A Study on Water Quality of Ami River in Uttar Pradesh

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Abstract

Ami river, which is tributary of Rapti river on its right bank receives industrial effluents at several locations in a major stretch starting from Rudhauli to its confluence point at Sohgaura into Rapti river. The river water which use to be quite clear in ancient time, is presently affected severely by industrial pollution ever since the establishment of paper mill at Khalilabad, distillery and sugar unit at Rudhauli at GIDA near Sahjanwa in 1989. As the river has been the life line of the population located in the nearby villagers across its serpentine length of 126 km from Sohnara to Sogaura, it is necessary to look into the qualitative aspect of river water in time and space. With this in view a study on water quality of Ami River is attempted in this work. For this purpose water samples taken from nine sampling stations, namely Sohanara, Rudhauli, Khalilabad, Maghar, Sahjanwa (near IGL), Adilapar, Chhatai bridge, Jarlahi and Sohgaura over a period of six month from August, 2009 to February, 2010, were analyzed and the results were reviewed. The parameters included pH, Temperature, Turbidity, Electrical conductivity, Colour, Odour, Total Solids, Total Suspended Solids, Total Dissolved Solids, Dissolved Oxygen, Biochemical Oxygen Demand, Chemical Oxygen Demand, Chloride, Total Alkalinity, Oil and Grease, Total Kjeldahl Nitrogen, MPN. It is found that its entire stretch from Rudhauli to Chhatai bridge with a very little recovery up to its point of influence in Rapti river. It is also reveals that, due to critically low D.O. levels the aquatic ecosystem is severly affected from Khalilabad to Chhatai bridge. A very high organic load in terms of B.O.D. and C.O.D. is shown into the river, which results in an irreparable loss the river system. It is noticed that a very high waste load is thrown into the river at various point, which is beyond the self-purification capacity of stream and the river is not able to recover itself in a body of clean water starting from Rudhauli to its confluence into Rapti river. The most sad part of the outcome is that the river, which was in class – A ahead of its point of origin, is deteriorates so much due to industrial pollution, that it is ultimately converted into a water bodies below Class – E. the necessitates urgent step towards the restoration of water quality and regeneration of river ecosystem, which may require a coordinated effort among government agencies, industrial units, local bodies and public at large. The outcome of the study is indicative and suggested in many ways and may help in formilating the action plan towards the cleaning of river and saving it from the fury of industrial pollution. The best way of managing the problems is to stick through the same, 'let the river remain a river'.

"1. INTRODUCTION"

Water is absolutely necessary for all forms of life. Because of its ubiquitous nature, 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. Water quality impairment is often a trigger for conflict in a watershed, simply because degraded water quality means that desired uses are not possible or not safe (Heathcote, 1998).

Ami River is a meandering river which originates from Sohanara and serves as a lifeline for the people of Siddarth Nagar, Sant Kabir Nagar, Basti and Gorakhpur district in Eastern Uttar Pradesh. It travels a distance of about 126 km and drains into Rapti in Gorakhpur district of Uttar Pradesh. It has been observed that people of this region suffer from water-borne health problems; therefore water samples were collected to analyse its quality along the entire length of Ami River.

The main goal of the present study was to assess the impact of urban and industrial activities on the water quality of river Ami 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 programmes as well as for better management of water quality related issues and problems.

"2. THE STUDY AREA"

Ami river is a tributary of Rapti river and flows through the Gangetic plains to find its way into Rapti river on right bank. The river originates from Sohnara located in Dumariaganj Tehsil of Siddarth Nagar district and flows through Basti and Sant Kabir Nagar district before meeting of Rapti river near Sohgaura village in Gorakhpur district. The location of study area is shown in Fig.1.

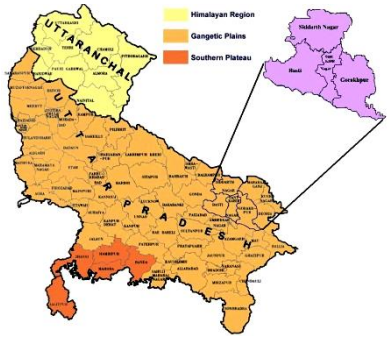

Fig. 1: The Study Area

The tributaries of the Rapti on its right bank are Ami and Taraina. The former rises near Rasulpur in Siddharthnagar district and enters Gorakhpur district near Rampur. Then it flows towards south-east falling into the Rapti near Sohgaura in paragana Bhauapar. It is a narrow and sluggish stream saves in rains when its swollen water developed into the Amiar Tal. The spill from the Rapti during heavy floods enters the Ami catchment, submerging the country as for west as the high right bank, save for two islands of bangar which always remain above the flood level. One stretches from Kalesar to Newas along the south side of the Basti - Gorakhpur road and the other lies on either side of the Azamgarh road from Hardia to Malaon.

Ami River is the tributary of Rapti river that flow in the eastern plain of Uttar Pradesh. Uttar Pradesh is between latitude 24°-31°N and longitude 77°-84°E. Area wise, it is the fourth largest state of India. The Gangetic plain occupies three quarters of the state except for the northern region, has a tropical climate. In the plains, January temperatures range from 12.5°C-17.5°C and May records 27.5°-32.5°C, with a maximum of 45°C. Rainfall varies from 1,000-2,000 mm in the east to 600-1,000 mm in the west.

"3. SELECTION OF SAMPLING LOCATION"

Water samples of Ami river were collected from nine sampling locations namely Sohanara, Rudhauli, Khalilabad, Sahjanwa (near IGL), Adilapar, Chhatai, Jarlahi and Sohgaura. The first sampling location Sohanara signifies nearly natural water quality because it is the origin point of the river. The second location is Rudhauli because a sugar mill and distillery situated in that area and discharges their waste water into the river. The third location is near Khalilabad, where paper mill effluent is discharged into the river. Fourth location Maghar is very critical in the sense that municipal waste water also joins here the river water, which is already carrying industrial effluents from upstream locations. The fifth location is near the India Glycol Limited (IGL) at Sahajnwa. Sixth location is at Adilapar Village, which is also very critical because industrial effluent from GIDA is discharged through a drain into the river and the pollution load is quite high. The seventh location is Chhatai bridge near Khajani and the eighth location is at Jarlahi bridge. The last and ninth location is Sohgaura which is the meeting point of Ami River with Rapti river on its right bank. A line diagram showing the location of sampling stations is shown in Fig.2.

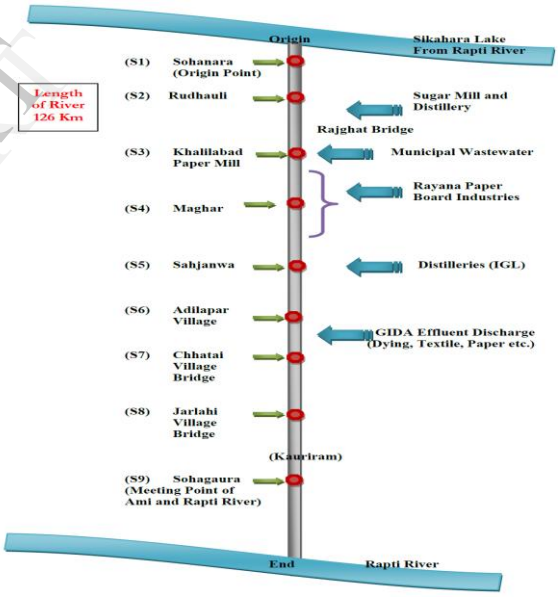

Fig 2: Location of sampling stations along Ami River

"4. MATERIALS AND METHODS"

Midstream surface water samples were collected in plastic bottles and stored in ice box for analysis from all the nine sampling stations. The samples were analysed for the physico-chemical and biological parameters namely pH (Electrometric Method), temperature (Thermometric Method), electrical conductivity (Conductivity Meter), turbidity (Nephelometric Method), total solids and total dissolved solids (Gravimetric Method), dissolved oxygen (Winkler's Method), biochemical oxygen demand (5 day incubation method), chemical oxygen demand (Dichromate reflux method), alkalinity

(Titration Method), Total Kjeldahl Nitrogen (Titration method), oil and grease (partition-gravimetric method), chloride (Argentometric method) and MPN of E. coliforms (Multiple dilution Method).

"5. RESULTS AND DISCUSSION"

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

5.1. pH

pH data obtained by digital pH meter as mentioned in Fig.5.1, which depicts the monthly variations during the monitoring periods.

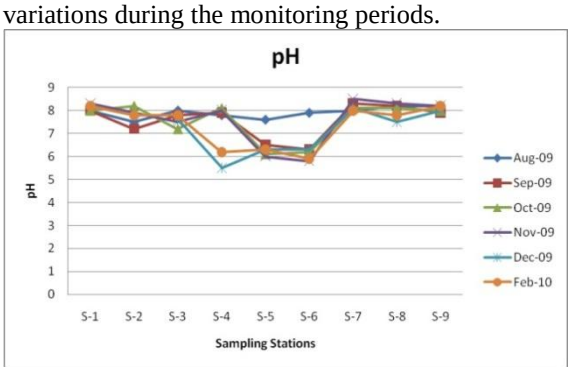

Fig. 5.1 Monthly Variation in pH

A review of pH data with respect to primary water quality criteria prescribed by Environment Protection Act, 1986 in terms of pH required in the range 6.5-8.5 for Class-A waters reveals that the river water quality does not conform to the norms at Khalilabad paper mill sampling location (S3) in December 2009 and February 2010, Sahjanwa (near IGL) from October 2009 to February 2010 and Adilapar village from September 2009 to February 2010. These sampling locations receive industrial waste water from Khalilabad paper mill, India Glycols Limited and GIDA drain from upstream side. Considering the prevalent condition beyond norms in terms of time period sampling location at Adilapar (S6), which receives industrial effluents from GIDA drain on upstream side, is affected the most. Next to this location is Sahjanwa (near IGL) (S5), which receive the industrial effluents from India Glycols Limited followed by Khalilabad paper mill sampling location (S3), which receive the paper mill effluent on upstream side. Thus it is seen that there the discharge of industrial effluent into Ami river is affecting adversely the water quality in terms of pH.

5.2 Temperature

The temperature of river water at various sampling locations, which was measured by using mercury thermometer, is summarized in Fig. 5.2. It is found that variation of temperature ranges between 17.2 °C and 24.0 °C. As per the standards, the temperature should not 40 °C in any section of the stream within 15 meter downstream from the effluent outlet. Thus it is reflecting that the temperature variation is within the normal limits and the river water quality is not affected by thermal pollution.

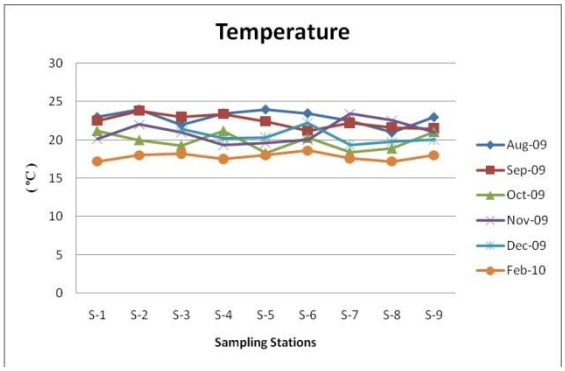

Fig. 5.2 Monthly Variation in Temperature

5.3 Turbidity

Turbidity was measured by using Nephalo-turbidity meter, and the data are summarized in Figure 5.3. 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. 5.3 reflect that at Khalilabad paper mill sampling location (S3), the turbidity exceeds the limit in the months October, 2009, November - 2009 and Fcbruary-2010, while it is touching the higher level in the months September and December - 2009.

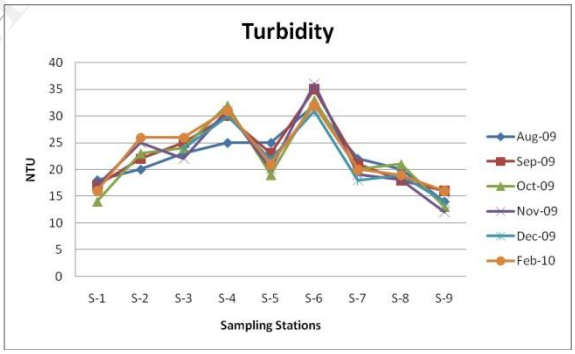

Fig. 5.3 Monthly Variation in Turbidity

Obviously this is observed due to the mixing of paper mill effluent on the upstream side of the sampling location. At the Adilapar village where - GIDA drain discharges into Ami river on the upstream side the turbidity exceeds the norms during the entire observation periods. The deterioration in water quality in terms of turbidity is problematic situation in the river as the high value affect the transparency of water and thereby, affecting healthy functioning of river ecosystem due to poor transmission of sunlight up to the full depth of river.

5.4 Electrical conductivity

The electrical conductivity data obtained by conductivity meter, which are presented in Fig. 5.4 for the entire observation periods. As per the Primary Water Quality Criteria for Class-E waters, the electrical conductivity should not exceed 2250µmho/cm. As against this, the conductivity

data at all the sampling locations are found within the limit. However a rising trend in Electrical conductivity data after Rudhauli (S2) till Chhatai Bridge (S7) indicate the effect of industrial effluents being discharged into river water in this stretch.

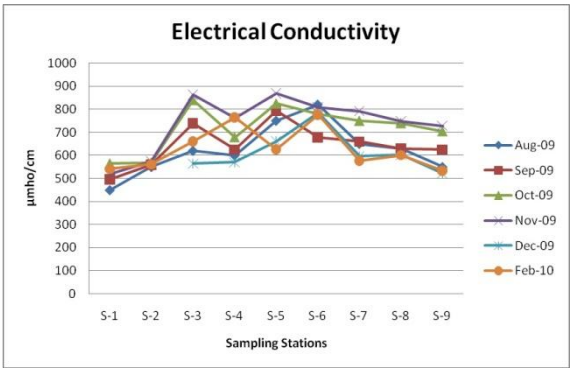

Fig. 5.4 Monthly Variation in Electrical Conductivity

5.6 Colour

A glance at Table – 5.1 incorporating colour data observed visually reflects that the river water possess noticeable colour different from natural (Muddy) colour appearance from sampling location Rudhauli (S2) to Chhatai Bridge (S7).

Stations	Months					
	Aug-09	Sept-09	Oct-09	Nov-09	Dec-09	Feb-10
S-1	Muddy	Muddy	Muddy	Muddy	--	--
S-2	Muddy	Muddy	Greenish	Light Grey	--	--
S-3	Light Brown	Light Brown	Light Brown	--	Blackish	Greenish
S-4	Greenish	Greenish	Greenish	--	Yellowish green	Yellowish green
S-5	Reddish	Reddish	Reddish	--	Blackish	Blackish
S-6	Blakish	Blakish	Blakish	Blakish	Black	Black
S-7	Muddy	Muddy	Muddy	Grayish	Muddy	Muddy
S-8	Muddy	Muddy	Muddy	--	Muddy	Muddy
S-9	Muddy	Muddy	Muddy	Muddy	Muddy	Muddy

Table 5.1: Colour (Colour observed visually)

In accordance with relevant norms prescribed for Class-A waters, there should be no noticeable colour in river water. Thus it is obvious that the entire stretch of Ami river from Rudhauli to Chhatai bridge is affected by the discharge of industrial effluent into the river.

5.7 Odour

Odour data collected by direct smelling presented in Table – 5.2 reveals adverse condition in the river starting from sampling locations Rudhauli (S2) to Chhatai Bridge (S7) in accordance with the relevant norms for Class-A waters there should be no offensive odour in the river water. Contrary to this the river water is characterized by pungent smell from sampling locations Rudhauli (S2) to Chhatai Bridge (S7). The alcoholic smell in river water at sampling location Sahjanwa (near IGL) indicates the versioning of river water quality.

Stations	Months					
	Aug-09	Sept-09	Oct-09	Nov-09	Dec-09	Feb-2010
S-1	Earthy	--	--	--	--	--
S-2	Earthy	Pungent	Pungent	Pungent	--	--
S-3	--	--	--	Pungent	--	Pungent
S-4	Pungent	--	--	--	--	--
S-5	Alcoholic	Alcoholic	--	--	--	--
S-6	Pungent	Pungent	Pungent	Pungent	Pungent	Pungent
S-7	Earthy	Pungent	Pungent	Pungent	--	--
S-8	Earthy	--	--	--	--	--
S-9	Earthy	--	--	--	--	Earthy

Table 5.2: Odour (Observed by direct smelling)

5.8 Total Solids

Total solids measured at various sampling locations and the monthly variation is shown Fig. 5.5. It is revealed that total Solids in the river water range between 1096 and 1870 mg/l during the observation periods. The increasing strength of total Solids at sampling locations Rudhauli (S2), Khalilabad (S3), sahjanwa (near IGL) (S5), Adilapar village (S6) indicates the effect of industrial waste water discharged into river water. The highest values or total Solids at sampling location Adilapar village (S6) clearly indicates of noticeable effect on river water quality, Due to the discharged of industrial effluent from GIDA drain.

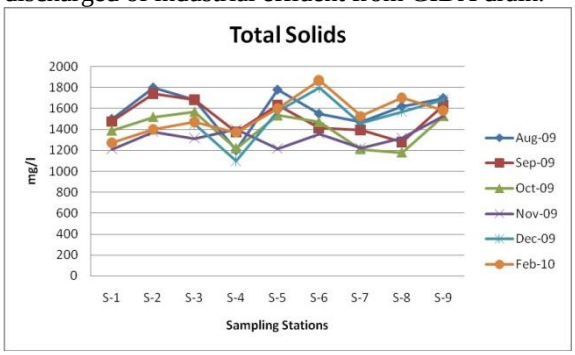

Fig. 5.5 Monthly Variation in Total Solids

5.9 Total Suspended Solids

Total suspended solids data collected at various sampling locations and the monthly variation is depicted in Fig. 5.6. According to Primary Water Quality Criteria for Class-A waters there should be no suspended solids from sewage or industrial waste origin in river water. As against this, Total suspended solids are high at all the sampling locations with the minimum values occurring generally at sampling location Sohnara, which is the origin point of the river. The increasing trend on the sampling location located

downstream with high values observed at sampling location khalilabad paper mill (S3), Maghar (S4) and Adilapar village (S6) indicate the effect of industrial waste water discharged on river water.

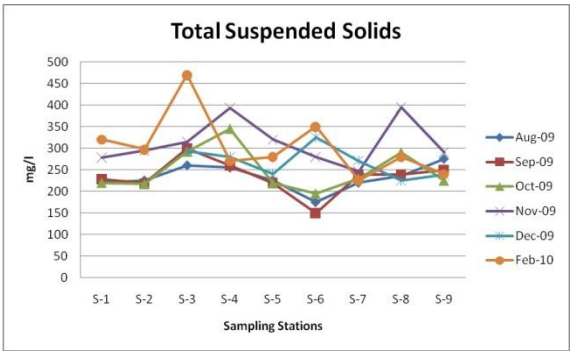

Fig. 5.6 Monthly Variation in Total Suspended Solids

5.10 Total Dissolved Solids

Total dissolved solids measured at various sampling locations and their monthly variation is shown in Fig. 5.7. It is revealed that the Total Dissolved Solids values show peaking tendency at sampling location Rudhauli (S2), Khalilabad paper mill (S3), Sahjanwa (near IGL) and Adilapar village (S6). This also indicates the effect of industrial waste water discharged on river water quality. This also necessitates the characterization of dissolved solids and their possible impact on aquatic flora and fauna.

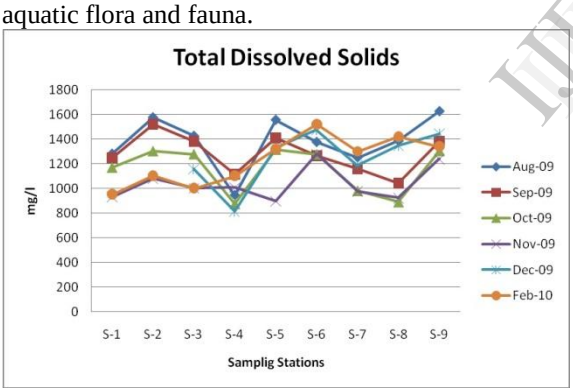

Fig. 5.7 Monthly Variation in Total Dissolved Solids

5.11 Dissolved Oxygen

The dissolved oxygen data pertaining to various sampling locations and the variation with respect to time is depicted in Fig. 5.8. A general relative picture emerging from the Fig. reveals that the river stretch from Rudhauli (S2) to Jarlahi village (S8) is in a state of oxygen sag. It is also seen that the discharged oxygen values at the origin point of Ami river. Sohnara (S1) reasonably good and the sag starts soon after the mixing of industrial waste water discharged at Rudhauli (S2) and the noticeable recovery is observed beyond critical minimum only at the confluence of Ami River into Rapti river at Sohgaura. A very depreciation in dissolved oxygen values is observed at sampling location Khalilabad paper mill (S3), Sahjanwa (near IGL) (S5) and Adilapar village (S6). The minimum values of Dissolved Oxygen 1.4 mg/l observed at Adilapar village in December, 2009 speaks loud about the criticality resulted is by high load of organic matter discharged with the industrial effect into the river and in this perspectives, a severe impact of industrial waste water discharged through GIDA drain in quite clear.

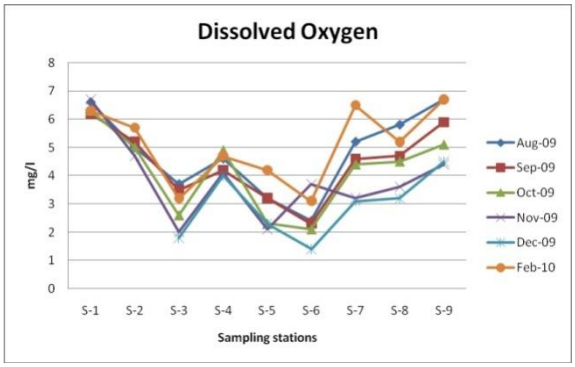

Fig. 5.8 Monthly Variation in Dissolved Oxygen

Looking at Primary Water Quality Criteria it is revealed that a minimum of 6.0 mg/l D. O. content is necessary for Class-B and Class-C waters. It is also known that not less than 3.5 mg/l of D. O. is necessary at any time for the protection of aquatic life. With this in view, it is found that, on many occasions, at sampling location Khalilabad paper mill (S3), Adilapar village (S5) and Chhatai bridge (S7) the dissolved oxygen values is much lower than the critical minimum and, at sampling location Sahjanwa (near IGL) (S5), the D. O. values is lower than the critical minimum during the entire observation periods. As the scenario is expected to have prevail clearly over a long period of time ever since the industrial unit started discharging their effluent into the river it may be inferred that the aquatic life might be practically absent in the stretch of the river starting from Khalilabad paper mill (S3) to a little before sampling location Jarlahi village (S8). It is also revealed that the river water quality conforming to Class-A waters in terms of D. O. contents at the origin point of river at Sohnara during the entire observation periods gradually deteriorates on account of industrial waste water discharged successively at downstream locations and it is not able to recover in the form of clean water even up to the confluence point of the river into Rapti at Sohgaura. This necessitates the implementation of an action plan to restore Class -A water quality in the entire stretch on the river.

5.12 Biochemical Oxygen Demand

The biochemical oxygen demand data presented and depicted in Fig. 5.9 reveal that at sampling location Khalilabad Paper Mill (S3), Sahjanwa (near IGL) (S5) and Adilapar Village (S6), the highest values of B.O.D. are obtained and

alarmingly high values of B.O.D. 180 mg/l at Adilapar village (S6) in December, 2009 is obtained, which may be in comparable value to a waste water stream. This also reveals that the discharged of GIDA industrial effluent at Adilapar village is rendering the river in the form of waste water stream in the downstream locations. This indicates the discharge of biodegradable organic matter through industrial waste water stream in the river owing to which the fall in D. O. level may also be attributable. As per norms, B. O. D. of Class-A waters should not be more than 2.0 mg/l. As against this successively high value of B. O. D. in river water indicate severe organic pollution in the river.

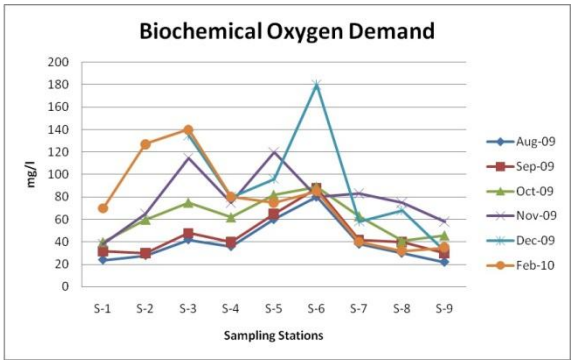

Fig. 5.9 Monthly Variation in Biochemical Oxygen Demand

5.13 Chemical Oxygen Demand

C.O.D. data depicted in Fig. 5.10 reveals that starting from sampling locations Rudhauli (S2) to the confluence point of Ami river into Rapti river at Sohanara.

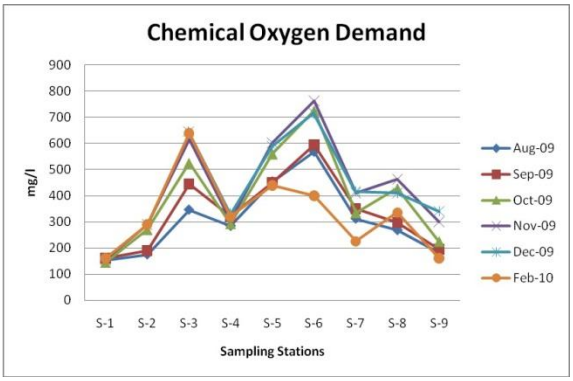

Fig. 5.10 Monthly Variation in Chemical Oxygen Demand

The river water quality is comparable more or less to a waste water with very high value obtained at the most of the sampling locations except the origin point of the river at Sohanara. Notably the C. O. D. for discharging sewage and trade effluent into stream is prescribed to be less than 250 mg/l. Contrary to this, starting from Khalilabad paper mill (S3) up to the confluence of the Ami river with Rapti river at Sohanara. The values are found in a much higher range and at Adilapar village (S6), where GIDA effluents meets Ami river, the highest values 756 mg/l is obtained. Thus immediate attention to manage the pollution load joining the river is needed.

5.14 Chloride

The chloride data depicted in Fig. 5.11. A review of the Fig. 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.

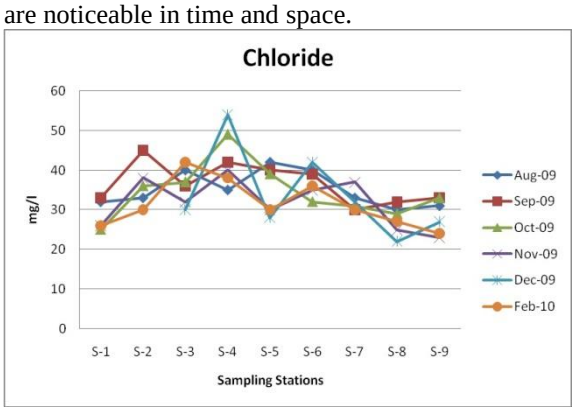

Fig. 5.11 Monthly Variation in Chloride

5.15 Total Alkalinity

Total alkalinity data depicted in Fig. 5.12 reveals that alkalinity values are high at many of the sampling locations barring Sahjanwa (near IGL) (S5) and Adilapar village (S6) this also indicates that the level of decomposition of organic waste added upstream of these locations is quite high. This also necessitates the treatment of industrial waste water joining the river near these locations.

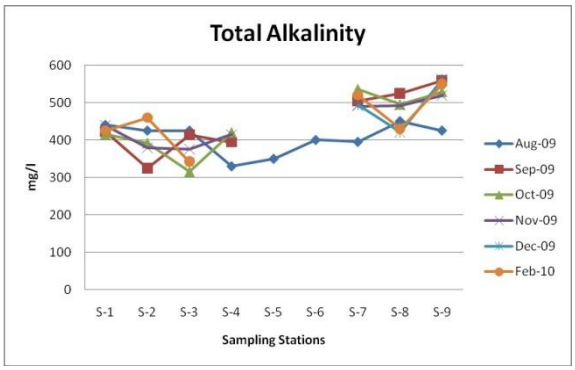

Fig. 5.12 Monthly Variation in Total Alkalinity

5.16 Oil and Grease

Oil and grease data for the river observed at various sampling locations and the variations is plotted in Fig. 5.13. As per Primary Water Quality Criteria oil and grease should not be more than 0.1 mg/l in river water because this has effect on fish eggs and larvae. Contrary to this the oil and grease are high at all the locations. Excessively high values are obtained from sampling locations Rudhauli (S2) to Adilapar village (S6), which is agreed point or concern. Suitable steps are needed for the inclusions of an oil and grease trap in the treatment system of relative industries.

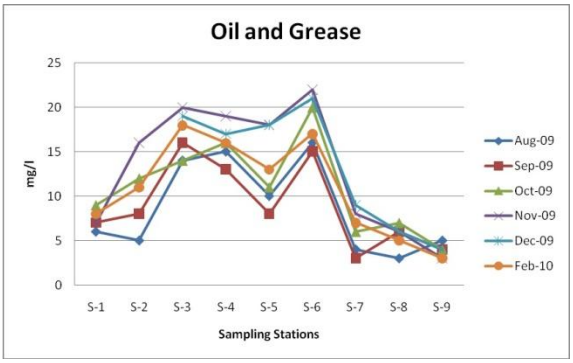

Fig. 5.13 Monthly Variation in Oil and Grease

5.17 Total Kjeldahl Nitrogen

Total kjeldahl nitrogen data indicates that there is enough presence of nitrogen in river water at all the sampling locations. However a glance at Fig. 5.14 reveals that the values obtained at Adilapar village (S6), where GIDA effluents joins Ami river, are the highest among all. This indicates that the T.K.N. load from GIDA effluent should be properly managed.

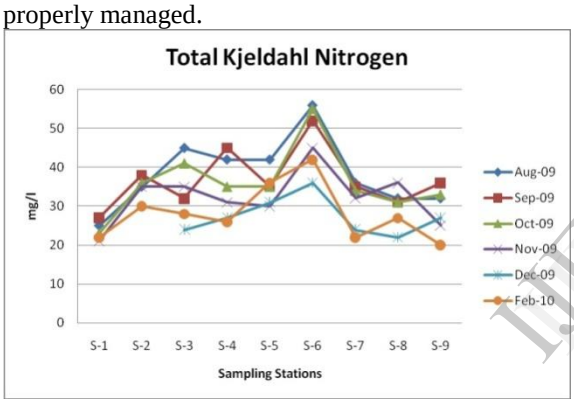

Fig. 5.14 Monthly Variation in Total Kjeldahl Nitrogen

5.18 M. P. N.

M.P.N. data obtained from river water at various sampling locations and the monthly variation is plotted in Fig. 5.15 as per the requirements for the Primary Water Quality Criteria for Class-A waters M.P.N. of total coliform/100ml should be 50 or less.

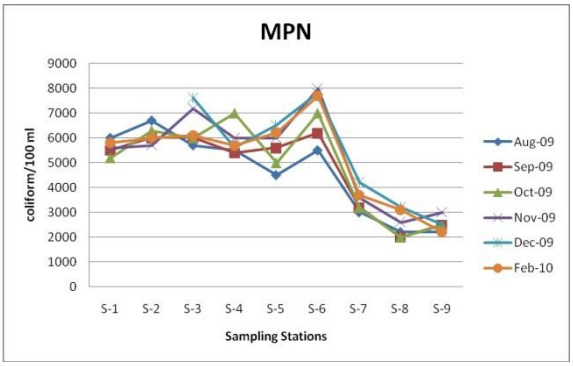

Fig. 5.15 Monthly Variation in MPN

Contrary to this the M.P.N. of total coliform/100ml observed to the much higher at all the sampling locations this also reveals the bacteriological quality of river water is not good. It may therefore, be resorted to that proper disinfection of treated effluents should be incorporated in the treatment system of the industry.

Thus it is realized that Ami river is severely victimized by anthropogenic pollution of industrial origin at many point along its length starting from Rudhauli to Adilapar village and a scientifically planed waste management programme is needed to be implemented urgently.

"6. CONCLUSION"

The assessment of water quality parameters at nine sampling locations selected along the stretch of river affected directly by industrial effluent discharged has yield it some very useful inferences as mentioned below:

1. The river water quality conforms to Class – A waters before Rudhauli, where industrial effluents from a distillery and a sugar mill get mixed with natural water. It continuous deterioration in water quality is observed at Khalilabad paper mill, Sahjanwa (near IGL) and Adilapar village, where GIDA drain discharges into the river. The effect of industrial waste discharge is also seen at downstream locations Chhatai Bridge, Jarlahi and Sohgaura.
2. The D. O. values being less than the critical minimum 3.5 mg/l for aquatic life from Khalilabad paper mill to Chhatai Bridge for most of the time during the observation periods indicates the absence of aquatic animals in this stretch of the river, which is a deep point of concern to the prevailing ecosystem in the river.
3. A glance at B.O.D. and C.O.D data reflects that the river is facing a high load of organic pollution beyond its dilution and self purification capacity. Ironically enough, at many sampling locations the B.O.D. and C.O.D. values of river water are no less than a waste water stream. This possesses a very high risk on the existence of the river itself.
4. The parameters like pH, Turbidity, Electrical Conductivity, Colour, Odour, Total Solids, Total Suspended Solids, Total Dissolved Solids, Chloride, Alkalinity, Oil and Grease also conform a severe deterioration in river water quality.
5. The biological examination of river water in respect of total coliform/100ml at various sampling location has confirmed that the river water is unfit for direct consumption, bathing or any other domestic use.
6. The Total Kjeldahl Nitrogen determination in river water has confirmed that there is enough nitrogen in river water, which rendered the problems of eutrophication.
7. It is also found that, due to lack of sincere and serious approach towards the treatment and

disposal of industrial waste water by industrial the condition is worsening day by day.

8. It is really excruciating to mention that the river Ami, which is a Class – A river ahead of its origin point gets victimized by industrial pollution in its forward journey and beyond Adilapar, where GIDA drain meets the river, it is converted into a river, which is below Class – E.

It is realized that urgent steps are needed to restore the water quality and regenerate the aquatic ecosystem in the river. This necessitates, on one hand, adequate treatment and disposal of industrial effluents and regular monitoring of the river water to ensure that the 'River remains a River' throughout its length from Sohnara to Sohgaura. This can materialized with a coordinated effort of government agencies, industrial units, local bodies and public, at large. This should go a long way towards saving Ami river form the fury of industrial pollution.

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