# Assessment of Water Quality in Rapti River from Gorakhpur to Kaparwar Ghat in Uttar Pradesh

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*Abstract*— The Rapti, originally Irawati and then corrupted as Ravati has its source in the outer ranges of Nepal. After traversing Bahraich, Gonda and Basti it enters Gorakhpur district between Talnatwa and Bersar and after forming the boundary for a few kilometres, flows in a south easterly direction. It again forms the boundary from Rigauli to Juinaraynpur village between Basti and Gorakhpur districts. Thereafter it moves southwards and traversing about 20 km. It turns towards east and touches Gorakhpur city and again takes a turn towards south-east. It then flows in an extremely tortuous course and flowing south-east.it then flows in an extreme south-east corner of tehsil Bansgaon. Rapti river has a confluence into Ghaghara river at Kaparwar ghat near Barhaj. Rapti river is joined by Ami river, which carries polluted water from industrial sources, at Sohgaura. So, it is worthwhile to assess the water quality of Rapti river and the impact of the discharge of polluted water of Ami river into it at Sohgaura into Gorakhpur district. For this purpose, the stretch of Rapti river from Gorakhpur to Kaparwar ghat were chosen for water quality assessment. Nine sampling stations were selected along Rapti river at Koliyan north (S1), Khadkhadwan (S2), Rajghat bridge (S3), Dangipar (S4), Kashihar (S5), Sahgaura (S6), Gajpur (S8), Kotha (S9) and Aswanpar (S10). In addition one sampling station was chosen at Jarlahi (S7) along Ami river whereas three sampling stations at Muktidham (S11), Kaparwar ghat (S12) and Barhaj (S13) were chosen along Ghaghara river. Monthly samples were taken from all the sampling stations and were analysed for pH, TDS, DO, BOD, COD, MPN, Turbidity, Hardness and Chloride. The data were analysed and based on inferences suitable recommendations are made. The outcome of the study is indicative and suggested in many ways and may help in formulating the action plan toward the cleaning of river and saving it from the fury of industrial pollution from the pollutant carried by Ami River into the Rapti River. The best way of managing the problem is to stick through the saying "let the river remain a river".

***Key words:*** Aami River, Rapti River, Ghaghra River, Water Quality, DO, BOD, COD, MPN, TDS, Hardness, Chloride

## I. INTRODUCTION

Water is absolutely necessary for all forms of life. The pollution of water bodies poses a potential threat to public health and aquatic ecosystems. This necessitates not only looking with the availability and consumption of water but also the qualitative aspects related therewith.

It is imperative to realize the importance of water to our quality of life because the water problem is not only confined to the quantity of water available, but also to the quality of water available.

The main goal of the present study was to assess the impact of urban and industrial activities the water quality on of river Rapti in Eastern Uttar Pradesh. Importance of the work is to impart the knowledge and current developments in the area of water quality and its management to the field engineers and researchers working in the related area, so as to train them for better planning and design of water quality monitoring programs as well as for better management of water quality related issues and problems.

## II. SELECTION OF SAMPLING STATIONS

With a view to assess the water quality of Rapti river and the effect of discharge of polluted water from Ami river into it at Sohgaura, nine sampling stations were selected along its stretches from Gorakhpur to Kaparwar ghat namely, Koliyan North, Khadkhadwan, Rajghat Bridge, Dangipar, Kashihar, Sohgaura, Gajpur, Kotha and Aswanpar. Of these, Koliyan north is located upstream of confluence of Rohini river with Rapti river. Sampling stations Khadkhadwan, Rajghat bridge, Dangipar and Kashihar are located downstream of confluence of Rohini river into Rapti river and upstream of confluence of Ami river into Rapti river. Another sampling station is selected at the confluence of Ami river into Rapti river at Sohgaura .


Fig.1: Location of sampling stations along the river.

A sampling station is also selected at Jarlahi along Ami river to assess the water quality prior to its discharge into Rapti river at Sohgaura.

 

Further three sampling stations, namely, Gajpur, Kotha and Aswanpar are selected along Rapti river downstream of Sohgaura. Also, three sampling stations are selected along Ghaghara river,namely, Kaparwar ghat at the confluence of Rapti river into Ghaghara river and Muktidham at upstream and Barhaj at the downstream location.

Thus nine stations among all the thirteen sampling stations are located along Rapti river, one station on Ami river and three stations along Ghaghara river. A line diagram of the stretch showing various sampling stations is shown in Fig.1.

## III. ANALYTICAL METHODS

Midstream surface water samples were collected in plastic bottles and stored in ice box for analysis from all the thirteen sampling stations. The samples were analyzed for the physico-chemical and biological parameters namely pH (Electrometric Method), turbidity (Nephelometric Method), total dissolved solids (Digital meter), dissolved oxygen (Winkler's Method), biochemical oxygen demand (5 day incubation method), chemical oxygen demand (Dichromate reflux method), chloride (Argentometric method), hardness, and MPN of E. coliforms (Multiple dilution Method).

## IV. RESULTS AND DISCUSSION:

The data collected by sampling at various locations are analyzed and the results are discussed here for various water quality parameters.

### *A. pH*

pH data obtained by digital pH meter as mentioned in Table-3.1 are presented in Fig.4.1,which depicts the monthly variations during the monitoring period at various sampling stations i.e. S1-S6 and S8-S10 on Rapti river, S7 on Ami river and S11-S13 on Ghaghara river.

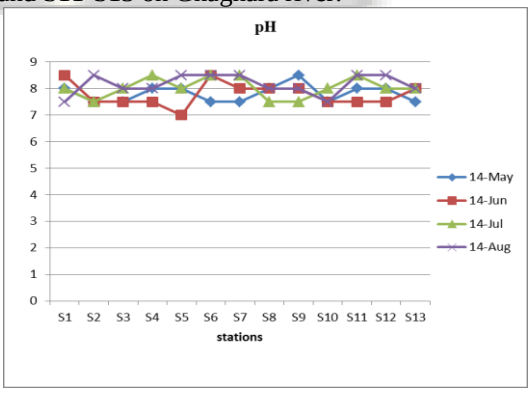


Fig. 4.1 (a): Monthly Variation in pH at all the sampling stations

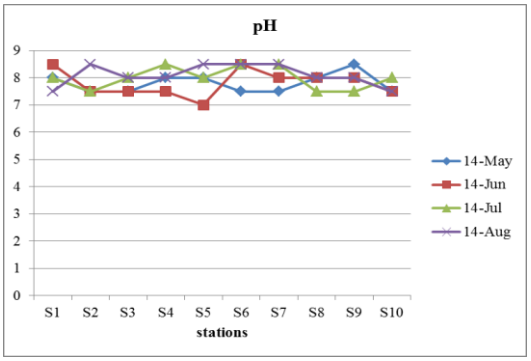


Fig. 4.1(b): Monthly Variation in pH at stations on Rapti river where S7 is the station at Ami river

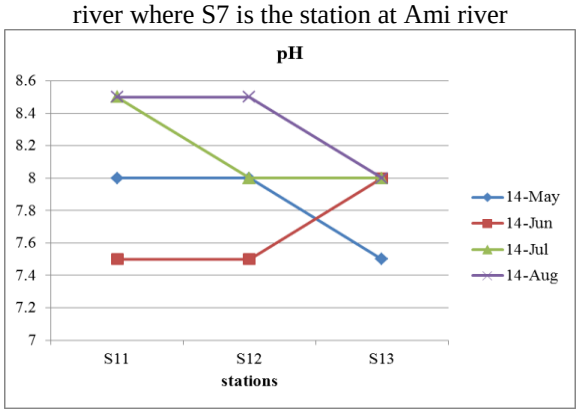


Fig. 4.1(c): Monthly Variation in pH at stations on Ghaghara river

A review of pH data with respect to water quality criteria prescribed by Central Pollution Control Board in terms of pH reveals that the river water quality confirms to pH range desired for Class-A, Class-B and Class-C waters.

### *B. Turbidity*

Turbidity was measured by using Nephalo-turbidity meter, and the data are summarized in Table – 3.3 which depicts the monthly variations during the monitoring period at various sampling stations i.e. S1-S6 and S8-S10 on Rapti river, S7 on Ami river and S11-S13 on Ghaghara river. As per the primary water quality criteria for class- B waters the turbidity should not exceed 30 NTU.

The monthly variations as shown in Fig. 4.2 shows that the water is generally found turbid and the maximum turbidity is observed at Jarlahi in Ami river followed by Sahgaura the meeting point of Ami and Rapti river.

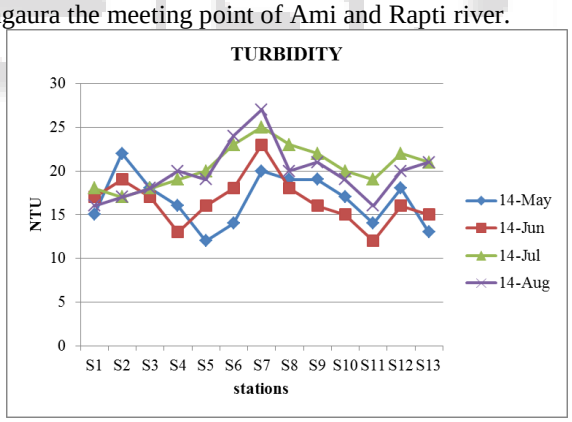


Fig. 4.2(a): Monthly Variation in turbidity at all the sampling stations

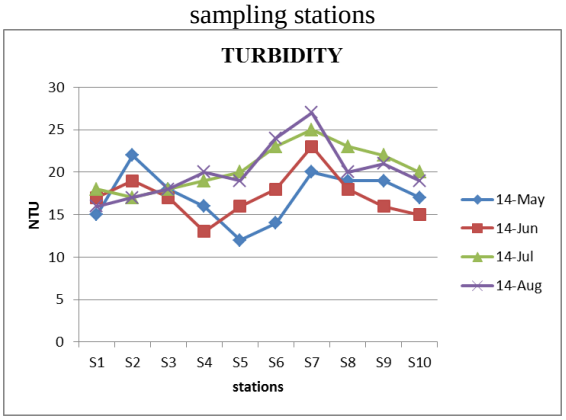


Fig. 4.2 (b): Monthly Variation in turbidity at stations on Rapti river where S7 is the station at Ami river

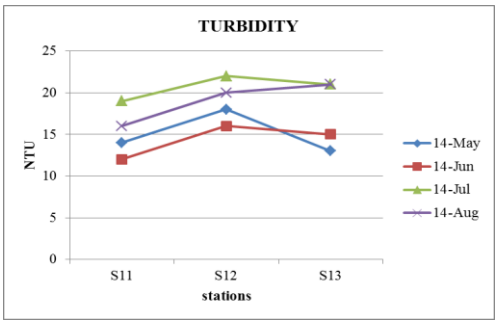


Fig. 4.2(c): Monthly Variation in turbidity at stations on Ghaghara river

*C. Total Dissolved Solids*

The total dissolved solids measured at various sampling locations are mentioned in Table- 3.3 and their monthly variation is shown in Fig. 4.3 which depicts the monthly variations during the monitoring period at various sampling stations i.e. S1-S6 and S8-S10 on Rapti river, S7 on Ami river and S11-S13 on Ghaghara river. It is revealed that the total dissolved solids shows a peaking tendency at sampling locations Sahgaura and Jarlahi. This also indicates the effect of industrial waste water discharged on river water quality.

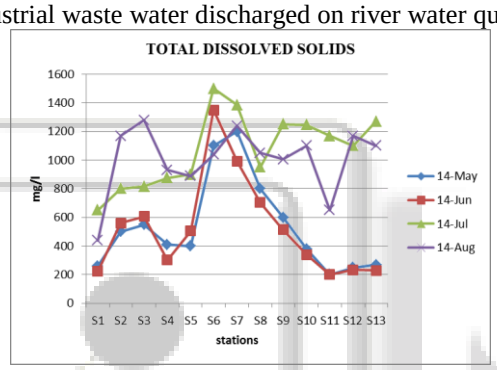


Fig. 4.3(a): Monthly Variation in TDS at all the sampling stations

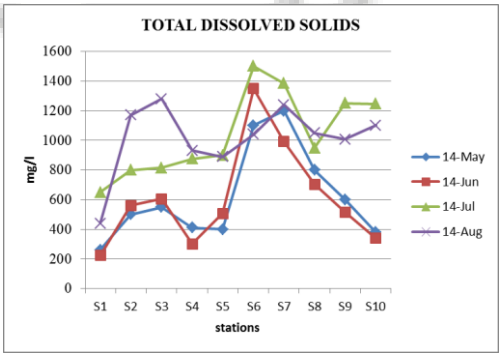


Fig. 4.3(b): Monthly Variation in TDS at stations on Rapti river where S7 is the station at Ami river

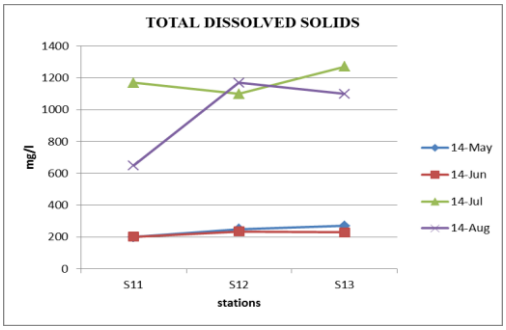


Fig.4.3 (c) Monthly Variation in TDS at stations on Ghaghara river

*D. Dissolved Oxygen*

The dissolved oxygen data pertaining to various sampling locations are given in Table- 3.4 and the variation with respect to time is depicted in Fig.4.4 which depicts the monthly variations during the monitoring period at various sampling stations i.e. S1-S6 and S8-S10 on Rapti river, S7 on Ami river and S11-S13 on Ghaghara river.

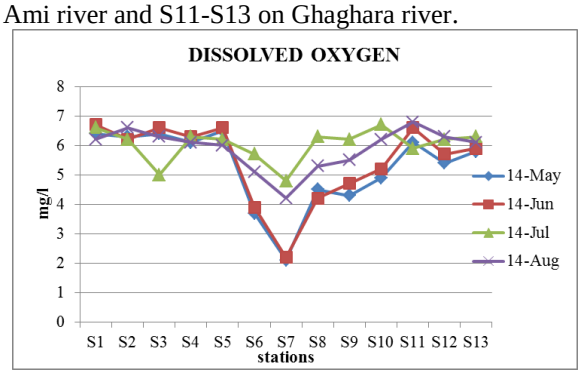


Fig. 4.4(a): Monthly Variation in DO at all the sampling stations

It is known that not less than 4.2 mg/l of dissolved oxygen is necessary at any time for the protection of aquatic life. In this context it may be clearly seen from the above graph that the DO of Ami river at Jarlahi and Sahgaura is below 4.0 mg/l in the pre- monsoon season. It is also seen that the polluted water of Ami river has its impact on Rapti river in terms of reduction of DO at Sohgaura and recovery till it reaches Aswanpar. The DO values confirms to the quality of river water to be in class-A till Sahgaura where the polluted water of Ami river mixes with it. However a degradation in DO value is observed downstream of Sohgaura, which remains in the recovery phase till Aswanpar and also effect DO level in Ghaghara river after the water of Rapti river get mixed with that of Ghaghara river at Kaparwar ghat.

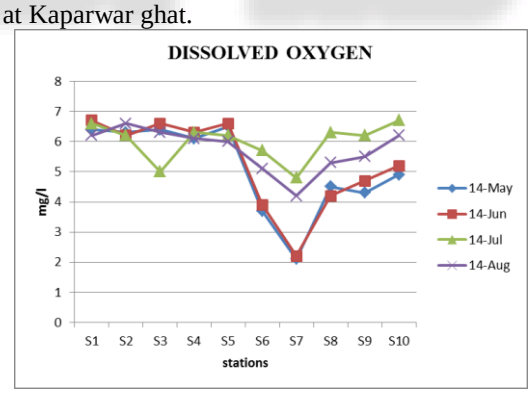


Fig. 4.4(b): Monthly Variation in DO at stations on Rapti river where S7 is the station at Ami river

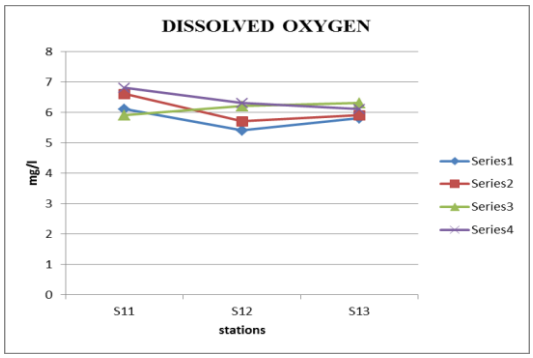


Fig. 4.4 (c): Monthly Variation in DO at stations on Ghaghara river

*E. Biochemical Oxygen Demand*

The biochemical oxygen demand data presented in Table-3.5 are depicted here in Fig. 4.5 which depicts the monthly variations during the monitoring period at various sampling stations i.e. S1-S6 and S8-S10 on Rapti river, S7 on Ami river and S11-S13 on Ghaghara river.

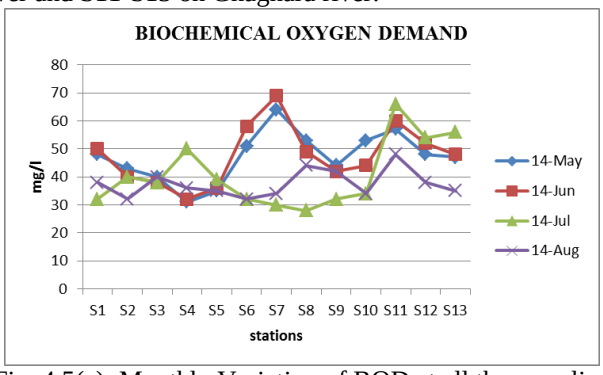


Fig. 4.5(a): Monthly Variation of BOD at all the sampling stations

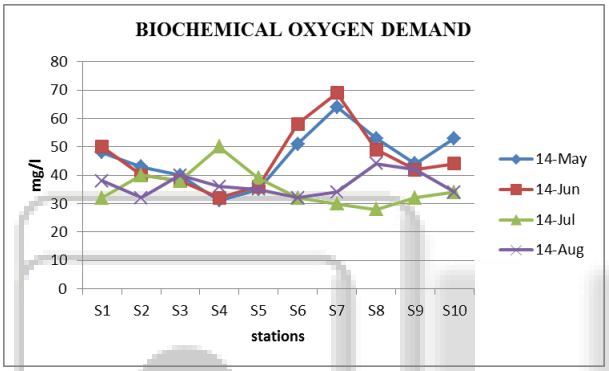


Fig. 4.5(b): Monthly Variation in BOD at stations on Rapti river where S7 is the station at Ami river

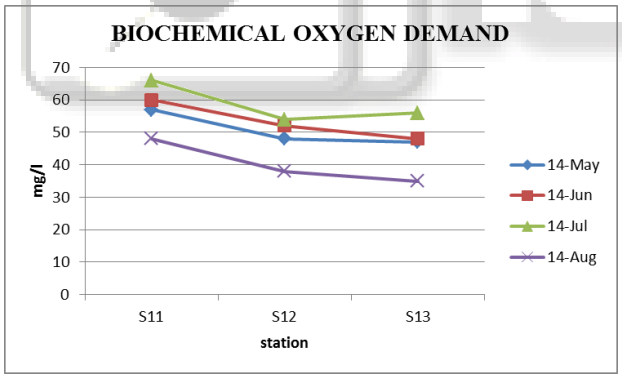


Fig.4.5 (c) Monthly Variation in BOD at stations on Ghaghara river

As per the norms, BOD of Class-C water should not be more than 4.0 mg/l. As against this successively high value of BOD in river water indicates high organic pollution in the all the three rivers under study, namely Rapti, Ami and Ghaghara river.

After the highly polluted locations of Sahgaura and Jarlahi along Rapti and Ami river respectively, a high BOD water is observed in Ghaghara river clearly seen near Muktidham at Barhalganj, which might be due to the cremation of dead bodies and dispersing the unburnt part and organic matter into the Ghaghra river.

*F. Chemical Oxygen Demand*

COD data are incorporated in Table-3.6 and depicted in Fig.4.6 which depicts the monthly variations during the monitoring period at various sampling stations i.e. S1-S6 and S8-S10 on Rapti river, S7 on Ami river and S11-S13 on Ghaghara river notably the COD for discharging. sewage and trade effluent into stream is prescribed to be less than 250 mg/l. With respect to this the values of COD of water in Ami river in various months, indicate as if the river water may be worse or less like a waste stream before it mixes with the water of Rapti river.

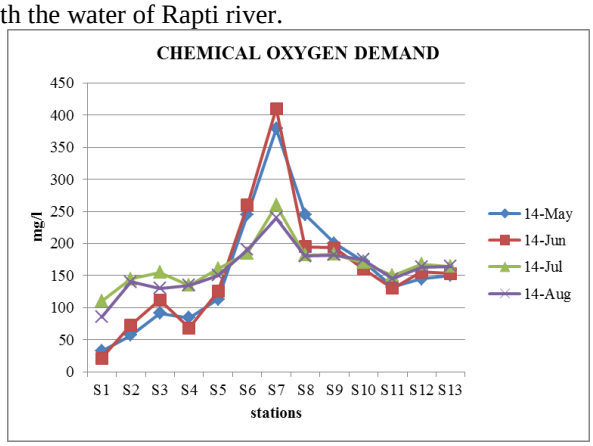


Fig. 4.6(a): Monthly Variation in COD at all the sampling stations

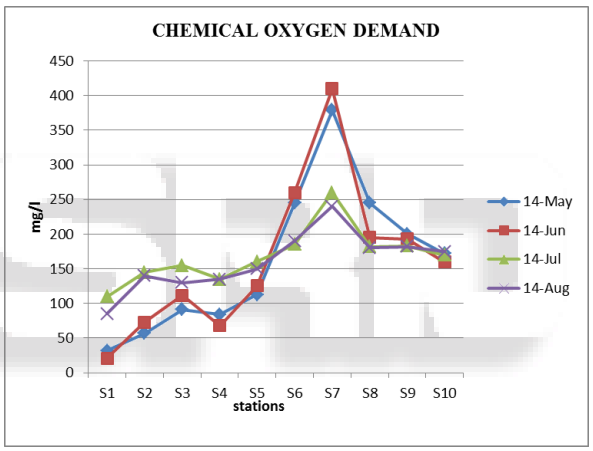


Fig. 4.6(b): Monthly Variation in COD at stations on Rapti river where S7 is the station at Ami river

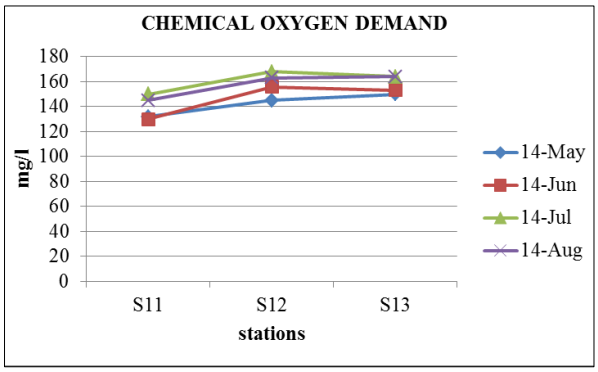


Fig. 4.6(c): Monthly Variation in COD at stations on Ghaghara river

This study reveals that the COD value of Ami river at Jarlahi is quite high and has a severe deteriorating effect on Rapti river at Sohgaura. The water of Rapti river remains in recovery phase even beyond Aswanpar till it meets Ghaghara river at Kaparwar ghat.

*G. Chloride*

The chloride data is presented in the Table-3.7 and its variation is depicted in Fig.4.7 which depicts the monthly

variations during the monitoring period at various sampling stations i.e. S1-S6 and S8-S10 on Rapti river, S7 on Ami river and S11-S13 on Ghaghara river. A review of the obtained graph reveals that there is no abrupt variation in the chloride concentration at any sampling locations even though minor variation are noticeable in time and space.

Thus it can be inferred that no significant contribution of municipal waste water discharge is observed at various sampling points along the river.

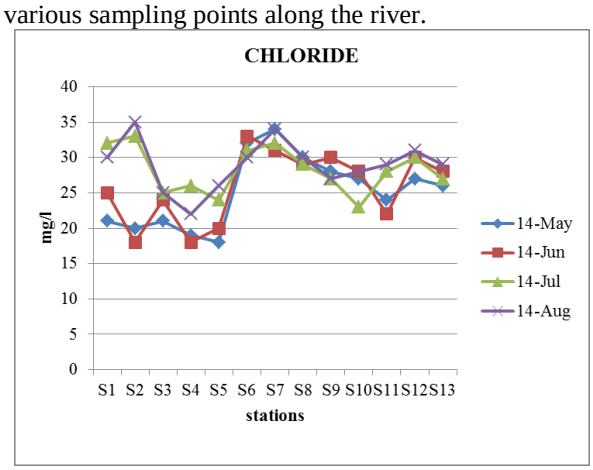


Fig. 4.7(a): Monthly Variation in Chloride at all the sampling stations

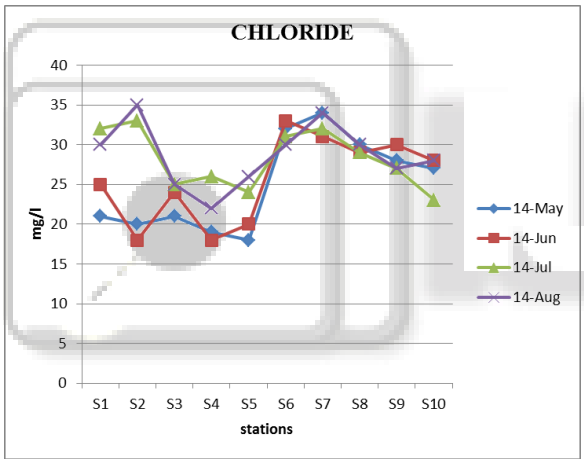


Fig. 4.7(b): Monthly Variation in chloride at stations on Rapti river where S7 is the station at Ami river

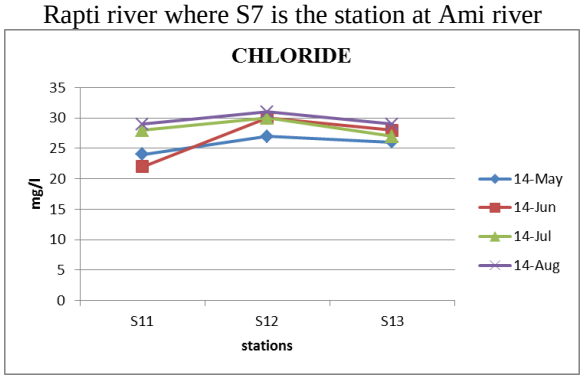


Fig. 4.7(c): Monthly Variation in Chloride at stations on Ghaghara river

*H. Most Probable Number*

M.P.N. data obtained from river water at various sampling locations are included in Table-3.8 and the monthly variation is plotted in Fig. 4.8 which depicts the monthly variations during the monitoring period at various sampling stations i.e. S1-S6 and S8-S10 on Rapti river, S7 on Ami river and S11-S13 on Ghaghara river. As per the requirements of the Water Quality Criteria prescribed by Central Pollution Control Board waters M.P.N. of total coliform /100 ml should be 50 or less for Class-A waters, 500 or less for Class-B waters and 5000 or less for Class-C waters. Thus the quality of water in Rapti river is below Class-C at sampling stations S1 – S5 in the entire sampling period.

However, in the month of May and June,2014, it falls in Class-C in terms of MPN of sampling stations S6 to S10 whereas in only and August,2014, there is a mixed trend of Class-C and below. M.P.N. of total coliform/ 100 ml observed in the water of all the rivers is found quite high at all the sampling stations this reveals the bacteriological quality of river water is not good. It may therefore, be recommended to restored to proper disinfection of treated effluents before discharging into these rivers anywhere.

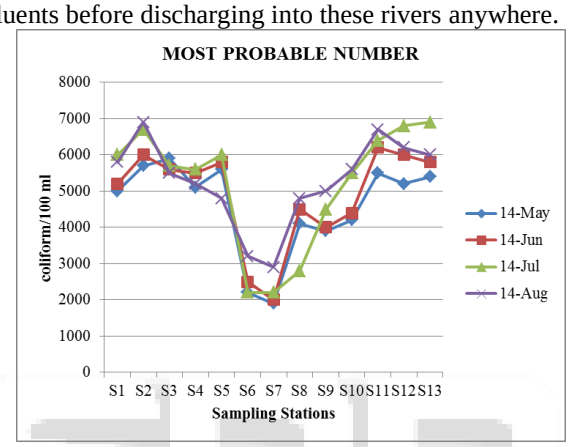


Fig. 4.8(a): Monthly Variation in MPN at all the sampling stations

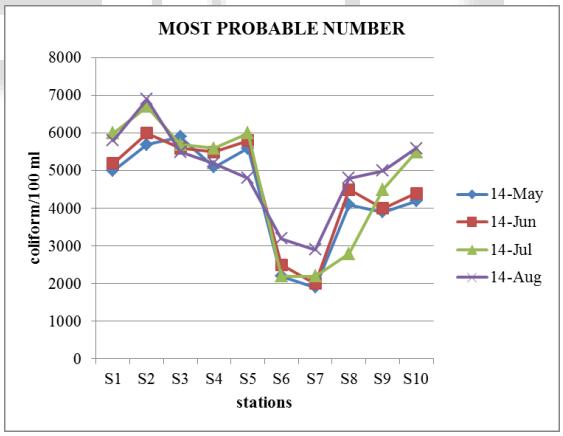


Fig. 4.8(b): Monthly Variation in MPN at stations on Rapti river where S7 is the station at Ami river

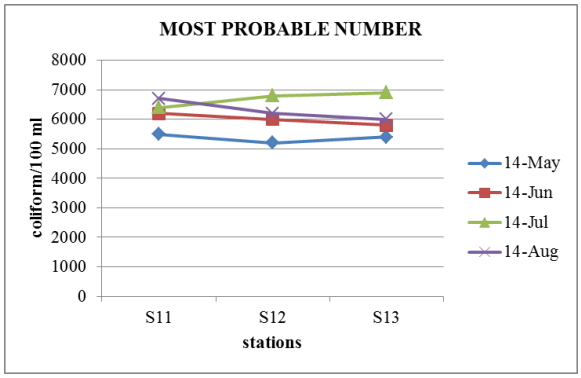


Fig. 4.8(c): Monthly Variation in MPN at stations on Ghaghara river

### *I. Hardness*

Hardness data obtained from river water at various sampling locations are included in Table-3.9 and the monthly variation is plotted in Fig. 4.9

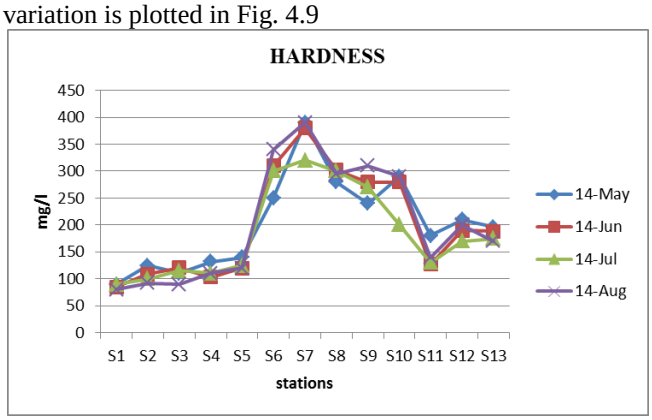


Fig. 4.9(a): Monthly Variation in hardness at all the sampling stations

These graphs depicts the monthly variations during the monitoring period at various sampling stations i.e. S1-S6 and S8-S10 on Rapti river, S7 on Ami river and S11-S13 on Ghaghara river. It is observed from the graphs that high value of hardness is found at Sahgaura and Jarlahi. Based on the results and discussion the recommendations and conclusions are presented in the next chapter.

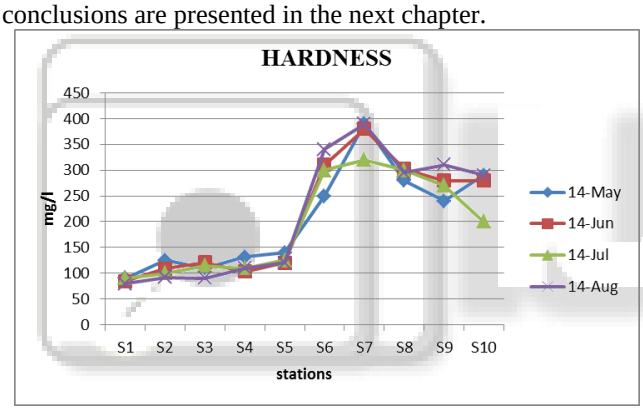


Fig. 4.9(b): Monthly Variation in hardness at stations on Rapti river where S7 is the station at Ami river

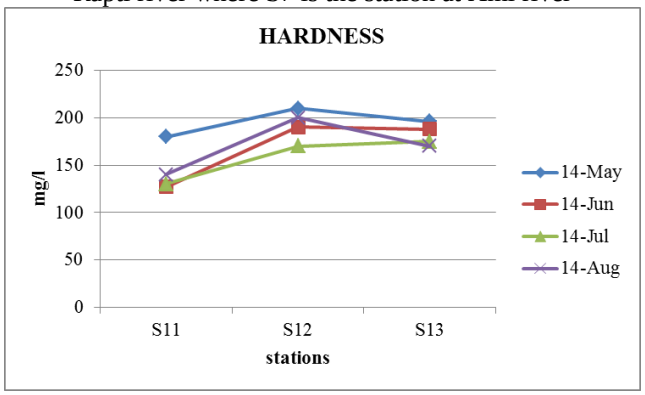


Fig. 4.9(c): Monthly Variation in hardness at stations on Ghaghara river

A glance at figures 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8 and 4.9 reflects that there is a noticeable impact of the pollution of Ami river on the quality of water in Rapti river at confluence point S6 at Sohgaura and downstream points S8, S9 and S10 located at Gajpur, Kotha and Aswanpar respective in terms of TDS, DO and organic matters.

It is also observed that the deterioration of water quality of Rapti river at downstream locations after Sohgaura remains mostly in recovery phase till it meets Ghaghra river at Kaparwar ghat, due to this season , it is also polluting Ghaghra river by and by.

## V. CONCLUSIONS AND RECOMMENDATIONS:

The present study incorporates the assessment of water quality of Rapti river from Gorakhpur to Kaparwar ghat with an intension to investigate the impact of discharge of polluted water from Ami river into Rapti river at Sohgaura and its likely impact on the quality of Ghaghra river.

The study spread over the collection of water quality data at nine locations from Rapti river, one sampling location from Ami river and three sample locations from Ghaghra river and analysis of data in respect of various water quality parameters has revealed the following:

1) It is found that discharge of polluted water from Ami river is deteriorating the water quality in Rapti river from the confluence point at Sohgaura and downstream till it meets Ghaghra river at Kaparwar ghat, which is supported by the data relating to dissolved oxygen (DO), COD and TDS.
2) The COD of water in Ami river at Jarlahi, which is located before its point of confluence into Rapti river at Sohgaura, is found to be more or less like a waste water stream, which indicates a high degree of pollution in Ami river at upstream locations. Considering the fact that the ill-fated river receives the industrial effluents from various industrial units located at Rudhauli , Sant Kabir Nagar and GIDA industrial area and municipal waste water from Khalilabad and Maghar towns, it is recommended that adequate treatment facilities should be setup and operated in accordance with regulatory norms. In view of the fact that the lean season flow in Ami river is low and its capacity to take up the pollution load is limited, it is recommended that no treated or untreated waste water should be disposed into the river. The study has also revealed that the deterioration in water quality of Rapti river at Sohgaura due to the discharge of polluted water from Ami river into it continues to remain in the recovery phase till its confluence into Ghaghra river at Kaparwar ghat. Hence it is likely that it will have a gradual deteriorating effect on water quality of Ghaghra river, which may eventually be a point of concern in due course.
3) Considering high BOD and COD values observed at various sampling locations along all the three rivers, it is suggested that suitable arrangements should be made for treating various waste water streams joining these rivers. With reference to Rapti river, the establishment of sewage treatment plant and biomass gasifier based cremation system or electric cremation with power backup at Gorakhpur city may be a step towards restoration of good quality of water flowing into the river.
4) The water quality data of Ghaghra river upstream and downstream of Kaparwar ghat reveals that the water qualities at Muktidham is worse than that at Kaparwar ghat and Barhaj. It is expected that, with the commissioning of the biomass gasifier based cremation system, which is under construction at present, the status of water quality may improve.

It is realized that the water quality management in rivers should be taken up at high priority. In the present situation the quality of Ami river has been found worsened like anything due to rampant discharge of industrial pollution into it. It is stabilized from the study that it is also having adverse impact on water quality of Rapti river which in turn purifies to some extent and carries the remaining pollution load to Ghaghra river. If adequate attention is not given to the problem at the present it may assume worriable dimensions in the future. It may therefore be concluded that a scientifically planned and well-coordinated river quality management program may go a long way towards saving Ami, Rapti and Ghaghra Rivers from the adverse effects of pollution in the near future.

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