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A CASE STUDY

River water quality: A case study of Yamuna at Allahabad

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SUMMARY : Rivers are an indispensable part of our biosphere which is essential for the overall development of the present civilization. The present study was focused on the different areas of the River Yamuna at Allahabad city. Sampling and analysis was conducted as per the guidelines of CPCB. The results revealed that there was significant difference in months due to the variations in temperature, weather conditions and even rainfall but there was no significant difference between the sites. The results revealed that the water was suitable for irrigation purpose as the values were found to be within the permissible limit except for DO whose values were found to be slightly less than the permissible limit which makes it unsuitable for bathing purpose. Data shows that the water quality of Yamuna river falls under C category of the surface water quality criteria by CPCB.

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Yamuna River covers as many as seven states and it flows almost entirely through Delhi, where it is exploited the most. In past the river used to be the main source of life for drinking water, communication and irrigation. Yamuna out numbers any other river in the number of industries on its banks because it passes through many major industrial cities.

Yamuna is one of the sacred rivers and the largest tributary of the river Ganga. It originates from the Yamunotri glacier in the Mussouri range peaks 38°59', 78°27'E of the lower Himalayas at an elevation of 6320 meter above mean sea level in the state of Uttaranchal of northern India. The total length of Yamuna is 1376 km. covering a catchment area of 3, 66,220 km^2.

The river provides a source of drinking water and bathing. The water of the river Yamuna is also used for irrigation purpose so degradation in the water quality definitely will have some impact on agricultural purposes. The river water in the upper segment is relatively unpolluted. However, domestic and industrial water from urban and rural areas are discharged into the river polluting the downstream (Abida and Harikrishna, 2008).

Three major barrages are located on river Yamuna, namely, Wazirabad and Okhla diverting water for irrigation and other uses.

It has been reported that the Yamuna river water is so polluted that it can hardly sustain aquatic life. The people of Delhi dump garbage into the river and on its banks, half of the city's raw sewage flows into the river which pollutes the river to such an extent, that the river water turns black and starts bubbling. Similar work was also done by Chattopadhyay *et al*. (2005); Joshi *et al*. (2009); Nayal *et al.* (2008); Sinha *et al.* (2005) and Singh (2010).

Yamuna is among one of the sacred river facing degradation in its water quality as a result of modernization. Allahabad has its religious status because of the confluence of three sacred rivers *viz.*, Yamuna, Ganga and Saraswati at Sangam. Every year during the winter season a religious festival is conducted for over a month in which thousands of pilgrims from all over the world come to take a dip in the Yamuna River at Allahabad. Thus, it becomes important to always keep an eye on the quality of the river water. Moreover, Allahabad is still not getting any recognization under YAP even, when the IIIrd phase was framed. The task of the YAP was to clean up the river Yamuna, but so far, they have not yet succeeded.

EXPERIMENTAL METHODOLOGY

Water samples were collected from seven different sites (Mahewa Ghat-S_1 (entering zone to Allahabad), Gaughat- S_2, Old Nanni Bridge- S_3, The region between the Old Bridge and the New Bridge-S_4, Shastri Bridge-S_5, Near Saraswati Ghat-S_6 and the region before collision (before Sangam)-S_7) of the river Yamuna at Allahabad during January to May 2010, at a frequency of once in a month. To analyze the quality of water at Allahabad, parameter taken into consideration were pH, EC, Turbidity, DO, BOD, COD, chloride, sulphate, total alkalinity, acidity, total hardness, calcium, magnesium and sodium. All the sampling and analysis were carried out as per the CPCB guidelines and later compared with surface water quality standard of CPCB based of utilization criteria.

EXPERIMENTAL FINDINGS AND DISCUSSION

The physio-chemical characteristics provide a fair idea of the water quality in any water body.

The results were based on the data collected during the experimental investigation of the study and are presented through subjective analysis and tables. Discussions are made for elaborating the interpretation of the results.

pH:

The maximum pH was recorded to be 8.96 in the month of May and the minimum pH was 7.56 in the month of January. The pH of all the water samples taken from the river Yamuna was found to be above 7 which shows that the water is alkaline in nature. It is necessary to check the pH because it affects the solubility and availability of nutrients to the different organisms present in water (Fig. 1).

EC:

The maximum EC was recorded to be 0.83 in the month of May and the minimum EC was recorded to be 0.41 in the month of January.EC is also influence by pH, whereby an increase in pH increases the EC of water and decrease in pH decreases the EC of water. Increase in EC also indicates the presence of polluting matter (Fig. 2).

DO:

The maximum dissolved oxygen was recorded to be 9.0mg/l in the month of March and the minimum DO was recorded to be 5.2mg/l in the month of February. Decrease in DO is due to increase in biological and photosynthetic activity (Bharadwaj, 2005). DO test is one of the most important indicators of pollution in rivers. It can also indicate whether there is excessive plant growth present. Normally water is 100% saturated with oxygen but if the oxygen is used up, either by polluting material or by plants that live in the water, the oxygen levels can decrease so it is necessary to carry out these test to maintain the quality of the water. Any organic waste matter entering a river/lake acts as a food source for the micro-organisms living in the water. These micro-organisms use the dissolved oxygen present in the water to break down the food (Fig. 3).

BOD:

The maximum BOD was recorded to be 4.8mg/l in the month of March and minimum value was recorded to be 2.3mg/l in the month of February. The data shows that the minimum value recorded was in the month of February although January is much colder than February. This is because of the Magh Mela festival in which thousands of pilgrims from all over the world comes to perform their religious rituals and sacrifices. Unpolluted river waters are likely to have a BOD value <3mg/1 O_2 and values significantly above 4-5 mg/1O_2 indicate possible pollution. The BOD value in rivers can also be affected by high flows or floods. BOD is also affected by temperature, higher the temperature, higher will be the BOD and lower the temperature lower is the BOD (Fig. 4).

COD:

The maximum chemical oxygen demand was 90mg/l

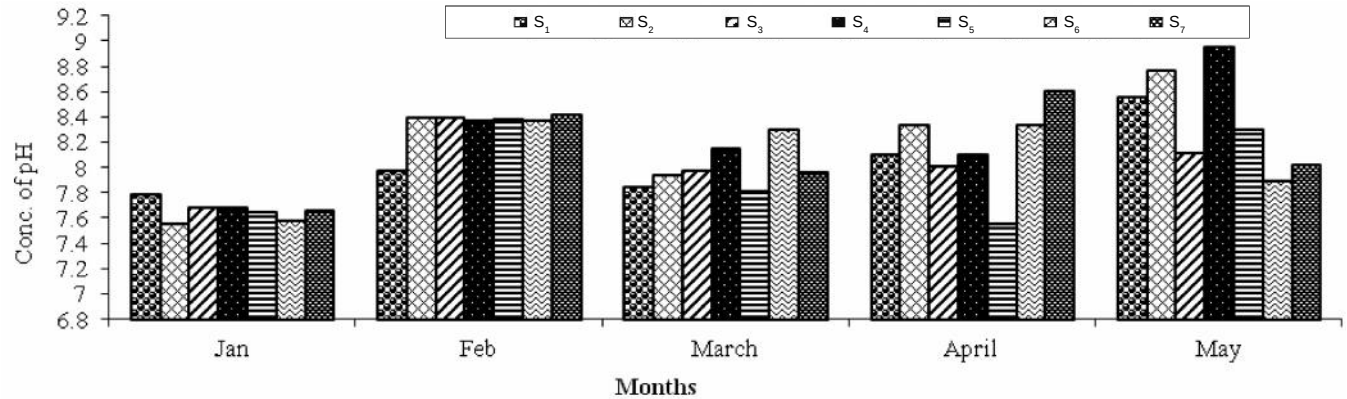

Fig. 1 : Graphical representation of pH of the river Yamuna in different months

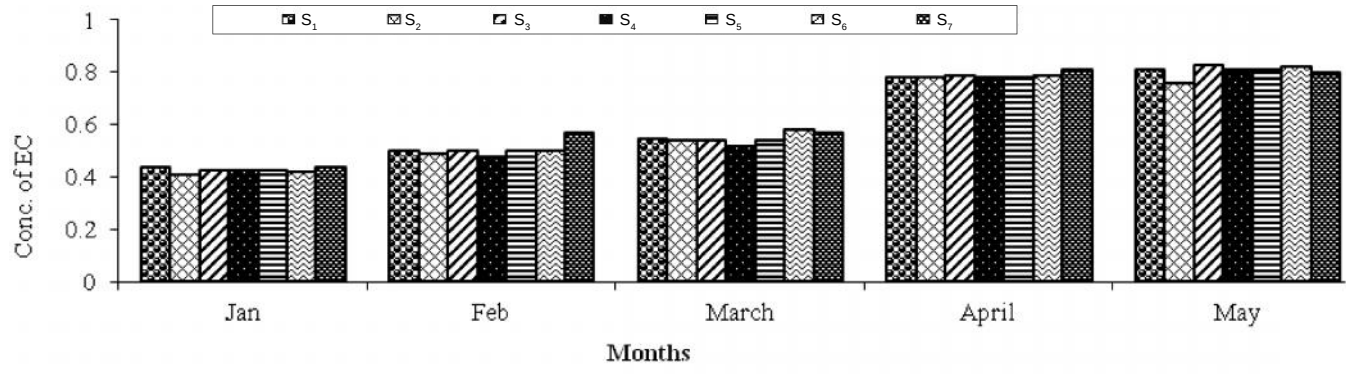

Fig. 2 : Graphical representation of EC of the river Yamuna in different months

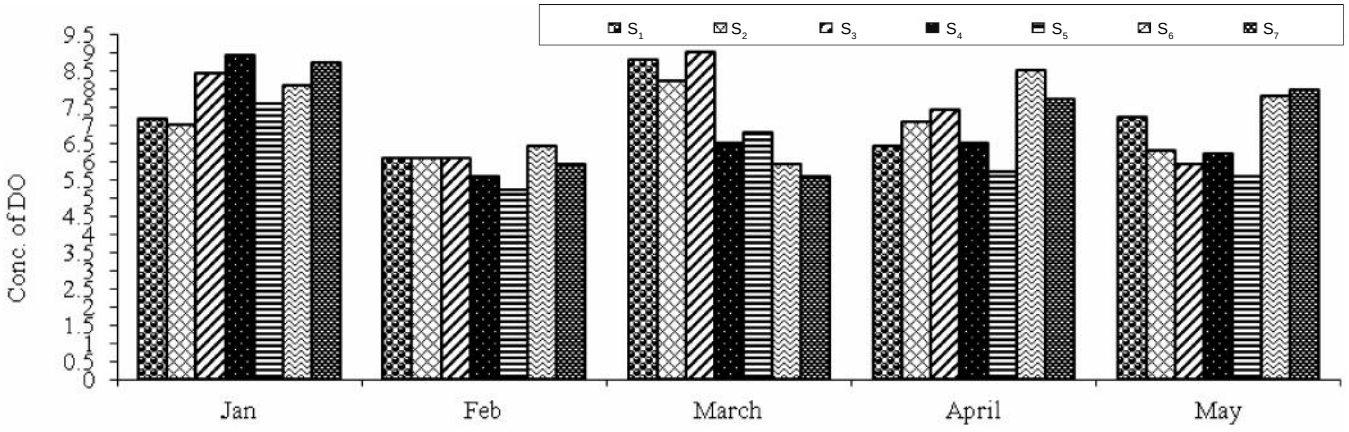

Fig. 3 : Graphical representation of DO of the river Yamuna in different months

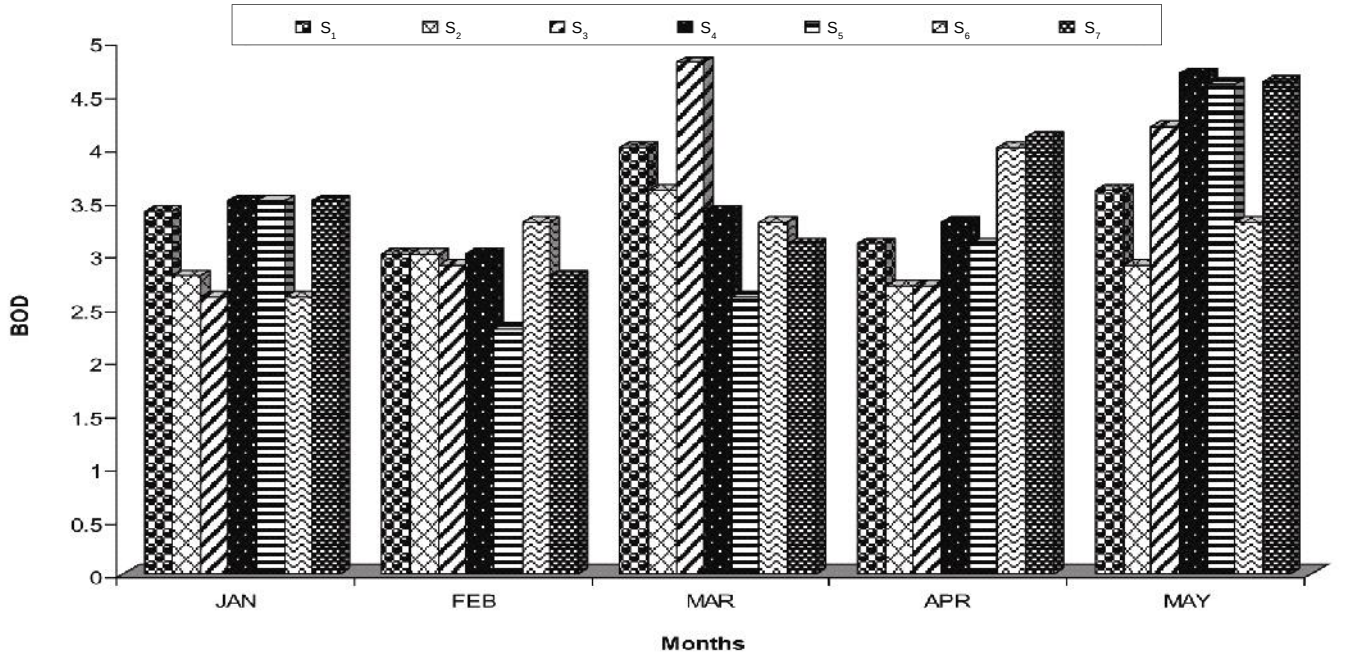

Fig. 4 : Graphical representation of BOD of the river Yamuna in different months

recorded in the month of February and minimum was 19.00mg/l in the month of April. The increase in the amount of COD in the month of January may be due to the mass bathing by which the people throw ash and organic materials like food, flowers clothes etc. Discharge of municipal waste and waste from drains into the water bodies also lead to deterioration of the water quality Mamias *et al.* (1993). COD determines the quantity of organic matter found in water. This makes COD as an indicator of organic pollution in surface water King *et al.* (2003) (Fig. 5).

Chloride:

The maximum chloride was 49.8mg/l recorded in the month of April and the minimum chloride was 14.5mg/l recorded in the month of February. The chloride content and the acidity of the water are highly affected by the amount of sewage and industrial effluent which are discharge into the water (Zafar and Allapat, 2004). It is necessary to check the quantity of chloride as the human population and the number of industries is increasing day by day. Increase in chloride content causes contamination of rivers and groundwater which can make it unsuitable for human to drink. High levels of chloride kill plants

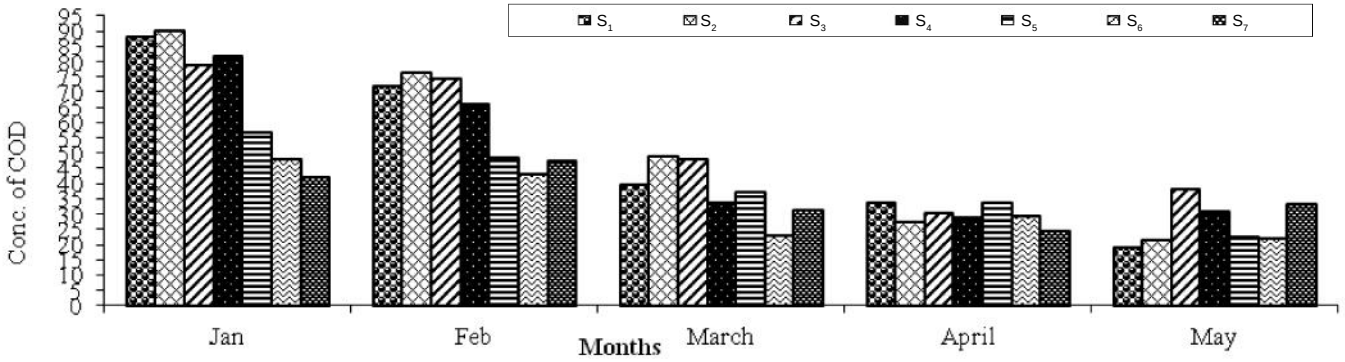

Fig. 5 : Graphical representation of the COD of the river Yamuna in different months

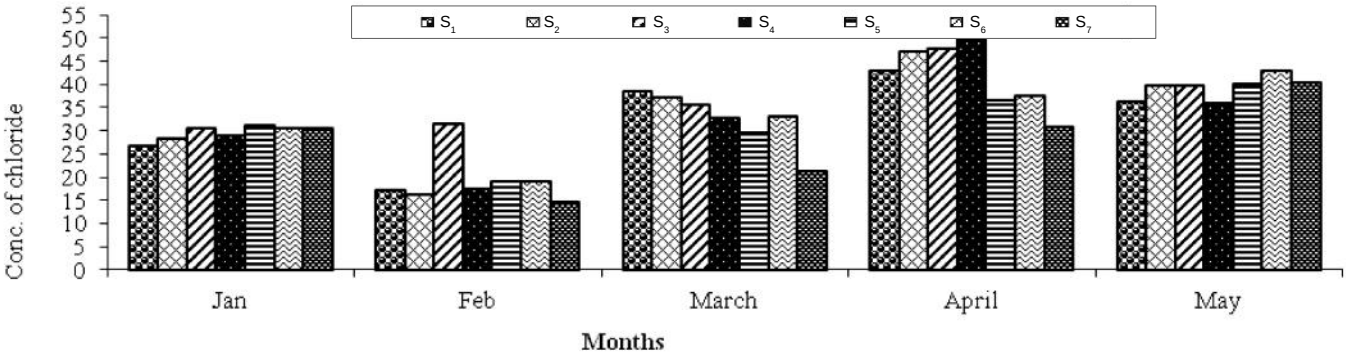

Fig. 6 : Graphical representation of chloride of the river Yamuna in different months

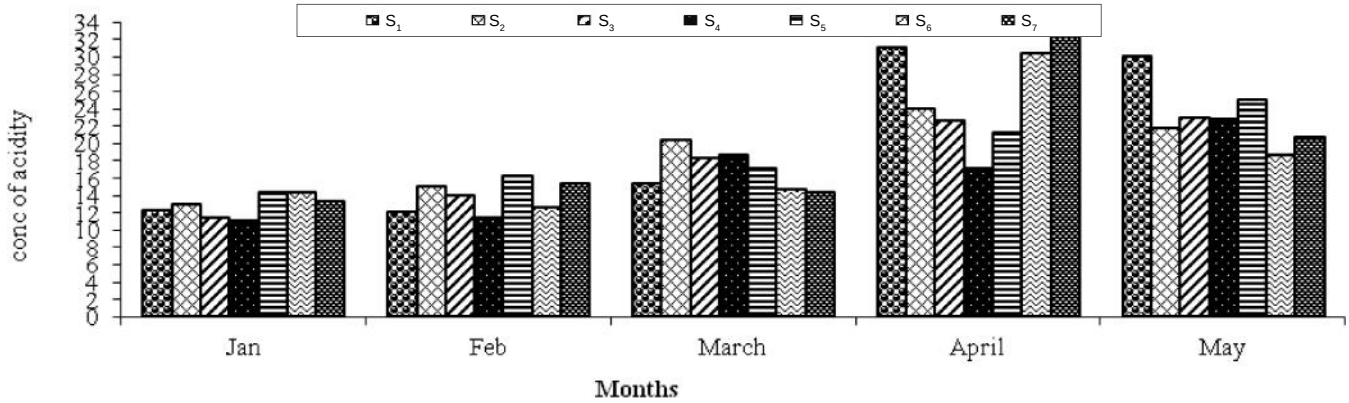

Fig. 7 : Graphical representation of the acidity of the river Yamuna in different months

and wildlife (Fig. 6).

Acidity:

The maximum acidity was 32.3mg/l recorded in the month of April. This is due to the increase of acids used in industry and acid rain. The minimum acidity was 11.0mg/l recorded in the month of January which may be due to low rainfall (Fig. 7).

Hardness:

The maximum hardness was 277mg/l recorded in the month of March. The hardness may be due to the presence of ions such as calcium and magnesium. The minimum hardness was 138mg/l recorded in the month of April. The hardness content is governed by the content of calcium and magnesium salts, largely combine with carbonate, bicarbonate, sulphate, chloride and other anions of mineral acids. This concentration of hardness helps to protect the fish against harmful effects of pH fluctuation and metal ions (Fig. 8).

Alkalinity:

The maximum alkalinity was 133.3mg/l recorded in the month of April. This may be due to increase in soil additives in agriculture, or less concentration in CO_2. The minimum alkalinity was 68.7mg/l recorded in the month of January. Water with low alkalinity or hardness may be susceptible to pH reduction by 'acid rain'. Increase concentration of CO_2 in water causes increased in alkalinity which also raises the pH level which in turn kills fish and other aquatic organisms (Fig. 9).

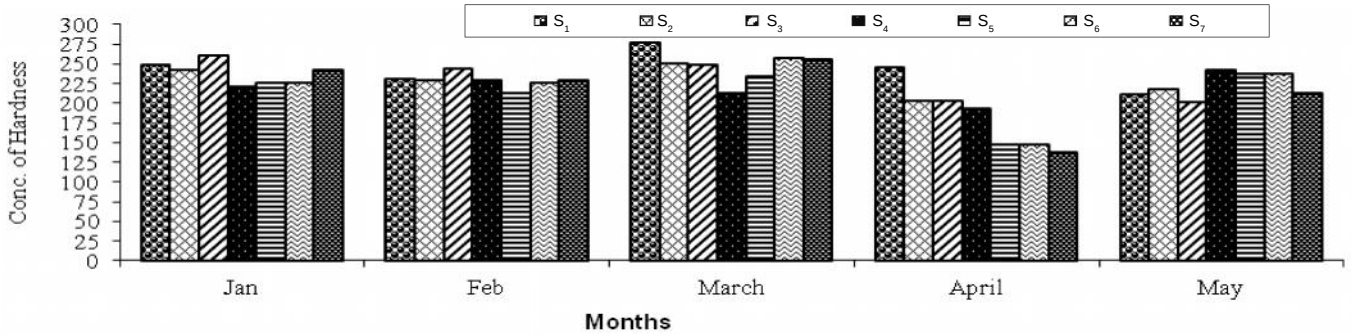

Fig. 8 : Graphical representation of the Hardness of the river Yamuna in different months

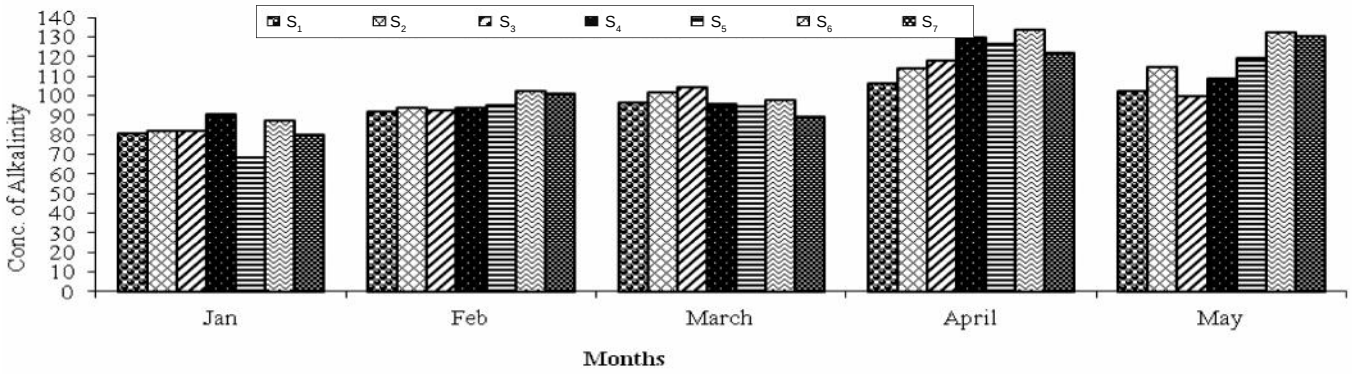

Fig. 9 : Graphical representation of the Alkalinity of the river Yamuna in different months

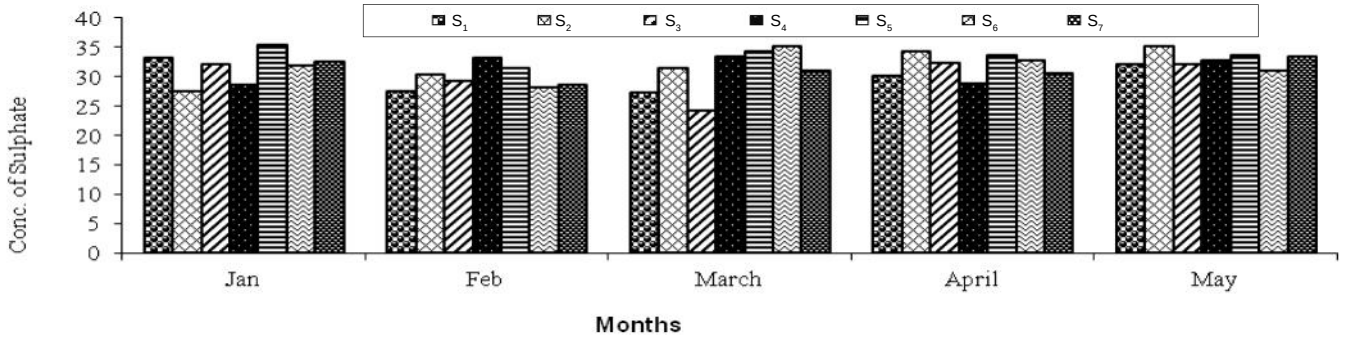

Fig. 10 : Graphical representation of Sulphate of the river Yamuna in different months

Sulphate:

The maximum sulphate was 35.23mg/l recorded in the month of January and the minimum was 24.36mg/l recorded in the month of March. The increase concentration of Sulphate was mainly due to acid rain. It is important to check the concentration of sulphate regularly as its increase adds to the increase of electrical conductivity of water (Fig. 10).

Conclusion:

The results obtained through this investigation helps us to conclude that the river Yamuna at Allahabad comes under C category of the water quality criteria since almost all the values are within the permissible limit except for DO whose values are found to be slightly higher than the permissible limit which makes it unsuitable for bathing activities but it is still suitable for irrigation purpose.

According to the Hindu Mythology the Yamuna is among holy rivers. And it is becoming polluted day by day with the increase in population, increase in pollution from various industries, urbanization, industrial effluent, domestic sewage and municipal waste thrown into the river. Unfortunately Allahabad is still not come under YAP, therefore proper monitoring is necessary for proper maintenance of its natural quality and beauty.

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