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Assessment and impacts of surface water environment in and around Jabalpur city, Madhya Pradesh, India

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Abstract

The physical, chemical and biological characteristics of surface water in and around Jabalpur city, M.P. have been studied to evaluate the suitability of water for irrigation and domestic uses. Samples of water were collected from various localities such as Narmada and Pariyat water supply system, various ghats of Narmada river, various tals and tanks, main drains of the city such as Omti nala and Moti nala and were analyzed for pH, electrical conductivity, temperature, dissolved oxygen, five days Biological oxygen demand , fecal coliform , turbidity, total solids, nitrates and phosphates.Water quality indices "WQI" developed in 1970 by the U.S. National sanitation foundation were calculated for these water samples. The results conclude that the water quality of water supply systems, various ghats of Narmada River is of medium quality and can be used for domestic use after suitable treatment. The water quality of various tanks and drains falls in the range of bad quality waters by index rating and can be used for irrigational purposes .This study is helpful to environmental planning and pollution control measures applicable to the area.

Introduction

In the developing countries like India the optimum development, efficient utilization and effective management of their water resources should be dominant strategies for economic growth. But in recent years, unscientific management and use of the resources for various purpose almost invariably has created undesirable problems in its wake; water logging and salinity in the case of agricultural use and environmental pollution of various limits as a result of mining, industries and municipal use (Rao and Rao, 1990; Rao and Prasad, 1997; Jain *et al*., 1996, 1997). An attempt has been made here therefore to evaluate the quality of surface water by collecting water samples from urban and rural areas of the study area and to assess the suitability and causes for deterioration of water quality in this region (Singh *et al.*, 1996; Chapman, 1992).

Study Area

The study area lies between the east longitude 79°53′ and 80°03′ and the north latitude 23°05′ and 23°15′ (fig 1). Physiographically, the area can be divided into the forested and hilly tracts and the plains. Geologically, the area comprise of

Palaeo-Proterozoic rocks of Mahakoshal Group to Deccan Traps (Cretaceous) and alluvium (recent). Mahakoshal rocks are metamorphosed sequence of varying grade and are intruded by the granites. Granites outcrop over quite a large area; the Gondwana rocks form low tracts where as the Lameta rock form conspicuous relief. Basalt occurs on the top of Lametas and it engrosses the terrain absolutely southeastwards.

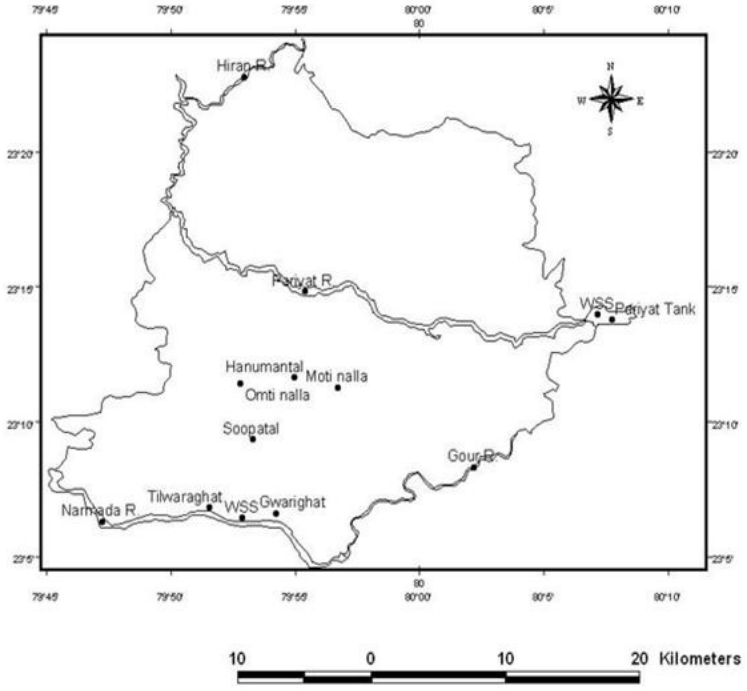

Fig. 1: Map of Jabalpur showing sample location

Methodology

Surface water samples from various sites in the study areas were collected and analyzed for their physical, chemical and biological characteristics following standard water quality procedures. Assessment of surface water quality was done using Water Quality Index. Electrical conductivity (EC) and pH were measured using conductivity and pH meters. Total dissolved solids (TDS) were computed from EC multiplied by 0.64. Sodium (Na^+) and potassium (K^+) were determined by flame photometers. Phosphates (PO_4^{3-}) and nitrates (NO_3^-) were estimated by calorimetric technique. Dissolved oxygen was determined using DO meters and five days biological oxygen demand was also calculated using standard techniques. All concentrations are expressed in milligram per litre (mg/lit.) except pH. Presence of fecal coliform in surface water was determined by MPN test.

Water quality has been assessed using water quality index (WQI) developed by the U.S. National Sanitation foundation (NSF) in 1970. The WQI was based on Delphi approach of series of questionnaires to develop functional relationships. The National Sanitation Foundation surveyed 142 people representing a wide range of positions at the local, state, and national level about 35 water quality tests for possible inclusion in an index. Nine factors were chosen and some were judged more important than others, so a weighted mean is used to combine the values. So that field measurements could be converted to index values, respondents were

asked by questionnaire to graph the level of water quality (0 through 100) corresponding to the field measurements (*e.g.* pH 2 - 12). The curves were then averaged and are thought to represent the best professional judgment of the respondents. When test results from fewer than all nine measurements are available, we preserve the relative weights for each factor and scale the total so that the range remains 0 to 100. The water quality factors and weights are given in Table-1.The 100 point index can be divided into several ranges corresponding to the general descriptive terms shown in the Table-2.

Table-1: Water Quality Factors and Weights

Water Quality Factors and Weights	
Factor	**Weight (Wi)**
Dissolved oxygen	0.17
Fecal coliform	0.16
pH	0.11
Biochemical oxygen demand	0.11
Temperature change	0.10
Total phosphate	0.10
Nitrates	0.10
Turbidity	0.08
Total solids	0.07

Table- 2: Water Quality Index Legend

Water Quality Index Legend	
Range	**Quality**
91-100	Excellent
71-90	Good
51-70	Medium
26-50	Bad
0-25	Very bad

Results and Discussion

The data obtained by physical, chemical and biological analysis of water of various ghats of Narmada River, tanks of the city (Hanumantal, Soopatal, and Devtal), Pariyat water supply system and Narmada river water supply system, main drains of the city (Moti nalla and Omti nalla) were evaluated in terms of its suitability for drinking and irrigation purposes using water quality index . Analytical data shows that surface water of the study area are suitable for drinking and domestic uses with few exceptions (drains) as most of the parameters are within the permissible limits. The values of total solids and EC exceed the permissible limits at some sites such as Pariyat tank water supply systems, Hanumantal, Devtal, Omtinala.

Water quality indices (WQI'S) were calculated for the water of Pariyat water supply system and Narmada river water supply system (Table-3), various ghats of Narmada (Table- 4), which shows that WQI for these water resources ranges between 51 - 70. Thus water is of medium quality suggested according to NSF.This

water can be used for domestic, irrigation and industrial purpose after suitable treatment.

WQI for Hanumantal, Soopatal and Devtal was calculated (Table-5) which shows that the value ranges between 26-50 and thus water is of bad quality. This water can be used for irrigation purpose.

Table- 3: Water Quality Index for Water Supply Systems

Variable	**Measurement**	**Q**	**W_i**	**Q W_i**
DO	3	3	0.17	0.51
Fecal coliforms	Nil	100	0.15	15
.pH	7.5	94	0.12	11.28
BOD_5	2.1	90	0.10	9
NO_3	0.24	99	0.10	9.9
PO_4	0	100	0.10	10
Temperature change	24	5	0.10	0.5
Turbidity	Clear	100	0.08	8
Total solids	950	20	0.08	1.6
			WQI =	65.79

Table- 4: Water Quality Index for Ghats of Narmada River

Variable	**Measurement**	**Q**	**W_i**	**QW_i**
DO	6	6	0.17	1.02
Fecal coliforms	Nil	100	0.15	15
.pH	7.7	91	0.12	10.92
BOD_5	2.2	90	0.10	9
NO_3	0.12	100	0.10	0.1
PO_4	0.1	100	0.10	10
Temperature change	31	5	0.10	0.5
Turbidity	Clear	100	0.08	8
Total solids	262	65	0.08	5.20
			WQI =	59.74

Table-5: Water Quality Index for Tanks

Variable	**Measurement**	**Q**	**W_i**	**QW_i**
DO	5	5	0.17	0.85
Fecal coliforms	Nil	100	0.15	15
.pH	7.7	92	0.12	11.04
BOD_5	14	21	0.10	2.1
NO_3	0.44	98	0.10	9.8
PO_4	9	5	0.10	0.5
Temperature change	24	5	0.10	0.5
Turbidity	>100 JTU	5	0.08	0.4
Total solids	880	20	0.08	1.6
			WQI =	41.79

WQI for Moti nalla and Omti nalla, which are the main drains (nallas) which drains through the city, was calculated (Table- 6).The water quality indices together fall in the value range of 26-50 which shows that water is of bad quality .The chemical analyses of the water samples of Omtinalla and Motinalla shows that the maximum of the city domestic waste find outlet through them. These nallas after leaving the periphery of the city move ahead through rural agriculture area. After their confluence, the Omtinalla runs northward to join Pariyat River. In fact, the course of the nalla offers good opportunity to use the water for agriculture.

Table-6: Water Quality Index for Drains (Nallas)

Variable	**Measurement**	**Q**	**W_i**	**QW_i**
DO	7.4	7.4	0.17	1.258
Fecal coliforms	10^6	2	0.15	0.3
.pH	7.85	91	0.12	10.92
BOD_5	112	2	0.10	0.2
NO_3	0.34	99	0.10	9.9
PO_4	0.12	99	0.10	9.9
Temperature change	30	5	0.10	0.50
Turbidity	>100 JTU	5	0.08	0.4
Total solids	1450	20	0.08	1.6
			WQI =	34.98

The basic feature of Jabalpur is that it has grown on a natural wetland (Tignath et al, 2005) that originally existed below the slope zone of the Madan mahal Granites along the low and relatively flatland of Gondwana rocks. With the growth of urbanization the wetland was reduced into isolated Tals (ponds) and later, most of them were reclaimed for lands to develop various civic buildings. However superfluously changed in the landuse and landcover, the area remains a either buried or non-functional wetland. That makes it more dangerous for it may eventually lead to complete deterioration of the aquifer beneath it. The WQI values, no matter how meager at negative side and which may not reflect the seriousness of the consequences at present, will certainly pollute the groundwater through vicious cycles or the self augmenting feedback loops by iterative increments of pollutants overcoming the function of the natural self balancing mechanism. This study therefore focuses on more dangerous which may go overlooked in appraisal of the index. It is further advised to other researchers involved in the assessment impacts that integration of the hidden variables related to geomorphology and lithology and the general anthropogenic changed that they have brought in with them in the natural systems.

Conclusion

The quality parameters determined for various water sources of the area indicate that the water of Pariyat water supply system and Narmada river water supply system, various ghats of Narmada fall quite within the acceptable range, while samples of sub urban ponds/tanks have one or the more parameters beyond the limits. The city drains give a cause for worry in terms of physical and bacteriological parameters.

The geomorphological and lithological setup of Jabalpur makes it all the more sensitive system heading towards serious consequences of subsurface water

pollution, as yet unregistered in WQI values, owing to its natural status of a shallow wetland.

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