Water Quality Assessment of Gomti River by using Modelling Technique: A Review

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ABSTRACT

This paper presents an approach to show the water quality of the Gomti River at Lucknow, Uttar Pradesh, by using the Qual2k modelling technique. The Gomti River originates in Gomat Taal, Pilibhit, Uttar Pradesh, India. In this paper, the Lucknow Gomti River stretch was considered for the water quality assessment. Water samples collected from ten sampling locations between Chhathghat and Mehndighat. The water were analysed on different parameters, namely electrical conductivity, hardness, nitrate, DO, TSS, etc. The results were taken as input in the Qual2k workbook. The analysed data were calibrated with Qual2k calibrated data and compared with Qual2k standard data in graphical form.

Keywords: Qual2k, Surface Water Quality, Water Quality Parameter, Gomti River

1 Introduction

Rivers provide a significant amount of drinking water for people and irrigation water for farmlands and serve as a home to several aquatic plants and living things. Due to pollution entering rivers from cities industrial and agricultural areas, surface water is continuously at risk. The demand for fresh water has significantly increased as a result of the rapid growth of both industrial and population sectors. Understanding the origins of pollution and ways to raise the quality of receiving waters can be done with the help of surface water quality modelling. The analysis of pollutant discharges and the forecasting of long-term river water quality are only two examples of the many uses for which water quality models can be put to use.

Using the modelling technique will allow you to combine complicated data and create a map that assesses water quality trends and describes the current state of the water. In integrating the many water quality variables, data is lost; however, this loss is balanced by the public and policymakers' growing awareness of water quality issues. This work focuses on determining and evaluating the surface water quality of the Gomti River in the Lucknow region using modelling technique.

2 Literature Review

Fawaz Al- Badaii *et al.*, (2013) concluded to assess the water quality of Semenyih River. From 8 points along the river, water samples were taken. Two times, in the winter and summer seasons, water sampling has been done. At the middle of the river, on the right bank and left bank, and at each station, three water samples were taken. By using a YSI metre, field characteristics including as pH, temperature, electrical conductivity, DO were measured immediately. While total hardness (TH), NO_3, faecal coliform (FC), NH_3-N, BOD, TSS, COD, turbidity, SO_4, PO_4 laboratory analysis were conducted. As a result, TSS, COD, NH_3-N, and

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TSS were all within acceptable ranges. Above the permitted threshold levels, PO_4 and FC were found. BOD, turbidity, and DO were all within normal limits [1].

A. Vinay Kumar, Pramod Kumar Singh and Pokhraj Shahu (2017) The Gomti River's extremely high water pollution level is a sign of poor water quality, making it dangerous to use for any kind of purpose. All of the indicators are above the threshold, which raises major concerns for the river's ecology. There were twenty-six drains throughout the water's length, which caused deterioration. The primary reason of the growing urbanization is a variety of industrial, agricultural, and household wastes. Additionally, as the population grew, the amount of heavy metals in the air increased, polluting river water. The river's ability to self-purify was compromised by the massive volume of organic and inorganic materials, which led to an increase in bacterial proliferation. Because of this, it is imperative that waste from businesses and other sources be treated before it is dumped into a river to protect aquatic life and human health.[2]

Deepshikha Sharma *et al.*, (2015) describe and analyse the water quality of Yamuna River at Delhi. Using the modelling, four monitoring stations were simulated for Total coliform, BOD, DO, and Total nitrogen. Old Delhi Railway Bridge, Nizamuddin, Okhla and Palla for ten years between October 1999 to June 2009, except rainy seasons from July to September. Throughout the study period these were divided into two phases: the model calibration phase and the model validation phase. High levels of pollution in Delhi's Yamuna River are brought on by the discharge of wastewater that has either not been cleaned at all or has only been partially treated and is either directly or indirectly entering the river system through sewer drains. For the purpose of improving the river DO-BOD water quality of Yamuna, numerous pollution assessment research has been carried out. However, no modelling has been carried out to evaluate the influence of other important factors like infections or nitrogenous chemicals on the quality of the river. Since, Qual2k is a 1-D model, the pollution load and a river with roughly constant flow can both be applied to it. The model is run through Excel, and the output is shown using Excel as the graphical user interface. The CWC and CPCB have provided information on the average river quality for the past year [3].

A. Pankaj Kumar (2018) A few decades ago, the Gomti River in Lucknow City, India, was an important supply of water for several applications. However, due to rapid worldwide developments, the river's current state is extremely crucial in terms of environmental, scenic, and commercial utilisation. Following that, this research concentrated on examining the existing condition as well as estimating its future state utilising various scenarios while considering main drivers of world change, particularly climate change and population expansion. WEAP, a numerical simulation programme, was used to model river water quality under two scenarios: business as usual (BAU) and scenario with mitigating measures. Water quality simulations were performed over a 24 km section of the Gomti River, from near Moosa Bird Sanctuary downstream to near Bharwara. In terms of simulated water quality measures, a comparison of present and BAU state clearly shows that water quality by 2030 would rapidly decline and will be unsuitable for many aquatic life forms. The results of the scenario with mitigating measures indicate that present planned wastewater treatment plants and regulations are insufficient to attain ideal river water quality within class B, necessitating quick and all-inclusive action. Using several scenario studies, this paper provided a complete picture of the water quality of the Gomti River in Lucknow City, India for both the present (2015) and future (2030) time periods. When compared to the class B issued by the Uttar Pradesh Pollution Control Board (UPPCB) for the year 2015, the simulated results clearly demonstrated that the Gomti River is moderately to highly polluted across the stretch. Furthermore, the quality status would deteriorate under the business-as-usual scenario by 2030. However, considering the scenario with mitigating actions as indicated in the local master plan for water resource management, the water quality will improve dramatically. However, water quality in downstream locations such as Pipraghat, The Gomti River Weir and Near Bharwara do not meet the ideal water quality of class B and require more improvement.[4]

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Aarti Patel and Dr. Manoj Datar (2019) concluded about the River Betwa's in 2017, WQI as its source. In order to indicate the entire water quality at a specific timing and place, the WQI offers a single number/grade. In this study, the Weighted Arithmetic Water Quality Index method was used. Eleven parameters were tested over a three-season span during the summer, rainy, and winter in Betwa river.
In the bottles made of polyethylene, water samples were collected. Using a pH metre, pH was determined. Using a conductivity metre, conductivity was measured. Water evaporation was used to calculate TDS and TSS. Using Mohr's method, the chloride content was determined. By using acid-base titration, total alkalinity was determined. On each sample, a complexometric titration was done to determine the total hardness. Winkler's method was used to measure dissolved oxygen. And Five days of incubation were used to conduct the BOD test [5].
A. Khan, R & Saxena (2021) The results from this study presented the status of high levels of HM pollution in River Gomti. The health risk assessment also signified the serious health hazards associated with consumption of water at all sampling stations. The values of HQ exceeding unity raise severe concerns towards the potential risk exposure for both adults and children. The THI at all sampling stations exceeded unity in adults and children, thereby marking the potential health risk with reference to various HMs. The highest health risk has been found at sampling station S10 (Bharwara STP discharge point-Gomti Confluence), raising an urgent need of evaluating the working status of STPs in Lucknow city. In contrast to sampling station S10, the THI at sampling station S1 for both adults and children was found to be lowest in comparison to other sampling stations, although above the permissible limit, but stating less influence of anthropogenic activities. The carcinogenic risks were found to be higher for children as compared to adults for all the sampling locations. Hence, it is recommended that all the sampling stations require interventions and remedial measures to control the levels of these toxic heavy metals to prevent the possibility of any irreversible damage. Thus, this study provides relevant inputs towards the high levels of HM contamination and associated potential health risks, creating an urgent need of remedial actions for reinstatement of River Gomti to its natural state.[6]

Akhil Pathak and Anand Patel (2021) concluded that Gomti receive massive amounts of runoff from farms and untreated sewage, pesticides, fertiliser and oil and asphalt-bringing roadway washouts, silt, and various forms of heavy metals at Gomti River. The environment of the Gomti river is negatively impacted by high amounts of pollution, endangering its aquatic life. River receives garbage from the sugar industries and several factories in Sitapur before arriving in Lucknow.
Eight sampling locations total were used for this study between Piparaghat and Guaghat upstream. Geographic information systems (GIS) and the method of remote sensing are used to prepare distinct water quality measures. Survey of India topo sheets produced a base map at a scale of 1:50.000. Water quality index is determined using samples of ground water from the chosen areas were subjected to various physico-chemical analyses. Clean plastic bottles with a 1000 mL capacity were used to collect water samples. To prevent leakage and contamination from contaminants during handling and transport, each sample was cap carefully in the bottles that were collected. It helps to identify how various factors vary in various places. A WQI range of 180.02 to 313.186 was also calculated for this study. Gaughat sample site has the lowest value, and Gomti Barrage location has the highest value. The quality of drinking water can be negatively impacted by all these elements over time, posing a risk to one's health. As a result, drinking water must be treated. Also, this study shows how beneficial WQI is for determining the river water quality [7].
Giao Thanh Nguyen, Huynh Thi Hong Nhien (2022) Concludes the water quality monitoring gives knowledge to help with water resource planning that is sustainable as well as aids in assessing pollution and predicting it for countries. At 58 locations throughout Vietnam, 17 water parameters were examined. The tests were carried out based on 8 sampling periods. The WQI index is determined by factors including as

BOD, DO, COD, pH, temperature, and N-NO_2, N-NO_3, As, Cd, and P.A value of 0 to 100 can be assigned to the WQI parameter [8].

3 Methodology

3.1 Study area

Lucknow is located along the Gomti River for about 30 kilometers. Waste from Sitapur's sugar and distillery factories is discharged into the Gomti River before it reaches Lucknow. Domestic wastewater is also discharged into the Gomti River, together with the effluent from all distilleries, the milk industry and the production of vegetable oil. The river receives untreated sewage from 25 city drains. The main portion of the river passes through the city's Centre as it runs from North to South "See Figure 1". Together with groundwater, the city is one of the primary sources of water supply sewage generation, adequate treatment, and garbage disposal are the main issues facing the city. The quality of river water has significantly declined as a result of an inadequately functioning sewage system and sewage treatment units.

The process of creating a parameter map comprises choosing various sampling sites along the Gomti River's bank and analysing those sites using approved testing methods "Sampling sites shown in Table 1". Parameters- Electrical conductivity, Organic Nitrogen, Total Nitrogen, Total Phosphorus, Total Hardness, Nitrate, DO, TSS, pH, Alkalinity.

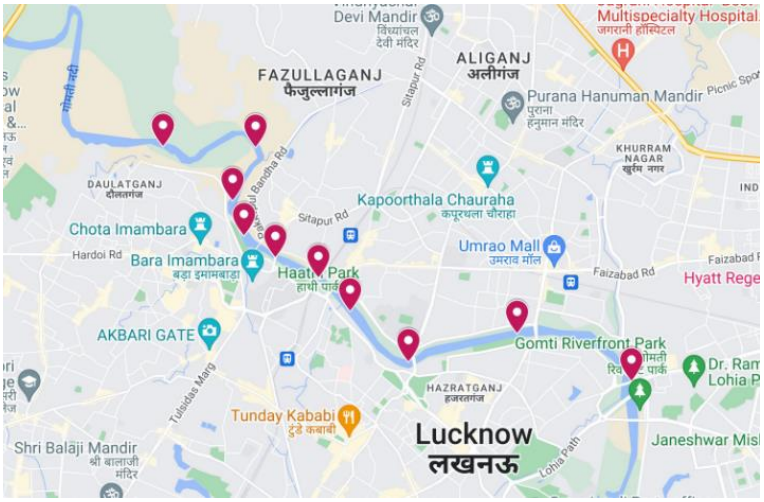

Figure 1: *Sampling Location site*

Table 1: *Sampling Location site description*

Point	**Location**
Point 1	Gaughat
Point 2	Hussainabad
Point 3	Gulalaghat
Point 4	Kuriyaghat
Point 5	Pakkapul
Point 6	Mohan Meakin
Point 7	Mankameshwar
Point 8	Hanuman Setu
Point 9	Laxman Mela
Point 10	Gomti baragge

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3.2 Water Quality Index Calculation (WQI)

WQI is an important instrument for assessing the water quality for a number of applications. Parameters for water quality are calculated using the relative weighted technique. The water quality parameters were assigned a weight based on their importance in the overall quality of water suitable for drinking. Using Qual2K, the location of the surface water sample was connected to the calculated WQI values.

3.3 Water Quality Modelling

Hydraulic parameters are fundamental inputs to the model of water quality and Each of the software's worksheets provides water quality parameters for mainstream data as well as point and non-point source data. For headwater, every reach, hydraulic, point source, diffuse, and water quality data, tables on the spreadsheets are color-coded differently to show whether the column or row is for user input or the calculated output. User input is represented by blue and yellow, output values are represented by green, while calculated hydraulic input data labels, such as discharge flow and velocity, are shown by dark colours. With the use of the QUAL2K software, water quality modelling will be carried out to ascertain the consequences of various pollution discharges along the river. Moreover, several pollution discharge scenarios would be simulated using the QUAL2K software.

4 Result and Discussion

Table 2: *Parametric description at different sites (i)*

Sites	pH	TSS (mg/l)	DO (mg/l)	Nitrate (mg/l)	Hardness (mg/l)
Gaughat	7.55	417.5	3.3	44.795	175.5
Gulalaghat	7.765	465	2.65	42.68	175.5
Hussainabad	7.84	525.5	2.3	55.065	166
Kuriyaghat	7.88	485.5	4	45.87	149
Pakkapul	8.265	460	2.55	53.925	249.5
Mohan Meakin	8.585	565	1.95	31.275	214.5
Mankameshwar	7.54	494.5	2.15.	66.475	231
Hanuman setu	7.855	453.5	2.85	73.545	183.5
Laxman Mela	6.88	557.5	2.6	77.39	206
Gomti baragge	8.28	595	2.65	64.58	161

Table 3: *Parametric description at different sites (ii)*

Sites	EC (µmho/cm)	Norg (mgN/L)	TN (mgN/L)	Alkalinity (mgCaCO3/L)	TP (mgP/L)
Gaughat	400	730	16.556	420.81	0.511
Gulalaghat	595	750	16.759	421.29	0.511
Hussainabad	619	670	16.353	420.81	0.511
Kuriyaghat	575	610	9.48	359.87	0.5
Pakkapul	530	530	9.523	314.77	0.511
Mohan Meakin	804	660	9.601	306.5	0.511
Mankameshwar	650	650	4.149	394.75	0.531
Hanuman setu	689	630	5.666	376.75	0.521
Laxman Mela	705	730	4.696	241.38	0.511
Gomti baragge	678	530	6.907	331.9	0.511

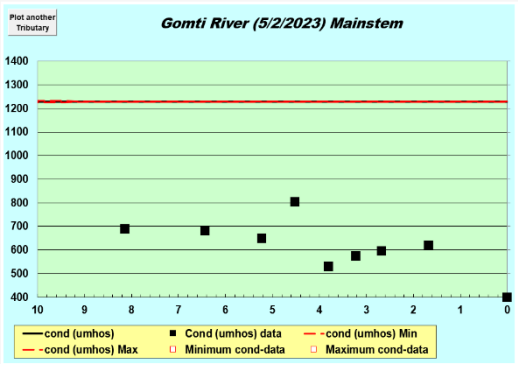

Figure 2: *Electricity Conductivity*

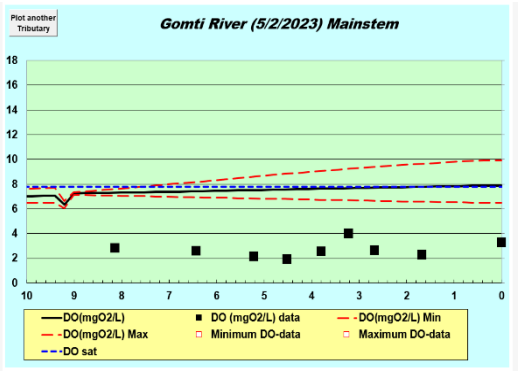

Figure 3: *Dissolve Oxygen*

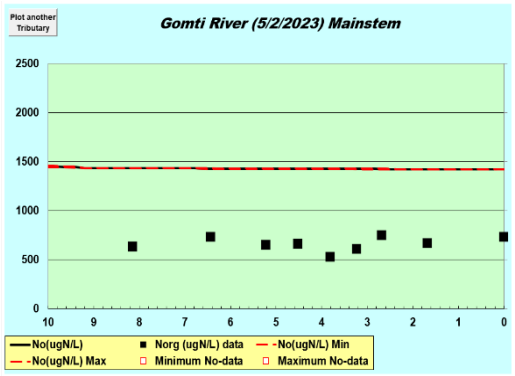

Figure 4:*Organic Nitrogen*

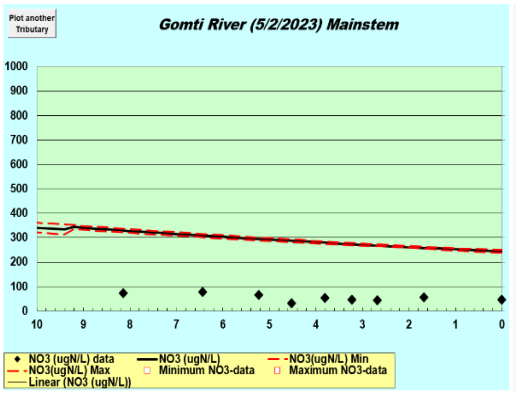

Figure 5: *Nitrate*

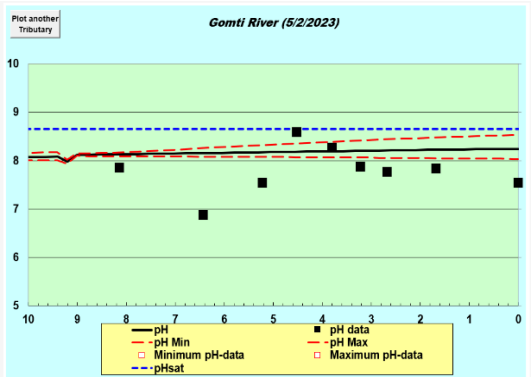

Figure 6: *pH*

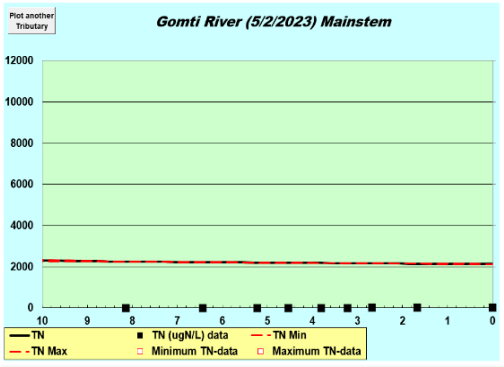

Figure 7: *Total Nitrogen*

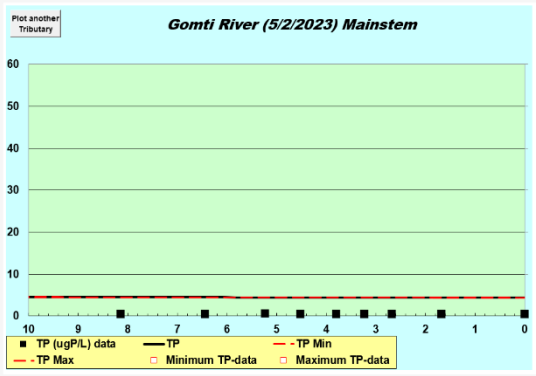

Figure 8: *Total Phosphorus*

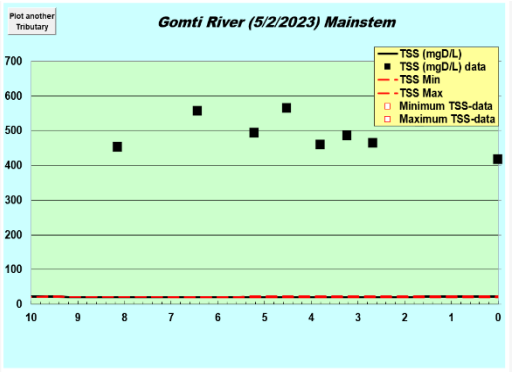

Figure 9: *Total Soluble Solid*

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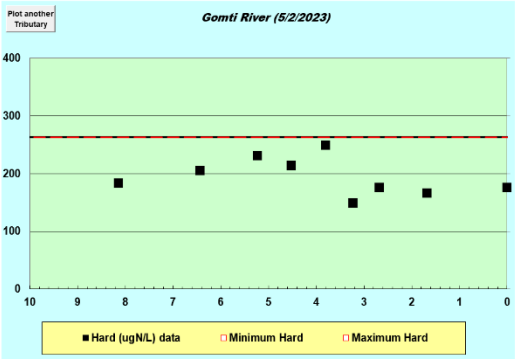

Figure 10: *Hardness*

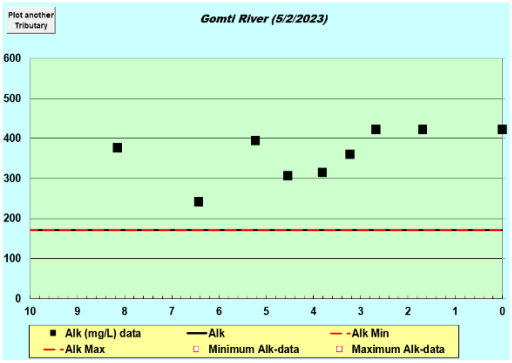

Figure 11: *Alkalinity*

In this study the results are summarized in Table 2 & Table 3, the minimum pH value 6.88 at Laxman Mela and maximum 8.59 at Mohan Meakin indicates that the water is mildly to moderately basic in character referring in figure 6. The level of dissolved oxygen is an impressive indicator of water contamination at Kuriyaghat, it reached a maximum of 4 mg/l and a minimum of 1.95 mg/l . With the exception of Gaughat and Laxman Mela, the majority of the sites were within the acceptable range of DO referring in figure 3.
Most commonly, the measurement of suspended solid-phase material concentrations in surface waters is done using total suspended solids (TSS) and it has a maximum desired limit of 500 mg/l. The maximum value was 595 mg/l at Ganga barrage , and the lowest value was 417.5 mg/l in Gaughat referring in figure 9 . Total Hardness has a maximum recommended level of 300 mg/l, Pakkapul has the highest total hardness reading 249.5 mg/l, and Kuriyaghat has the lowest reading 149 mg/l, so this parameter is in the allowable limit referring I figure 10. Nitrate in drinking water has been linked to health issues. The maximum nitrate concentration that is desirable for drinking water is 45 mg/l.
Nitrate concentrations ranged from 77.39 mg/l at the Laxman Mela to 31.27 mg/l at Mohan Meakin. With the exception of Kuriyaghat, Mohan Meakin and Gulaghat, the majority of the sites were above the allowable limit of nitrate referring in figure 5.

5 Conclusion

The graph obtained from Qual2k clearly shows that at some of the sites, the water was contaminated and needed conventional treatments because dissolved oxygen, total suspended solids, total dissolved solids, nitrate, and other parameters were not lie between allowable limit and had not been used for any beneficial purpose. Due to the discharge of domestic and industrial waste through numerous drains, the river is severely polluted in some areas. Domestic discharges were also to blame for the increase in chloride, nitrate, and total hardness values. The amount of dissolved oxygen in the water is a potent sign of pollution. For fish and other aquatic species, aquatic life depends on dissolved oxygen, which is dependent on water temperature. No aquatic life is feasible in rivers because of low dissolved oxygen levels. The amount of total soluble solid was higher, which reduced the amount of naturally dissolved oxygen in the water and raised the temperature. The alkalinity of water is a gauge of its acid-neutralizing power. Alkalinity is in excess, it can degrade water quality, promote algal blooms, and endanger aquatic life. Algae growth was decreases because there was less amount of total nitrogen and total phosphorus present in the river.

6 Publisher's Note

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7 How to Cite

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