Research Paper

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Seasonal Variations in Physico-Chemical Parameters of River Narmada (M.P), India

Environmental Science

KEYWORDS : Seasonal variation, Water quality, Water pollution, Narmada river.

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ABSTRACT

The present study was carried out to assessment of the seasonal variations of physico-chemical parameters in the water samples of river Narmada at Hoshangabad District. (M.P). during April 2010 to December 2010. The purpose of this study was to assess to quality of water from the sources in three different seasons, such as summer, rainy and winter season. The result showed that variations in analyzed parameters of the water sample as follows: air temperature 18.6-40 °C, water temperature 16.8-36.2°C, turbidity 6.2-47 NTU, pH 6.46-8.92, conductivity 240-460 µs/cm, total dissolved solids 130-334 ppm, free carbon dioxide 6.4-31.2 mg/l, total alkalinity 106-248 mg/l, chloride 13.99-56.99 mg/l, total hardness 102-262 mg/l, Calcium hardness 60.9-140 mg/l, dissolved oxygen 2.88-9.2 mg/l, nitrate 0.452-6.648 mg/l, orthophosphate 0.136-0.84 mg/l, biochemical oxygen demand 2.8-28 mg/l and chemical oxygen demand8.6-64 mg/l respectively. The findings of the present study concluded that the water quality of river Narmada was moderately polluted at the selected sampling sites in Hoshangabad District. (M.P).

Introduction

Water is most abundant and familiar liquid, widely distributed in nature. About FOUR-FIFTH of the surface of the earth is covered with water. It occurs in nature in the free state and also in the combined state. The important sources of water in nature are rain water, river water, spring water, well water and sea water. It has been a potential carrier of toxic, inorganic & organic materials, non biodegradable matter, pathogenic microbes which can endanger health and life.

India has vast aquatic resources comprising 2.02 million km^2. Exclusive economic zone, 8129 km coast line, 1.3 million ha of wetlands, lakes and swamps, 45,000 km rivers, 3.10 million ha reservoir, 0.12 million km of canals, 0.92 million ha brackish water and 2.25 million ha of ponds and tanks. The riverine resources of India containing 113 major and the minor rivers along with principal tributaries have a combined length of 45,000 km of which 80% of the total length is contributed by 14 major rivers. River basins of 720000 km^2 catchment area characterise the major rivers (Rao; 1979, Jhingran; 1991, Kumar *et al.*; 2000).

Rivers are the life line for a very large population of the world. In India many rivers are venerated and are considered holy & these are life providers to teeming millions of Indians, yet unfortunately they have not been looked after properly and have been used and abused badly which resulting in reduced flow and increased pollution load.

Assessment of water quality is very important for knowing its suitability for various purposes. Due to ever increasing industrialization in their urban areas with its waste making a head way into the rivers and also owing to the rapid urbanization and growing population, there is an impending danger in the quality of the water resources. Hence, it is essential to assess the quality of water bodies before it can be safely utilized for various purposes. The objective of the present study is to find out seasonal changes in the water quality of river Narmada.

Materials and methods

Study area

The Narmada is a river in central India and the fifth largest river in the Indian subcontinent. It is known as the life line of Madhya Pradesh. Therefore this is selected for the present research work. In the present investigation twelve sampling sites were taken for the assessment of water quality. These sampling sites are located in central zone of the river Narmada (Hoshangabad district, M.P.). The following sampling sites as: 1. Shahganj, 2. Chandani nala, 3. Bandrabhan, 4. Tawa confluence, 5. Kothi bazar, 6. Sethani ghat, 7. Lendia nala, 8. Hoshangabad bridge, 9. SPM (Security paper mill at Hoshangabad) nala, 10. Dongarwada, 11. Hasilpur and 12. Randhal.

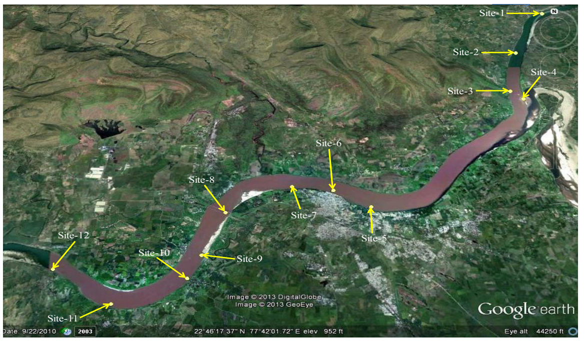

Fig: 1 Showing sampling sites

Laboratory methods

The surface sample were collected in 1 litre plastic canes at twelve sampling sites of river Narmada in three seasons i.e. summer, rainy and winter season from April 2010 to December 2010. The sampling was done 9 am to 3 pm. The collected samples were properly transferred in laboratory. Some important physico-chemical parameters like water temperature, pH, conductivity, dissolved oxygen, free Carbon-dioxide and total alkalinity were measured in the field. Other parameters were mostly tested within 24 hrs of collection. Preservation of water samples was done at 4°C temperature. The water quality parameters were analyzed by standard methods given in APHA (1998) and Trivedi and Goel (1987).

Results and Discussion

The results of the various physico-chemical parameters of river Narmada are shown in fig. 2-17.

During the study period, the air temperature ranges from 18.6 °C to 40 °C. Air temperature was maximum in summer while minimum was in winter due to Photoperiod. The Photoperiod was shorter in winter than summer. Photoperiod is directly related to temperature (Odum, 1971). Photoperiod and temperature, both were maximum in June.

The water temperature of the river Narmada stretch explored ranges between 16.8 °C to 36.2 °C. The minimum water temperature 16.8 °C was recorded during winter season at site-6 and the maximum 36.2 °C at site-11 during summer season. The pattern of fluctuation was more or less similar to all stations. The low water temperature in winter season can be explained on the basis of high water levels and lower solar radiations whereas higher temperature in summer was on account of low water level, low velocity, greater solar radiations and clear atmosphere. Similar observation was made by Vyas (1968) and Kumar (1996), Chacko and Ganpati (1949) reported about the atmospheric temperature being hottest during May and June and lowest during December and January.

Turbidity is the term for the suspended dirt and other particles in water. Turbidity in natural water restricts the penetration of light thereby reducing the photosynthetic activity hence; act as limiting factor for productivity. In the present study the lowest turbidity 6.2 NTU was observed in winter season at site-12 and highest 47 NTU in rainy season at site-7 showing floods and rains at various places from where river Narmada passes, which brings clay, sand and organic matter from adjoining areas of the river. After July, there was a rapid decrease in water turbidity. Turbidity showed an inverse relationship with light penetration. When turbidity was low, light penetration was high and when turbidity was high light penetration was low. Salam and Rizvi (1999) and Ali *et al.,* (2000) reported the same results while working on river Chenab and Rachna Doaab respectively.

During the present study, the pH of the river water ranged from 6.46-8.92 this may be due to the high buffering capacity of the river system. Maximum values reached 8.92 at site-8 in winter season and the lowest value of pH 6.46 at site-7 recorded in summer season. The higher values of pH recorded during winter season could be attributed to decreased decomposition rate owing to reduced microbial activity and increased algal productivity (Ahipathy and Puttaiah, 2006). Chetana and Somashekar (1997) reported the summer minima are due to increased decomposition rate, leading to acidification and lowered pH. In keeping with the present observations, Das *et al.,* (1992) and Bhargava and Sewani (1996) obtained summer minima.

Conductivity is the capacity of water to conduct electricity. It is an indirect measure of the salt concentration. The conductivity of polluted water is higher. This measure therefore is often used as an index of pollution. The Conductivity values of water samples ranged between 240-460 **µs/cm**, with a maximum in summer season at site-9 and a minimum at site-4 in winter season. Maximum conductivity was found at site-9 indicates the mixing of sewerage in river water. Begum *et al.,* (2009) found high conductivity in downstream of Cauvery river and suggested an immediate attention from the concerned authorities is required in order to protect the river from further pollution.

Total dissolved solids is a measure of the amount of particulate solids that are in solution. This is an indicator of non-point source of pollution problems associated with various land use practices. The observed values of TDS were comparatively lower at site-10 (130 ppm) during winter season and higher at site-7 (334 ppm) during rainy season. Its lowest values were recorded during winter season which gradually increased with the onset of rainy season due to addition of solids from runoff water, sewage and erosion of the river bank. This result was supported by the finding of Payne (1986). Gupta and Singh (2000) reported higher concentration of TDS in the Damodar river due to mixing of sewage and industrial wastes.

During the present study free CO_2 fluctuated between 6.4-31.2 mg/l, highest being recorded in summer season (2009) at site-7 and lowest during rainy season at site-10. Maximum free CO_2 level in summer could be due to the increase in aerobic population as well as pollution load (Desai *et al.,* 1995). Kosygin *et al.,* (2007) observed high concentration of free CO_2 in Moirang river in summer may be attributed to heavy inflow of organic waste. In the present investigations free CO_2 shows an inverse relationship with dissolve oxygen. A similar trend was reported earlier by Welch (1952) and Odum (1971).

Alkalinity of water is its capacity to neutralize a strong acid and is characterized by presence of all hydroxyl ions capable of combining with hydrogen ions (Koshy and Nayar, 2000). Determination of alkalinity is useful in understanding about parameter such as pH and hardness of water. It is useful in assessing the water used for irrigation and portability of drinking water. It can be also help in understand the water quality from pollution perspective. Total alkalinity values in the present observations fluctuated from 106 to 248 mg/l. Total Alkalinity was higher during summer season at site-7 (248 mg/l) followed by steep fall in winter season (106 mg/l) at sampling site-3.The minimum total Alkalinity noticed in winter season is attributed to the low water level in the river as dilution plays an important factor in lessening the alkalinity values which is in accord to the findings of Chakrabarty *et al.,* (1959).

Chloride concentration is one of the most indicators of water pollution (Munawar, 1970). In the present study maximum value of chloride 56.99 mg/l was recorded at site-7 in summer season while minimum 13.99 mg/l was observed at site-4 and site-10 in winter season. Increase in chloride values in summer season may be due to evaporation of water and addition of large amount of organic matter. The seasonal variation of chloride content agreed with the findings of Mishra and Yadav (1978), Cole (1979), Ajmal *et al.,* (1985), Pandey and Mishra (1991) and Pandey and Sharma (1999).

In the freshwater, hardness is imparted by the calcium and magnesium ions which are in combination with bicarbonates and carbonates apart from sulphates, chlorides and nitrates. Kannan (1991) has classified water on the basis of hardness values in the following manner; 0-60 mg/l-soft, 61-120 mg/l- moderately hard, 102-160 mg/l-hard and greater than as 180 mg/l-very hard. Total hardness varies from 102 to 262 mg/l at all selected sampling sites. The maximum value of total hardness was observed at site-7 in summer season while minimum recorded at site-10 in winter season. Palharya *et al.,* (1993) recorded similar observation that peak value of hardness during summer season in the Narmada river. The maximum value for hardness were observed due to evaporation and reduced inflow in summer (Ahipathy and Puttaiah, 2006). Mohanta and Patra (2000) stated that addition of sewage, detergents and large scale human use might be the cause of elevation of hardness.

During the present study period the lowest Calcium hardness 60.9 mg/l was observed at site-4 in winter season (2010) while maximum 140 mg/l at site-9 in summer season. The maximum values of calcium hardness were recorded during summer which had a decreasing trend in monsoon and reaching lowest values in winter. During winter, decomposition of organic matter became reduced and CO_2 is not liberated into the aquatic medium. Generally the dilution of Ca hardness depends with the advent of rains (Chakraborty *et al.*, 1959; Goldman and Wetzel, 1963; Sreenivasan 1964) and increases with the decrease in water levels (Rao and Govind, 1964). Higher value of calcium hardness at site-9 may be attributed to inflowing industrial effluent and sewage from Hoshangabad city.

Dissolved Oxygen is an important parameter which is essential

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to the metabolism of all aquatic organisms that possess aerobic respiration. Concentration of dissolved oxygen indicates water quality and its relation to the distribution and abundance of various aquatic organisms. Good water should have solubility of oxygen i.e., 7.6 and 7 mg/l at 30 and 35ºC respectively (Chaturvedi *et al.,* 2003). In the present study, the dissolved oxygen of water samples ranged from 2.8 to 9.2 mg/l were maximum and minimum value was recorded at site-8 in winter season and site-7 in summer season. The high DO values in winter were possibly due to low water temperature and considerable growth of algae, which release appreciable amount of oxygen as a result of photosynthetic activities and low DO observed during summer season, might be due to high metabolic rate of organisms.

In the present investigation, nitrate content varied between 0.452 mg/l to 6.48 mg/l throughout the study period. On the other hand, seasonal variations are taken into consideration higher values were recorded during rainy season at site-7 and lower values of nitrate recorded during winter season at sampling site-12. Reddy (1984) observed that nitrates are abundant during monsoon season. These changes commonly associated with erosion and transportation of nitrogenous rich fertilizers, soil and local sources into the water. The maximum values of nitrate were recorded at site-7 than rest sites during rainy season due to influx of nitrogen rich flood water that brings large amount of contaminated sewage water. Similar findings have been reported by Sunder (1988) and Kumar (1998).

Phosphates are essential for the growth of organism and a nutrient that limits primary productivity of the water body. When the phosphate is in low concentration behaves like most important nutrient, when it is excess causes algal blooms. In the present study orthophosphate ranges from 0.136-0.84 mg/l. The lowest value 0.136 mg/l was found at site-12 in winter season while highest 0.84 mg/l was noted at site-9 in rainy season. There is a slight fluctuation during study period. The low content of phosphate in winter season may be due to utilization of phosphate by the phytoplankton. The phosphate concentration was high in the month of June and July i.e. rainy season could be attributed to agricultural runoff and discharge of water containing detergents etc. from Hoshangabad city. The higher phosphate concentration therefore indicates pollution. Higher value of phosphate reported in river Ganga at Kanpur by Chattopadhya *et al.,* (1984) during the monsoon periods due to coming agricultural runoff and sewage from the river.

Biochemical oxygen demand is an important parameter for usage conditions of surface waters. It is an approximate measure of the amount of biochemical degradable organic matter present in a water sample. Excessive BOD loads damage the quality of river water. It causes low DO concentration and unsuitable life conditions for flora and fauna in the river. The minimum BOD 2.8 mg/l was observed at site-8 in winter season which indicates that has not contributed to increase the pollution level of the Narmada river while maximum values i.e. 28 mg/l were noted at site-7 in summer season which could be due to the influence of sewage. Higher values of BOD indicate a higher consumption of oxygen and a higher pollution load. Low BOD in winter season was mainly due to higher algal productivity, along with increased solubility of oxygen at low temperatures, while summer maxima resulted from the rapid utilization of oxygen at higher temperatures (Chetana and Somashekhar, 1997).

During the present study Chemical oxygen demand measured in the range of 8.6 to 64 mg/l. The lowest COD 8.6 mg/l was observed at site-8 in winter season. Highest values 64 mg/l were observed at site-7 in summer season due to mixing of wastewater. Yadav and Srivastava (2011) find similar observation that values of COD seasonally were highest in summer followed by rainy and winter season in river Ganga at Ghazipur. Jain *et al.,* (2003) reported the effluent of the pulp and paper mill and the distillery add a high concentration of organic matter to the Hindon river.

Conclusion

The findings of present study elucidated that the seasonal changes are the major factors in fluctuation of most of the physico-chemical characters of the water. Most of the parameters higher during in summer season which may be due to high temperature, low water level and high evaporation and minimum in winter due to increased water level and low metabolic activities. During the study period it was observed that the water quality of river Narmada degraded at the selected sampling sites. Domestic sewer drain is one of the major sources of pollution of river Narmada within Hoshangabad city, in which Lendia nala (site-7) and SPM nala is most polluting among the other nallas. The highly impacted site-7 and site-9 which has found heavy pollution load due to directly draining of sewage and industrial effluent from Hoshangabad city.

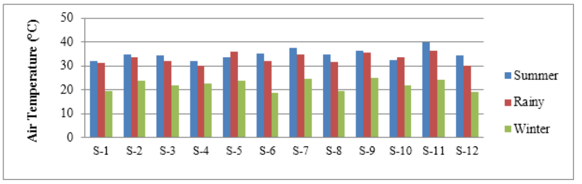

Fig: 2 Showing seasonal variation in Air temperature at different sites of river Narmada

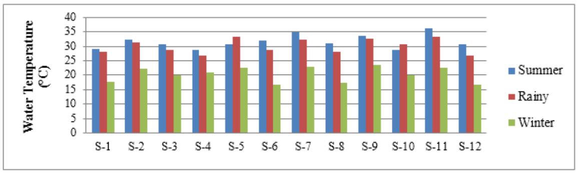

Fig: 3 Showing seasonal variation in Water temperature at different sites of river Narmada

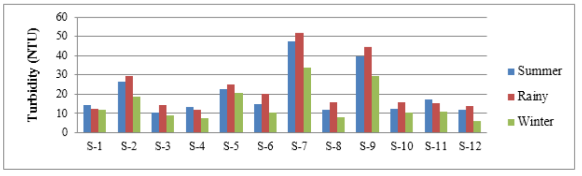

Fig: 4 Showing seasonal variation in Turbidity at different sites of river Narmada

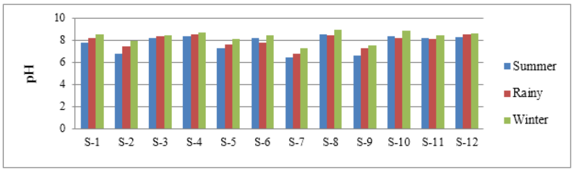

Fig: 5 Showing seasonal variation in pH at different sites of river Narmada

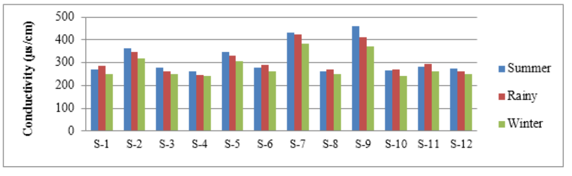

Fig: 6 Showing seasonal variation in Conductivity at different sites of river Narmada

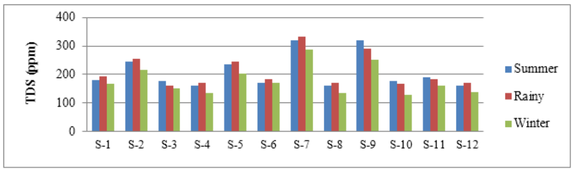

Fig: 7 Showing seasonal variation in TDS at different sites of river Narmada

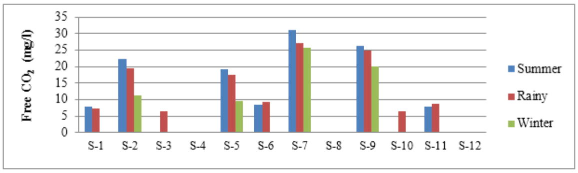

Fig: 8 Showing seasonal variation in Free CO_2 at different sites of river Narmada

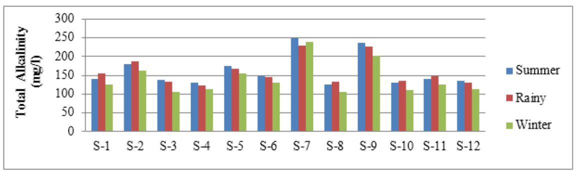

Fig: 9 Showing seasonal variation in Total Alkalinity at different sites of river Narmada

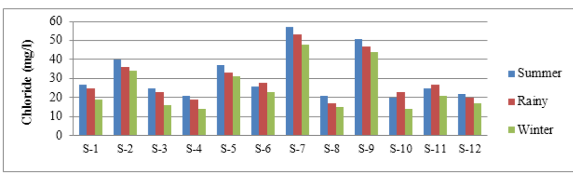

Fig: 10 Showing seasonal variation in Chloride at different sites of river Narmada

Fig: 11 Showing seasonal variation in Total Hardness at different sites of river Narmada

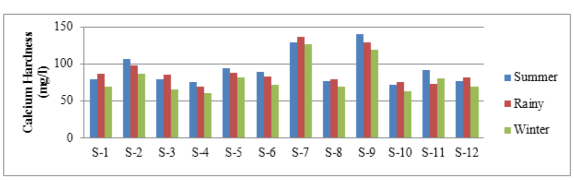

Fig: 12 Showing seasonal variation in Calcium hardness at different sites of river Narmada

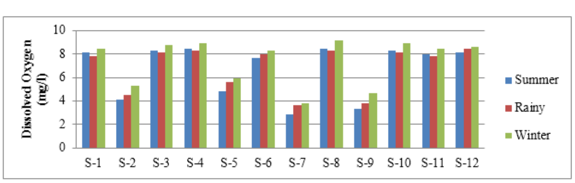

Fig: 13 Showing seasonal variation in Dissolved Oxygen at different sites of river Narmada

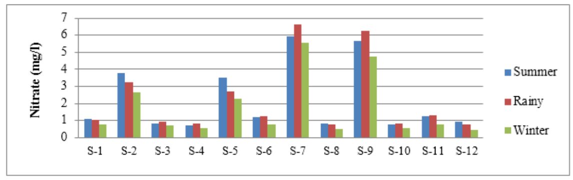

Fig: 14 Showing seasonal variation in Nitrate at different sites of river Narmada

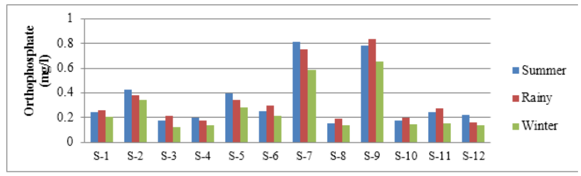

Fig: 15 Showing seasonal variation in Orthophosphate at different sites of river Narmada

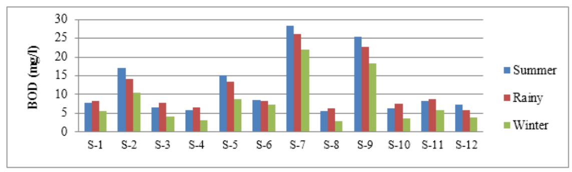

Fig: 16 Showing seasonal variation in BOD at different sites of river Narmada

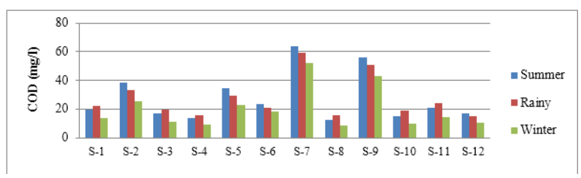

Fig: 17 Showing seasonal variation in COD at different sites of river Narmada

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