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Impact of industrial wastes on the water quality of tropical river, Ami (India)

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Abstract: Industries discharge their effluents which are rich in solids, may it be in the form of TSS or TDS. These solids affect the other physicochemical parameters of the water body. Present study deals with the investigation of seasonal variation and statistical analyses of the selected parameters, in river Ami, in light of the industrial effluents. The study records that summer season, appears to be the most polluted, that is during the period when the river carries little amount of water. Statistical analysis showed that all the physicochemical parameters were positively correlated except TDS and temperature.

Keywords: Industrial effluent, Physico-chemical parameters, River Ami and Seasonal variation

INTRODUCTION

River Ami a tributary of river Rapti originates from Sikhra tal near Hallur (Tehsil-Dumariyaganj) of Siddarthnagar district (Dwivedi *et al.*, 2007; Prajapati, 2010) and passes from a border between Siddarthnagar and Basti and its rout includes Sant kabirnager and Gorakhpur districts of Uttar Pradesh. It is one of the ancient rivers in India and initially the river was called Anoma (Law, 1972). During the course of 90 km it receives waste and effluent from many large and small industries, basically distilleries and paper industries. The wastes from these industries are rich in the solids, which regulate certain other parameters also (Prajapati and Dwivedi, 2010).

In present investigations the selected parameters (colour, odour, temperature, total solids, total dissolved solids, total suspended solids, conductivity and turbidity) have been undertaken to observe the impact of industrial wastes in the river Ami. Statistical analyses have also been conducted to study the correlation among the parameters.

MATERIALS AND METHODS

For detail investigation of the river, five study sites were selected along the river Ami, as given in Table 1. The study sites are also shown in the Fig. 1. Water samples were collected (during June 2007 to May 2008) using the prescribed standard methods. Colour and odour were analysed by direct manual observation method at the study site itself; however, for analysis of the other parameters the water samples were brought into laboratory. Temperature was also estimated at the study site itself using the electronic thermometer. Samples were subjected for analysis as prescribed by APHA (1998) for all the selected parameters.

Sampling was conducted fortnightly, but for the ease of convenience the values are represented seasonally, through graph. The values have been subjected to statistical correlation analysis also.

RESULTS AND DISCUSSION

The colour of river Ami in summer was dark yellow to blackish at site 5 followed by reducing intensity during winter season. Decomposition of organic pollutant result into the formation of humic acid which dissolve and give dirty colour, but in the month of July to October they become muddy due to heavy rainfall (monsoon). The dark colour of river water was due to industrial effluents, similar to the observations of Singh *et al.* (2003), Dwivedi *et al.* (2006). This is also brought about by deposition of some air pollutants, as reported by Tripathi *et al.* (2010). During pre-monsoon period *i.e.* from the month of March to June the river water emits rotten sugar like smell at study site 2, 4 and 5 due to heavy discharge of industrial effluents. At the ends of rainy season odour of the water was fish like. Chattopadhyay *et al.* (2003) reported that DO values below 5 mg/l may adversely affect the functioning and survival of biological communities and below 2 mg/I may lead to the death of most of the fishes.

Seasonal variation of temperature of the water of river Ami (Fig. 2) show that the higher temperature remains during summer followed by rainy and the least temperature was during winter season.

Comparative study of all the sites show that river Ami water has the minimum temperature of water 21.0^0C during January at site 1 and maximum temperature 38.0^0C during June at site 5 (Fig. 2). Temperature shows positive correlation with all the parameters except the TDS, which shows negative correlation at 0.01% level of significance

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Table 1. Detail of the study sites.

Study sites	Location	Source of pollution
Site- 1	Lahurikhurd, Siddharthnagar	Control site, as no prominent source of pollution.
Site- 2	Rudhauli, Basti	Effluents from a sugar factory.
Site- 3	Maghar, Sant kabirnagar	Effluent from a paper industry.
Site- 4	Chhatai bridge, Gorakhpur.	Effluents from many small and large scale industries situated in GIDA (Gorakhpur Industrial Development Area).
Site- 5	Kauriram, Gorakhpur	This site was selected as a study site to evaluate the change in water quality incurred after traveling 21 Km. distance from the last source of pollution *i.e.* the study site 4.

(Table 2). The fluctuation in temperature was due to variation in ambient air temperature and pollutants. Ahamd *et al.* (2006) observed that water temperature fluctuate during environmental changes. Similar results were also obtained by Kulsherstha *et al.* (2004).

Conductivity denotes the capacity of a substance of solution to conduct the electric current. Inorganic substance show better conductance while organic compounds are poor conductors as they do not dissociate easily. Conductivity of water is expressed in millisiemens per meter (mS m^{-1}) which is equal to 10 micron mho/cm.

Seasonal variation of conductivity in the water of river Ami, (Fig. 3) show that the highest conductivity remains during post-monsoon followed by pre-monsoon and monsoon period. Comparative study of all the sites show that in the river Ami the minimum conductivity 309 mg/l was recorded during September at site 1 and maximum conductivity 510 mg/l during June at site 5.

Conductivity of the river water was higher during summer season. This was due to the fact that due to high temperature and low relative humidity, the rate of evaporation of river water was high and at the same time the effluent coming from industries remained the same. As a result the river water becomes rich in ionic content which enhances the conductivity of the water sample. The presence of high ionic concentration also affects the water quality adversely, that is why conductivity shows positive correlation with all the other parameters of pollution from the statistical point of view. Similar results have been observed by Dwivedi *et al.* (2007-08) and Bhatnagar *et al.* (2009).

Turbidity of the river water was higher during summer season especially in the month of June however it was lowest during winter. Particles of colloidal dimension suspended and do not settle easily giving a dirty or turbid appearance. Industrial effluents carry chemicals which react among themselves and form colloidal particles which remain suspended for most of the time and finally settle down after traveling long distance. The beam of light

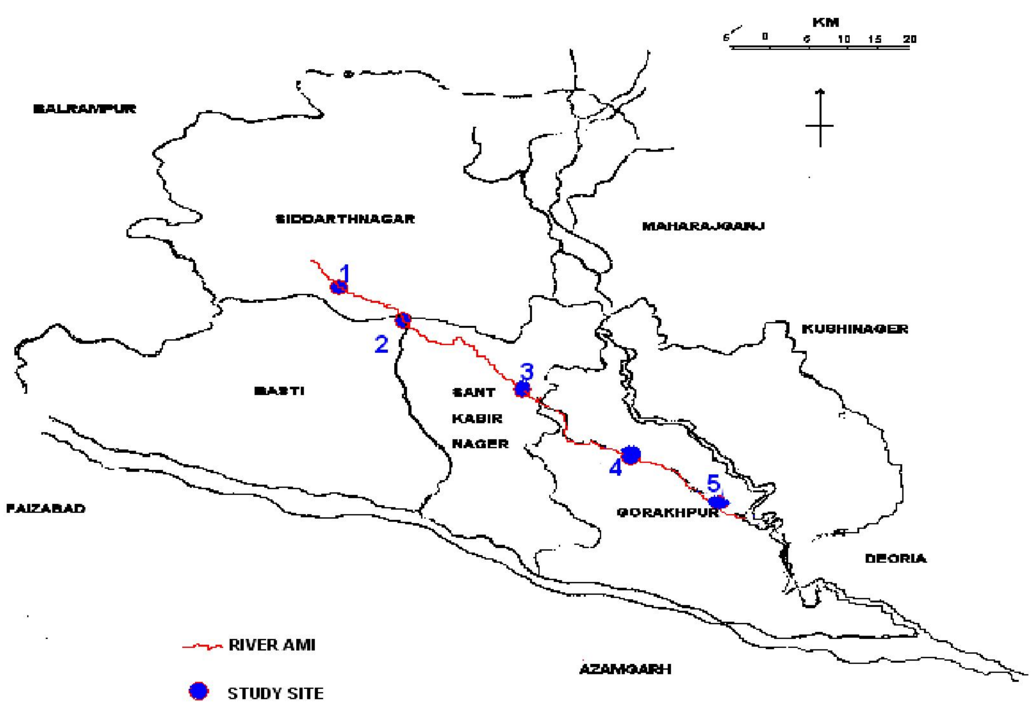

Fig. 1. *Route of river Ami.*

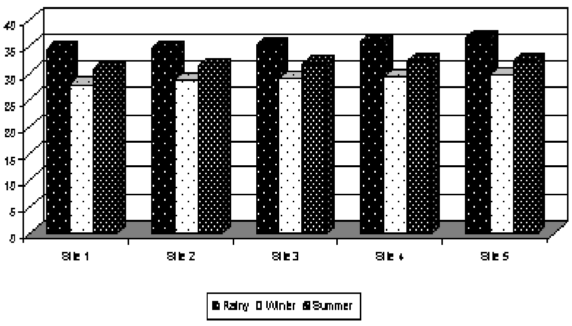

Fig. 2. *Seasonal variation in temperature of river Ami.*

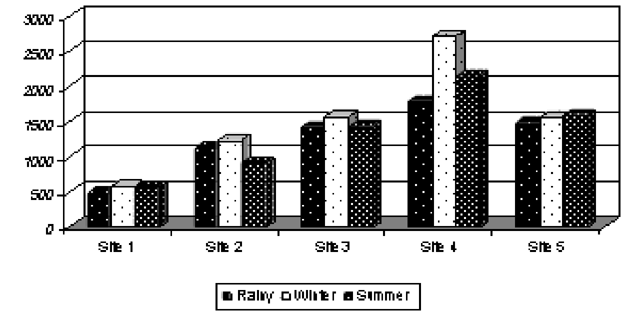

Fig. 5. *Seasonal variation in TS of river Ami.*

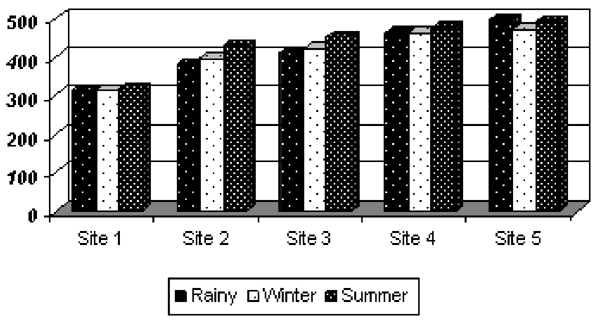

Fig. 3. *Seasonal variation in conductivity of river Ami.*

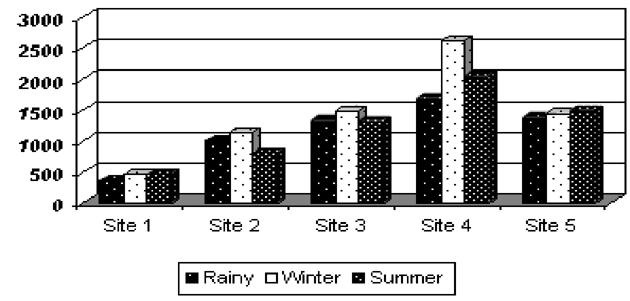

Fig. 6. *Seasonal variation in TDS of river Ami.*

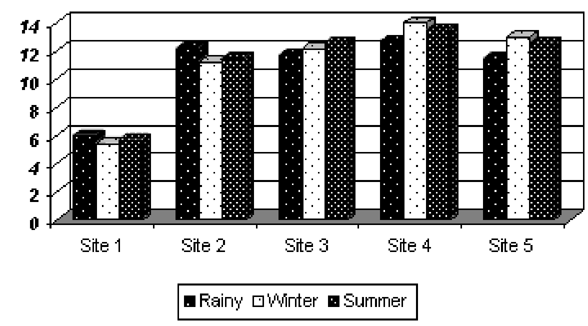

Fig. 4. *Seasonal variation in turbidity of river Ami.*

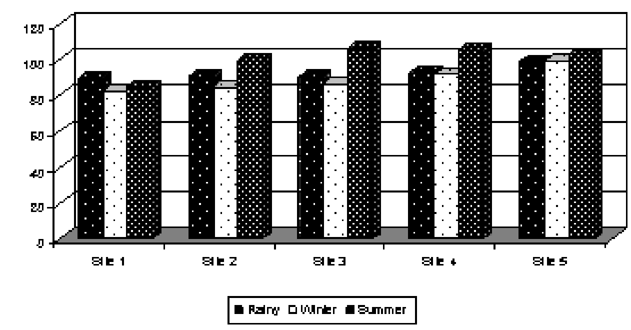

Fig. 7. *Seasonal variation in TSS of river Ami.*

passing through colloidal solution gets scattered. During summer temperature is higher, due to which the rate of Brownian motion is higher at the same time TSS of the water samples was also higher indicating the contribution of suspended solid in turbidity.

The study of seasonal variation in turbidity (Fig. 4) show that the highest values were during summer followed by rainy and the least turbidity was during winter season. Turbidity shows positive correlation with all the parameters at 0.01% level of significance (Table 2) Gupta (2004) found similar results regarding turbidity and other pollutants in the study of river Mekong.

Total solid can be determined as the residue left after evaporation of the unfiltered weight. Total dissolve solid can be determined as the residue left after evaporation of the filtrate sample. The total solid content is the amount of non-volatile substances present in a colloidal and molecular dispersed state. Source of solid, either in dissolve or in suspended form is unexceptionally the industrial effluent. Some of the solid dissolve in water while others remain suspended together they constitute the TS. During winter TS and TDS was high because in winter the rate of flow of water was very slow and due to low temperature the complex compound which is present in industrial effluent cannot dissociate completely, rather than get sufficient time to react and together from the colloidal material, therefore TS and TDS were high in winter but during rainy season the river water is diluted as a result TS and TDS was low during July and August.

The study of seasonal variation in TS (Fig. 5) shows that the highest value was during summer followed by post-monsoon and the least total solid was during monsoon. TS show positive correlation with all the parameters, at 0.01% level of significance (Table 2).

Comparative study of all the sites show that the minimum TDS was 350 mg/l during June at site 1 and maximum total dissolve solid 2722 mg/l during November at site 4. Seasonal variation of TDS in the water of river Ami (Fig.

Table 2. Correlation between different physico-chemical parameters.

	Temp.	Cond.	Turb.	TS	TDS	TSS
Temp.	+1.0000					
Cond.	+0.2485	+1.0000				
Turb.	+0.1318	+0.8862	+1.0000			
TS	+0.1958	+0.7954	+0.8457	+1.0000		
TDS	-0.0011	+0.7939	+0.8439	+0.9998	+1.0000	
TSS	+0.3011	+0.7307	+0.5832	+0.4211	+0.4131	+1.0000

P<0.001(0.1% Level of significance for all values)

6) show that the higher TDS remains during winter followed by summer and the least TDS was during rainy season. TDS shows positive correlation with all the parameters at 0.01% level of significance (Table 2). Karthikeyan and Singh (2004) reported that high TS and TDS may cause soil sickness due to poor aeration and higher BOD. These also affected the availability of trace elements, as also reported by Dwivedi *et al.* (2007).

The study of seasonal variation in TSS (Fig. 7) show that the highest values were during winter followed by summer and the least TSS was during rainy season, similar reporting regarding TSS were made by Kannan *et al.* (2003) and Upadhayay (2004) also. Total Suspended Solid (TSS) denotes the suspended impurities present in the water. TSS shows positive correlation with all the parameters except the DO, which shows negative correlation at 0.01% level of significance (Table 2).

Conclusion

The study reveals that slight modification in one parameter affects the other parameters also. The industrial effluents release large amount of pollutants. Statistical analysis shows that all the selected parameters are positively correlated except the TDS and temperature. Industries should discharge their effluents after proper treatment. As, the river covers a large area, the remedial measures are required. It has self-purification property, but this is possible only when the river receives a diluted pollutant and is provided an adequate time.

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