ASSESSMENT OF WATER QUALITY OF GOMTI RIVER USING WATER QUALITY INDEX AND GIS, IN LUCKNOW CITY, UTTAR PRADESH

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ABSTRACT

Gomti River originates from Pilibhit district, U.P. It passes through the district of 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 nature. Healthy soil, clean water and air are the soul of life. Often soil, water and air are no longer clean and pure, but pose human health risks. 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. After travelling about 240 km Gomti enters Lucknow, where it travels for 16 km. 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, and vegetable oil, pouring effluent directly into Gomti and besides this domestic waste water are also discharge into the River Gomti. In this study, Total of eight sampling sites were selected between Guaghat upstream and Piparaghat. Parameters like Temperature, Total suspended solids (TSS), Total dissolved solid (TDS), pH, Hardness, Dissolved oxygen (DO), Biochemical Oxygen Demand(BOD), Chemical Oxygen Demand(COD), Nitrate, Nitrite, Chlorine, Alkalinity, Calcium, Magnesium 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, Chromium, Copper and Lead, Nickel were noticed. This study monitors ground water quality, relating it to land use /land cover and habitation mask of different water quality parameters are prepared by using geographic information systems (GIS) and remote sensing technique. Base map was prepared by Survey of India topo sheets on 1:50.000 scale. The land use /land cover map was made from satellite imagery and GIS software like ARC GIS 9.3. The ground water samples were collected from the selected locations and were analyzed for different physico-chemical analysis and a water quality index was prepared. Water quality index (WQI) was then calculated on the basis of WHO standards to classify suitability for drinking water.

Keyword: - *Water Quality Parameters, Gomti River, Water Quality Index(WQI), GIS.*

1. INTRODUCTION

Water a basic requirement for life along with air not only for humans but also for other living beings. The percentage of water that can be used for daily life is very low. Water is provided for our activities can be ground or surface, for many decades we are relentlessly degrading our ground water both in quality as well as its quantity. Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source. Water Quality Index (WQI) is the most effective tool to analyze the water quality of the particular area and to produce information regarding water quality in the simplest form to the general community, legislative/government

and other decision-makers. WQI transforms the large and complex information of raw water quality data into a simplified and logical form with different categories of water quality that reflects the overall water quality status of the selected area. WQI is defined as, a rating reflecting the composite influence of different water quality parameters. It is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy-makers. it is imperative to prevent and control the rivers pollution and to have reliable information on the quality of water for effective management. In view of the spatial and temporal variations in the hydrochemistry of rivers, regular monitoring programs are required for reliable estimates of the water quality. This results in a huge and complex data matrix comprised of a large number of Physico-chemical parameters, which are often difficult to interpret and draw meaningful conclusions. Further, for effective pollution control and water resource management, it is required to identify the pollution sources and their quantitative contributions. To thoroughly describe the water quality index (WQI) in the Gomti River Lucknow city, Uttar Pradesh. Eight sight are selected in different places of the Gomti River. Water sample are analyzed for physico-chemical parameter that are pH, alkalinity, hardness, TSS, TDS, chloride, Fluoride, DO, BOD, COD, calcium, Magnesium, etc. and heavy Metals like iron, Nickel, Copper, Lead, Chromium.

Fig. 1 Water pollution in Gomti River

2. MATERIALS AND METHODOLOGY

2.1. Site Description:

Lucknow is the capital of Uttar Pradesh. The study area covers the Gomti River in part of Lucknow city of Uttar Pradesh lies between 80.899893 to 80.968180 N latitude 26.886799 to 26.833321 E longitude. To thoroughly analyses the Physical, Chemical Parameters and heavy metals in the Gomti River of Lucknow city, eight uniquely sites are further selected for sampling and analysis. Water Samples are collected and analyzed from the proposed locations once a month January-February. Samples are analyzed for physicochemical characteristics that are pH, Turbidity, Electrical Conductivity, Total dissolved Solids, Total Suspended Solids, Dissolved oxygen, BOD, COD, Total Hardness, Calcium Hardness, Alkalinity, Chloride, Sulphate, Nitrate, Fluoride, etc. The Eight sites were selected for the water quality parameters in the Gomti River. Samples from eight points were collected in the middle of the Gomti River, Coordinates of each sample point location were recorded in the field through handset GPS. These sample point locations have been shown in Table.

Table 1: Location of Sampling Points

S.No.	Locations	Latitude	Longitude
I.	Gaughat	X:80.899893	Y:26.886799
II.	Kudia Ghat	X:80.911987	Y:26.874454
III.	Mohan Maikain	X:80.920119	Y:26.871519
IV.	Hanuman Setu	X:80.935602	Y:26.858943
V.	Hyderabad colony	X:80.948044	Y:26.862579
VI.	Bairrage	X:80.962147	Y:26.861414
VII.	River front	X:80.970994	Y:26.852400
VIII.	Piparaghat	X:80.968180	Y:26.833321

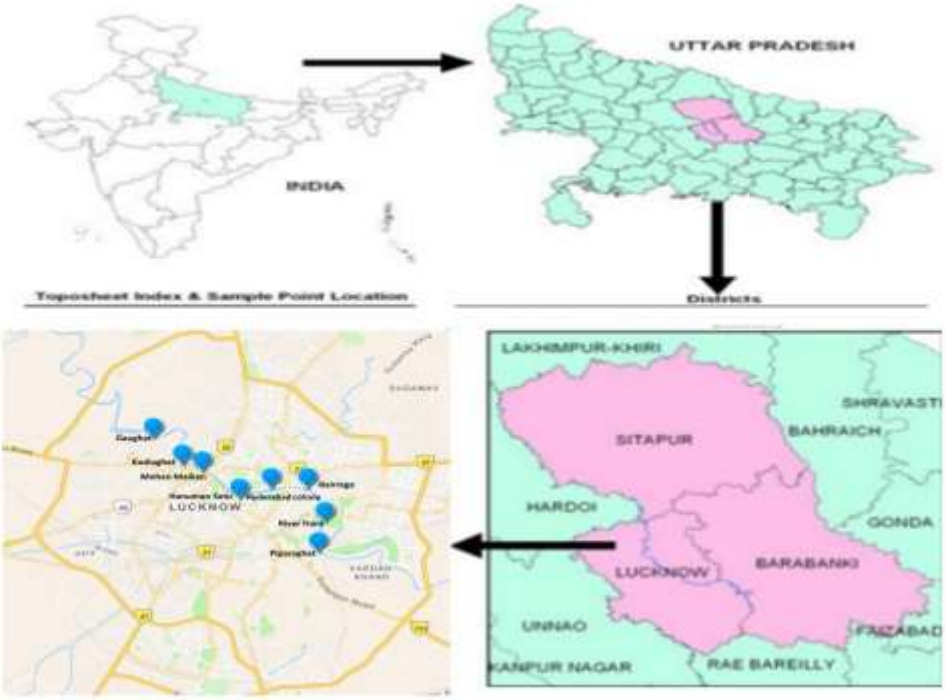


Fig. 2 Location of the sampling points

2.2. Sampling Procedure

The ground water samples were collected in pre cleaned polyethylene bottles or tarson of 1000mL capacity. Proper procedure was followed as described by APHA AWWAWPFC (23rd edition) for the sampling and the analysis purpose of the selected parameters to avoid any contamination during collection, storage and precise determination of concentrations of the groundwater samples. Each selected hand pump for sampling was put on for at least 5 min

to remove any contaminants. Each sample in the collected bottles was capped tightly to avoid leakage and contamination from any pollutants during handling and transportation. The bottles were adequately labeled by date and locations, the source of water i.e Hand pump, etc. to recognize sampling point during chemical analysis. All the collected samples were preserved in cold and transported to the laboratory where they were stored in the freezer at 4 °C until used for final chemical analysis. For heavy metals analysis the sample is taken separately in tarson bottle of 500ml capacity. Sample is diluted with Concentrated Nitric Acid and then it is analysed for heavy metals.

Fig. 3 Samples

Fig. 4 Sample Collection

2.3 Calculation of water Quality Index(WQI)

Water quality index (WQI): - Water quality index (WQI) is valuable and unique rating to depict the overall water quality status in a single term that is helpful for the selection of appropriate treatment technique to meet the concerned issues. The concept of water quality index (WQI) was introduced by Horten. WQI is defined as the rating that reflects the composite influence of the different parameters.

Weighted Arithmetic Water Quality Index Method:

Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables. The method has been widely used by the various scientists, for calculating WQI various steps are followed:-

Step 1: Collect data of various physico- chemical water quality parameters and heavy metals.

Step 2: Calculate Proportionality constant " K " value using formula $K = \frac{1}{\frac{1}{\sum_{i=1}^{n} S_i}}$ is standard permissible for nth parameter.

Step 3: Calculate quality rating for nth parameter (q_n)where there are n parameters. This is calculated using formula $Q_n = 100 \times \frac{(V_n - V_{io})}{(S_n - V_{io})}$. Whereas Vn = Estimated value of the nth parameter of the given sampling station. Vio= Ideal value of nth parameter in pure water. And Sn=Standard permissible value of the nth parameter.

Step 4: Calculate unit weight for the nth parameters. Wn= (k/Sn). Step 5: Calculate Water Quality Index (WQI) using formula, $WQI = ((\Sigma W_n * Q_n)/W_n)$.

3. RESULT AND DISCUSSION

After analyses in laboratory, Water quality of samples of eight sampling sites. The water samples were analyzed for physical, chemical and metal analysis. A total of physicochemical parameters were analyzed namely Temperature, Electrical conductivity, Turbidity, Total suspended solids (TSS), Total dissolved solids (TDS), pH, Hardness, Dissolved oxygen (DO), Biochemical oxygen demand, chemical oxygen demand, Nitrate, Sulfate, Chlorine, Fluoride, Alkalinity, Calcium, Magnesium and five metals are iron, nickel, copper, lead, chromium. Variation of these parameters are analyzed by using GIS and interpolation method.

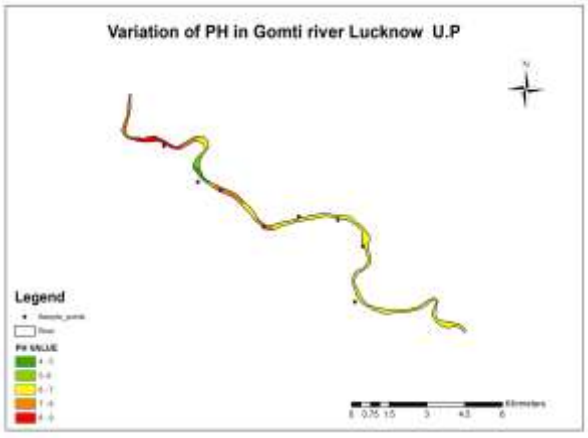
3.1 Analysis of Parameters:

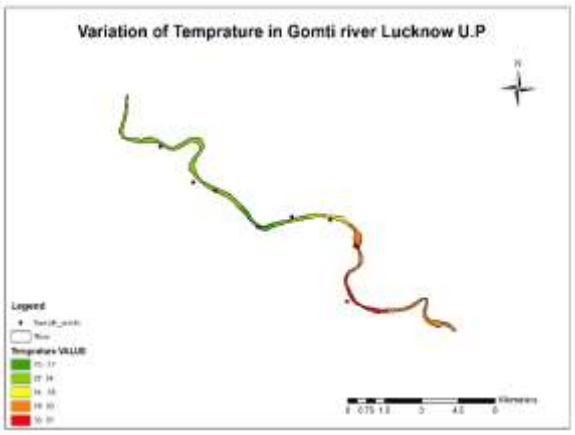
Table 2: Parameters at different locations

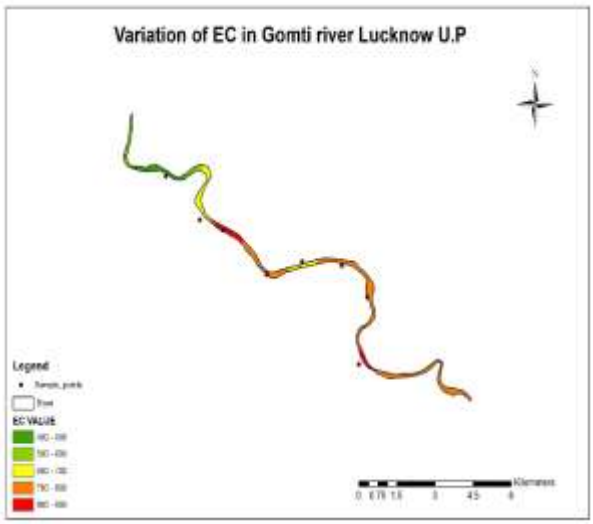
Quality Parameters	Units	Gaughat	Kudia ghat	Mohan Makain	Hanuman Setu
P^H		8.28	6.43	7.87	7.6
Temperature	^0C	22^0C	21^0C	22^0C	17^0C
Electrical conductivity	µmho/cm	400	575	804	689
Turbidity	NTU	5	7	8	10
Total suspended solids	mg/l	11.2	13.4	6	22.2
Total dissolved solid	mg/l	242	394	405.2	361
Total solids	mg/l	253.2	407.4	411.2	383.2
Hardness	mg/l as CaCo3	172	184	122	162
Calcium Hardness	mg/l as CaCo3	102	96	84	120
Magnesium hardness	mg/l as CaCo3	72	88	38	42
Calcium	mg/l	40.8	38.4	33.6	48
Magnesium	mg/l	17.01	21.384	9.234	10.20
Alkalinity	mg/l as CaCo3	186	234	220	222
Chloride	mg/l as CaCo3	104.96	135.95	30.99	32.98
Sulfate	mg/l	17.4	26.5	27.5	30.5
Nitrate	mg/l	18.64	5.44	19.11	6.235
Fluoride	mg/l	0.432	0.621	0.657	0.695
Dissolved oxygen	mg/l	5.9	3	2.3	0
Biochemical oxygen demand	mg/l	21	28	30	32
Chemical oxygen demand	mg/l	84	92	96	104
Iron	mg/l	4.2	1.9	4.35	3.87
Nickel	mg/l	0.05	0.08	0.06	0.1
Lead	mg/l	0.009	0.012	0.019	0.017
Chromium	mg/l	0.1	0.08	0.016	0.08
Copper	mg/l	0.12	0.1	0.23	0.11

Quality Parameters	Units	Hyderabad Colony	Gomti Barrage	River front	Pipraghat
P^H		7.53	7.57	7.43	7.32
Temperature	^0C	22^0C	24^0C	27^0C	29^0C
Electrical conductivity	µmho/cm	619	678	708	729
Turbidity	NTU	6	7	7	5
Total suspended solids	mg/l	15.2	14.2	25.8	39.2
Total dissolved solid	mg/l	313.6	333.4	494.6	389
Total solids	mg/l	328.8	347.6	520.4	428.2
Hardness	mg/l as CaCo3	148	168	236	280
Calcium Hardness	mg/l as CaCo3	104	114	134	184
Magnesium hardness	mg/l as CaCo3	44	54	102	96
Calcium	mg/l	41.6	45.6	53.6	73.6
Magnesium	mg/l	10.692	13.122	24.786	23.328
Alkalinity	mg/l as CaCo3	256	230	280	258
Chloride	mg/l as CaCo3	38.98	33.98	34.79	43.98
Sulfate	mg/l	39.3	35.4	35.8	28.9
Nitrate	mg/l	3.205	6.085	4.205	3.824
Fluoride	mg/l	1.379	0.689	0.453	0.537
Dissolved oxygen	mg/l	0	0	0	0
Biochemical oxygen demand	mg/l	37	29	21	22
Chemical oxygen demand	mg/l	164	112	84	92
Iron	mg/l	1.73	2.61	3.89	3.46
Nickel	mg/l	0.138	0.128	0.09	0.08
Lead	mg/l	0.006	0.02	0.013	0.011
Chromium	mg/l	0.12	0.07	0.1	0
Copper	mg/l	0.06	0.08	0.09	0.089

3.2 Comparison of Physical-Chemical parameters at different sites:






Variation of EC in Gomti river Lucknow U.P
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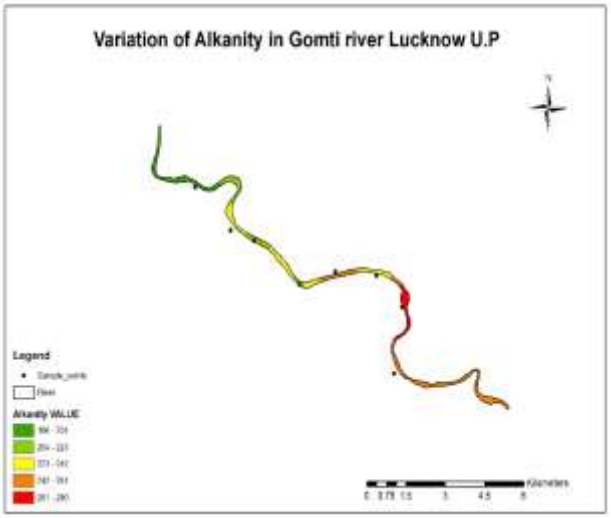
EC VALUE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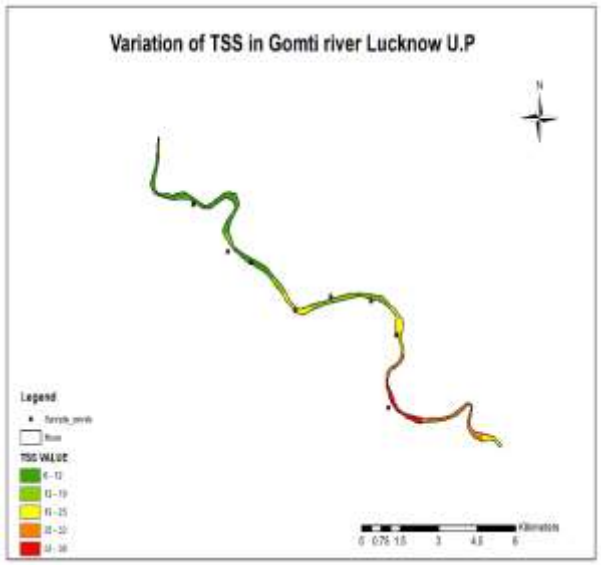
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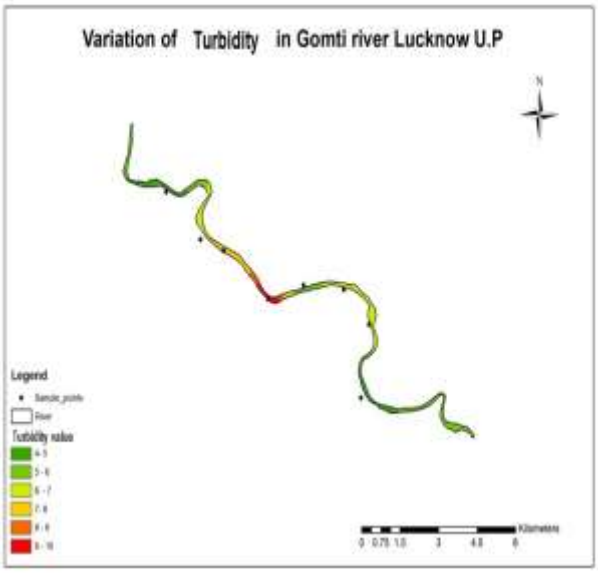
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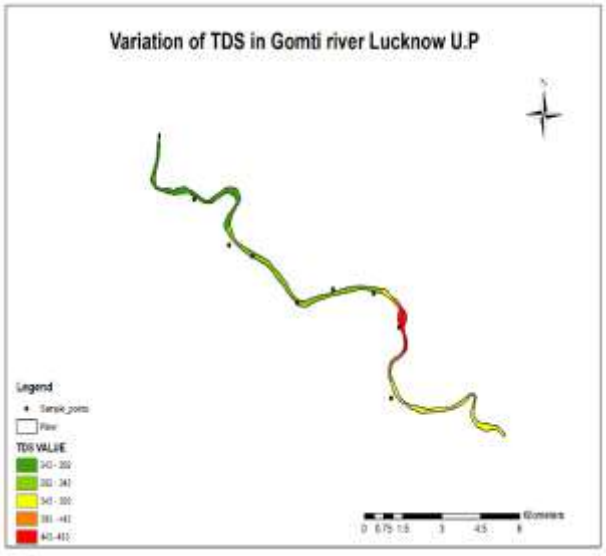
Turbidity value


Variation of TDS in Gomti river Lucknow U.P
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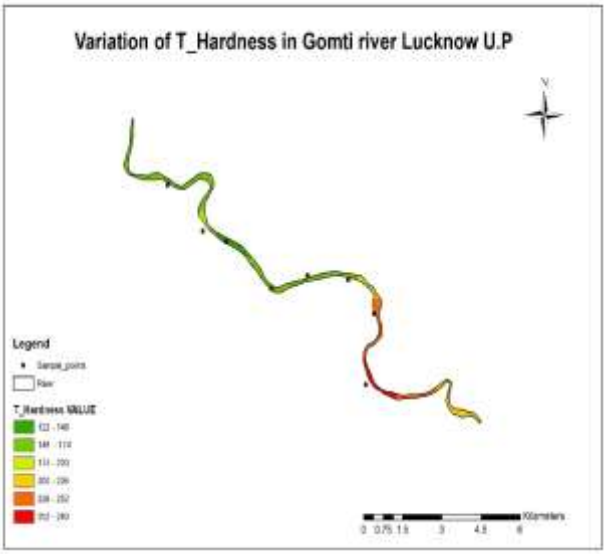
TDS VALUE


Variation of T_Hardness in Gomti river Lucknow U.P
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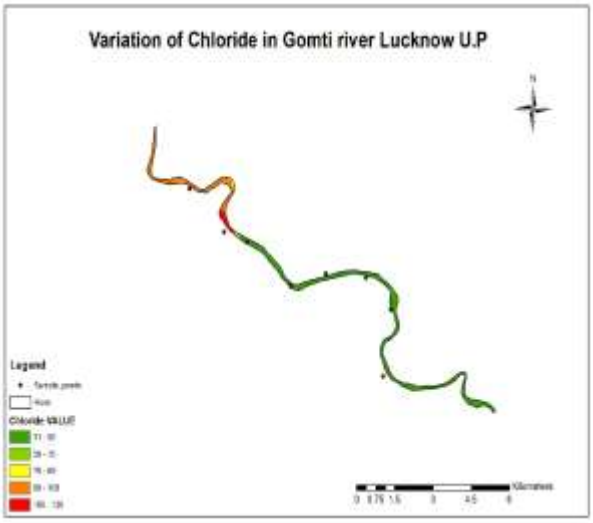
T_Hardness VALUE


Variation of Chloride in Gomti river Lucknow U.P
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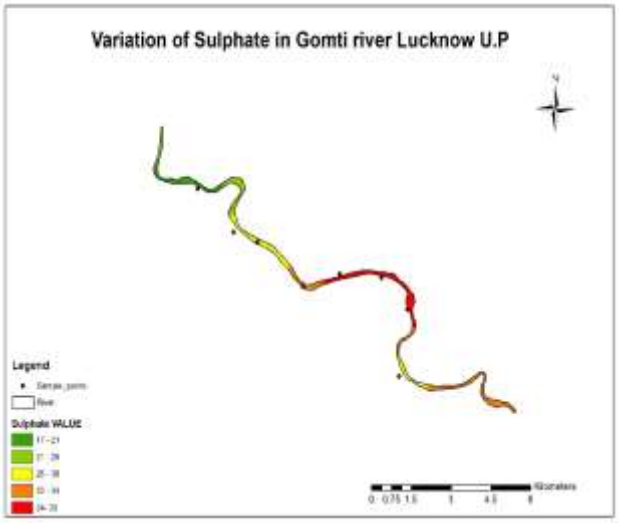
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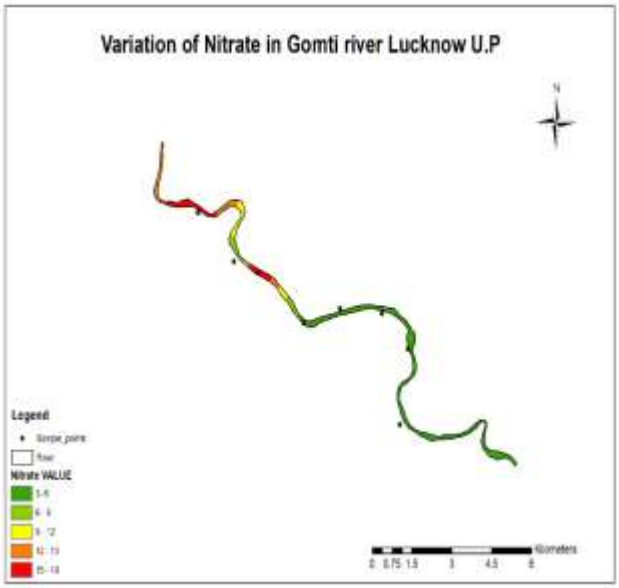
Sulphate VALUE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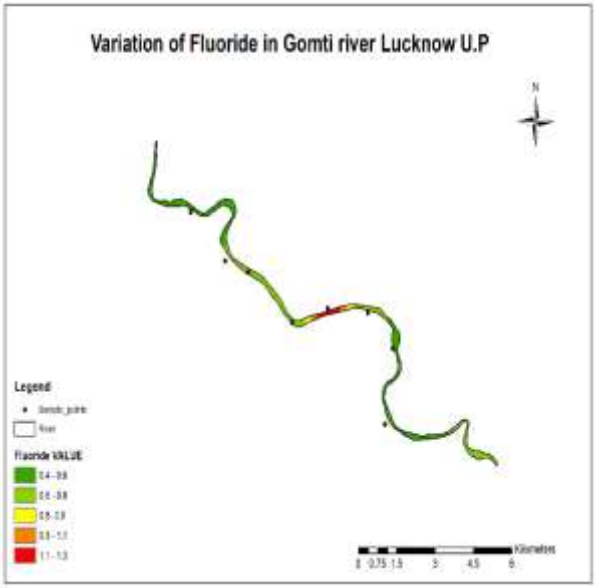
Nitrate VALUE


Variation of Fluoride in Gomti river Lucknow U.P
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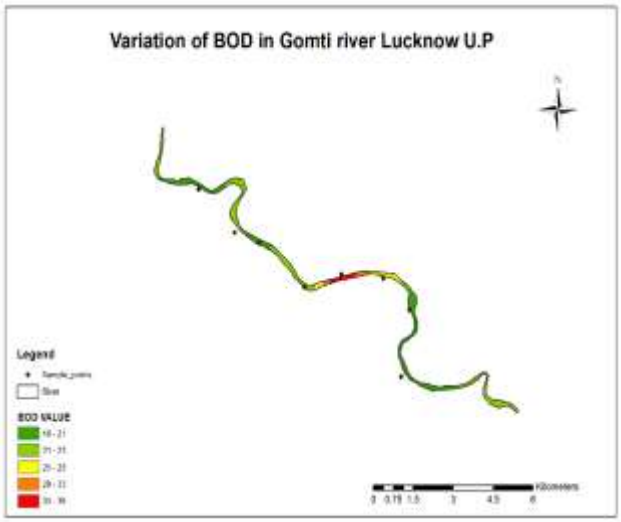
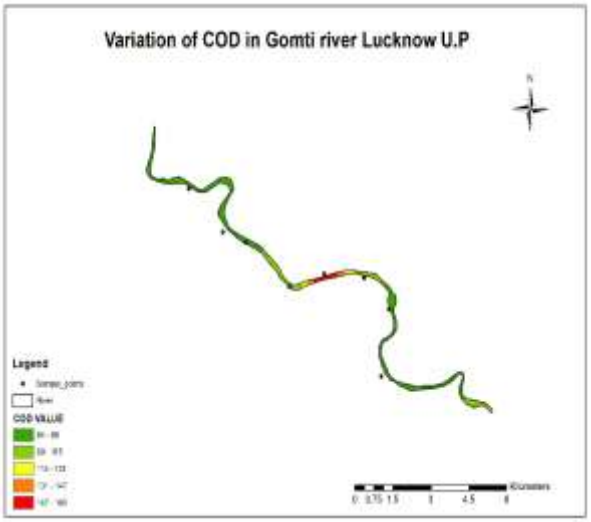
Fluoride VALUE





3.3 Water Quality Index:

Table 3. WQI and their status

Water Quality Index	Water Quality Status
< 50	Excellent Water Quality
50 – 100	Good Water Quality
100 - 200	Moderately polluted
200 – 300	Severely polluted
> 300	Unsuitable for human use

Table 4. Water Quality index and their status at different locations

S.No.	Location	Water Quality Index	Water Quality Status
1.	Gaughat	180.02	Moderately Polluted Water
2.	Kudia Ghat	212.633	Severely Polluted Water
3.	Mohan Makain	242.219	Severely Polluted Water
4.	Hanuman Setu	277.244	Severely Polluted Water
5.	Hyderabad Colony	255.559	Severely Polluted Water
6.	Gomti Barrage	313.186	Unsuitable for human use
7.	River Front	243.857	Severely Polluted Water

8.	Pipraghat	197.58	Moderately Polluted Water

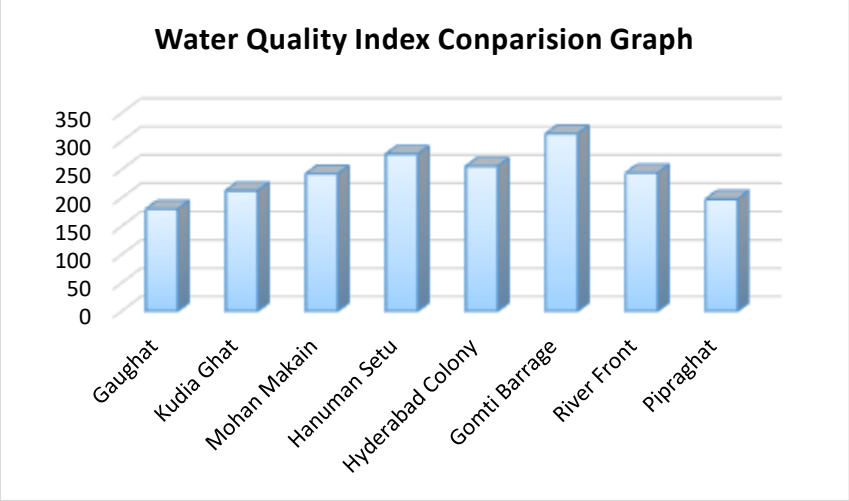


Fig. WQI Compression Graph

4. CONCLUSION

In this research, Various parameters are analyzed in lab and plotted on map using GIS interpolation method. It helps find the variation of different parameters at different locations. We can have analyzed water quality at different sampling points. It also helps to find the source of the pollution. This study also computed WQI ranges from 180.02 to 313.186. The minimum value has been recorded for Gaughat sampling point while maximum has been recorded for Gomti Barrage location. Based on the WQI table only Gaughat and Piparaghat location's river water have Moderately polluted water in terms of quality while other five locations have Severely Polluted Water and Gomti Barrage have water which is Unsuitable for human use. The high value of WQI has been found due to Calcium, sulphate, alkalinity, Iron and Chromium in ground water. The higher values of Total Dissolved Solids, Total hardness and alkalinity are due to leaching of waste from urban Residents. All these factors may pose health hazard on long term and can degrade quality of drinking water, therefore required to be treated for drinking purpose. Regular monitoring of groundwater quality, abolishment of unhealthy waste disposal practices should be there in Lucknow city. The Study also indicates the usefulness of WQI in estimating the river water quality of the river water.

6. REFERENCES

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