in river Ganga is found within desired limit which indicate that river is pollution free. Maximum Nitrate is observed at Chinyalisaur and minimum at Nalluna-Senj.

Calcium- Calcium concentration in River Ganga water is observed within limit and no health hazard is observed. River is healthy and pollution free. Maximum concentration is observed at Khadkhadi (53mg/l) and minimum at Tehri.

Iron- Concentration of iron is found within desirable limit in entire length of river from Gangotri to Haridwar except at Jangla Bridge (Due to watershed rock characteristics). The maximum concentration is observed at Jangla Bridge and Minimum at

Bisanpur village and Khadkhadi but overall concentration of iron is found within desired limit which indicate healthy river condition.

Magnesium- Magnesium concentration found maximum at Khadkhadi and minimum at Chinyalisur but both limit are within prescribed limit which indicated that river is pollution free and there is no health hazards. Concentration of magnesium is varying from site to site. Variation does not follow any specific trend, it is unsymmetrical in nature.

Sodium- The sodium concentration in river Ganga from Gangotri to Haridwar is found within limit. The maximum concentration of Sodium is observed at UK Laghuvidhut pariyojana site and at Naluna -Senj at Khadkhadi the concentration of Sodium is observed 5.0 mg/l .But as a conclusion it can be say that river is pollution free and Healthy in terms of Sodium.

Potassium- Concentration of potassium is found within prescribed limit. Which shows that river is pollution free from Gangotri to Haridwar and there is no Health hazard. The maximum concentration is observed at Upstream of Uttarkashi and minimum at Khadkhadi and Bisanpur village.

Sulphate- Sulphate in River Ganga is found within limit and hence river is free from sulphate pollution from Gangotri to Haridwar and there is no health hazard due to excessive sulphate. However Sulphate concentration is not uniform in entire length of river, maximum sulphate concentration is observed at Gangotri (54mg/L) and minimum at Alaknanda (12mg/l).

Total Dissolved Solid- TDS in river Ganga (from Gangotri to Haridwar) is found within prescribed limit. Its values vary from location to location .Maximum TDS is observed at Saptarishi Aashram (311mg/l) and minimum at upstream of Uttarkashi (57mg/l). But overall water quality is good in river Ganga.

IV. CONCLUSIONS /SUGGESTION /FINDING

Overall water Quality of River Ganga from Gangotri to Haridwar is found Healthy and Pollution free. However, most of the parameters were in increasing as the river travels. Maximum concentration for most of the parameter was observed at Khadkhadi (Haridwar) which is an indication of impact of pollution due to anthropogenic activities. Drains which directly or indirectly discharging into the river, without proper treatment is found to be major source of pollution. Policy should to be framed for proper treatment of the drains before reaching river Ganga, so that water quality could be maintained. Co-ordination integration, participatory approach among various agencies, departments and groups should to be essential part of Ganga Rejuvenation Scheme.

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AUTHORS

First Author – Singh Rajesh, National Institute of Hydrology, Roorkee, Uttarakhand, India

Second Author – Bahukhandi Kanchan, University of Petroleum and Energy Studies, Dehradun, Uttarakhand, India

Third Author – Mondal Prasanjeet, University of Petroleum and Energy Studies, Dehradun, Uttarakhand, India

Fourth Author – Singh Satendra, University of Petroleum and Energy Studies, Dehradun, Uttarakhand, India