ASSESSMENT OF WATER QUALITY PARAMETERS OF NAG RIVER FLOWING THROUGH NAGPUR, MAHARASHTRA

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ABSTRACT

Nag River flows through the city of Nagpur in Maharashtra, India. The city, which has population of about 40 lakh, derives its name from the river. A tank named Ambazarilakehas been constructed on the river at the upstream of Nagpur city. After flowing through the city of Nagpur, the river onfluences with Kanhanriver, in Pranhita sub-basin of Godavari basin.Central Water Commission has conducted a special study of all Physico-chemical parameters and Heavy metals in water samples of Nag river at eleven sites. The core parameters examined and the values observed are pH (7.0 to 8.8), Electrical Conductivity (254-960 µmho/cm), Dissolve oxygen (0.0 to 9.1 mg/L), Biochemical Oxygen Demand (1.8 to 455.0 mg/L), Nitrate (0.83-63.41mg/L), Nitrite (0.20- 34.71 mg/L), Total Coliform (350 – 120000 MPN/100 mL), Faecal Coliform (100 - 120000 MPN/100 mL) and Chemical Oxygen Demand (6.4 -571.0 mg/L). For this, the recent data of February 2012 to January 2013 has been analysed. The results show that the parameters like pH, EC, NO_3^- ,NO_2^- are within the permissible limit for designated best uses of water at most of the sites. However, Total Coliform (Tcol) &Faecal Coliform (Fcol), BOD values are higher and the DO values are lower than the acceptable limit at most of the sites. COD values are high at most of the sites. Over the year of time, Nag River has been subjected to human interference regularly and water quality has got deteriorated due to alteration in the physicochemical and biological parameters of the river system. The Nag river eco-system is under maximum stress due to anthropogenic activities along the stretch of the river which mainly consists of discharge of sewage waste, open defecation and other domestic activities. This study would help to understand the recent water quality scenario of Nag River which would be helpful in adopting efficient treatment technology. The above case study would also call for attention to other rivers flowing through cities for its revival and sustenance of environment.

Keywords: Nag river, Water Quality, Core Parameter

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INTRODUCTION:

Nagpur is the third largest city in Maharashtra after Mumbai and Pune. It is winter capital of the state of Maharashtra, With a population of 40 lakh,Nagpur Metropolitan Area is the 13th largest urban conglomeration in India. It has also recently been ranked as the second greenest city of India. In addition to being the seat of annual winter session of Maharashtra state assembly 'VidhanSabha', Nagpur is also a major commercial and political center of the Vidarbha region of Maharashtra, and is also famous throughout the country as "Orange City" for being a major trade center of oranges that are cultivated in the region. The Nag River, a tributary of the Kanhan River, flows through the city of Nagpur. And hence, the city is named as Nagpur. Forming a part of Kanhan-Pench river system, Nag river confluences withPili River before pouring into Kanhan River in Wainganga (Pranhita) sub-basin of Godavari Basin. It has about 50 km of length.A lake 'Ambazari' has been constructed at the upstream reaches of the river Nag and was the prime source of water to Nagpur city till a few years ago. However, the river riceives fresh water only during a few days of monsoon. The untreated sewage and industrial effluent of about 345 MLD aredischarged directly in the river. Presently, in non monsoon season only these effluents only flow through the river. Because of this, the river water is dark gray and emanates foul smell.

Most of the present day rivers in India are severely contaminated owing to the negligent approach & misconduct by the community. The many cities of India may be termed as an excellent and classic example of the mismanagement of the rivers. Nag river flows for most of its course through the urbanized part of Nagpur city, a city with approx. population of about 40 lakh. The Nag river eco-system is under maximum stress, due to the social and economic activities carried out by various population classes on different land use patterns. The occupational and domestic activities in various households invariably result in the production of liquid, solid and gaseous wastes of various types and quantities, which subsequently find their way into the river.

NEED OF THE STUDY:

The river water quality management requires evaluation of pollution loads from various sources. Catchment management plans require to recognize that total pollutant load to a water body consists of three components: (1) Direct/point wastewater discharges; (2) Diffuse/non-point contribution in seepage and runoff water from the catchment manipulated/managed by human; (3) A background contribution from natural sources (possibly due to scouring/erosion from catchment surfaces and in stream secondary pollution). Improvement of water quality in the natural water resources may require control of both point and nonpoint pollution sources (Khadse et al., 2008).

There is a strong public opinion for purification of Nag river. This has become more important as water from Nag river ultimately finds its way in Gosikhurd dam constructed on river Wainganga near Pauni town. The reservoir supplies water for irrigation, domestic and industrial use. Further, there are reports of pollution of ground water in the villages on the banks of the river. Hence knowing the level of pollution would be very essential to tackle the issue and adopt proper purification measures. As such, Central Water Commission, a Govt. of India organization conducted a special study to observe the extent of pollution in the river. The study was conducted for a year during February 2012 to January 2013. This study would help to understand the water quality scenario of Nag River which would be helpful in adopting efficient treatment technology. The above case study would also call for attention to other rivers flowing through cities for its revival and sustenance of environment.

SAMPLING AND ANALYTICAL WATER QUALITY PROCEDURES:

Central Water Commission follows the standard protocol as set by the Water Quality Assessment Authority for sampling, transportation and preservation and analysis of the water samples. The qualitative parameters derived from water samples were collected at various locations along the urban stretch of Nag River as shown in Fig. 1. The eleven (11) sampling stations were fixed at various locations starting from Ambazari Lake to Shivani village i.e. the before confluence of Nag river with Kanhan river. Water samples were collected from all these 11 stations for analysis. The water samples werecollected on first working day of every month during the study period of February 2012 to January 2013 between 8.00 to 11.00 AM. The samples were collected in clean and pre-rinsed polythene bottles of one liter capacity,

filled up to their fullcapacity without air bubbles. The collected water samples are transported to Wainganga Divisional Laboratory, CWC, Nagpurwithin 24 hours of collection, for physico-chemical analysis. The method of analysis is as per the procedure prescribed in Hydrology Project, Standard

Analytical Procedures for Water Quality Analysis (Hydrology Project, 2003).The instruments used were as per the accuracy and precision prescribed in the standard procedure. Chemicals of analytical grade were used during the analysis.

RESULTS AND DISCUSSION:

Water quality parameters are means to describe the chemical, physical and biological characteristics of water usually in respect to its suitability for particular purposes. The variations were noticed in various physico-chemical parameters of water in Nag river basin. The annual average values of core parameters viz. Temperature, pH, EC, DO, NO_3-N, NO_2-N, BOD, COD and Total Coliform(Tcol) &Faecal Coliform(Fcol) are obtained at various locations as shown in Fig.1. These values are compared with standard values of parameters prescribed for Classification of Inland Surface Waters, IS: 2296-1982 (CPCB, 1995) given in Table 1. The results are as discussed below:

Temperature: Temperature of water may not be as important in pure water because of the wide range of temperature tolerance in aquatic life, but in polluted water, temperature can have profound effects on dissolved oxygen (DO) and biological oxygen demand (BOD).The fluctuation in river water temperature usually depends on the season, geographic location, sampling time and temperature of effluents entering the stream (Ahipathi et al., 2006). The Temperature of water in Nag riverwas found to be varying from 17to 32 ^{0}C during the year as indicated in Table 2.

pH: Hydrogen ion concentrationis an important factor that determines the suitability of water for various purposes,including toxicity to animals and plants. pHplays an important role in the biological processes of almost all aquatic organisms. Low pH values indicate acidic water having corrosive properties. High pH values indicate alkaline properties. pH values between 6.5 to 8.5 is considered acceptable. However, no health-based guideline value has been proposed for pH. The pH in Nag river is varying from 7.0 to 8.8 during the year as shown in Table II. The average values at all the location of Nag riverare as shown in fig.2. The values are above 7.4 and it shows that the river water is of alkaline nature. The alkaline pH river water might be due to high domestic effluent in the river and microbial activities(Venkatesharaju et al., 2010). As per the Classification of Inland surface waters (IS: 2296-1982) it is suitable for A and B class of water.

Electrical Conductivity (or specific conductance): The ability of water to conduct an electric current is known as conductivity or specific conductance and depends on the concentration of ions in water. It is an index to represent total concentration of soluble salts in water. Electrical conductivity is an estimate of total dissolved salts in water and water with EC values between 2500 and 10000 µmho/cm is not recommended for human consumption and normally not suitable for irrigation (Kueli,2009).

The value of conductivity of water at all locations on Nag river water in is varying from 254 to 980µmho/cm as shown in Table II and average values were found to be varying from 317 to 716 µmho/cm.The electrical conductivity in entire year is less than 2250 µmhos/cm.

Dissolved Oxygen: Dissolved Oxygen (DO) is of considerable importance in water quality as its concentration in water is an indicator of ability of a water body to support a well balanced aquatic life. DO in water is replenished through photosynthesis, dissolution from the atmosphere and addition of oxygen-rich water such as through runoff. Simultaneously, DO is consumed during heterotrophic oxidation of organic matter and respiration by aquatic flora and fauna as well as oxidation of some naturally occurring constituents in water. Thus, equilibrium is maintained between consumption and replenishment of DO. In natural waters the rate of consumption of DO is lower than the rate of replenishment resulting in maintenance of adequate concentration of DO. Oxidizable matters such as sewage and certain pollutants consume more DO than that the water body can replenish, thereby degrading the ecological quality.

As per the Classification of Inland surface waters (IS:2296-1982) minimum value of DO for water is 4.0 mg/L.The value of DO in water of Nag riveris varying from 0.0 to 9.1 mg/Las shown in Table 2. The average value of DO is less that 1.0 mg/Lin all location of Nag river except Ambazari and Gorewada

as shown in Fig.2. These locationsare at the upstream of Nagpur city and hence there are very less anthropogenic activities compared to other location on Nag River. The average lower value of DO is observed atSangamwadi , Mokshdham, Hivarinagar, Nari, Kamthi Road , Pawangoan, Mahalgoan, Parsad and Shivani are less than the the value required for even class D of water. This indicates that the water is not fit for drinking and even for propagation of wild life and fisheries.

Biochemical Oxygen Demand: The biochemical oxygen demand (BOD) is indication of relative oxygen requirements of water for oxidation of organic matter. Micro- organisms use the atmospheric oxygen dissolved in water for biochemical oxidation of organic matter. The BOD is used as an approximate measure of the amount of bio-chemically degradable organic matter present in water. A BOD value depends on the dissolved oxygen and oxidizable organic matter in water. The greater the decomposable matter present, higher the oxygen demands and greater the BOD values (Admoroti, 1996).

The value of BOD in Nag river basin is varying from 1.0 to 377 mg/L as shown in Table 2 . Surface water (river, lake) having BOD values 10 mg/L are considered as moderately polluted and BOD values of more than 20 mg/L are considered as highly polluted (Paul,1999). The average higher values of BOD are observed atSangamwadi, Mokshdham, Hivarinagar, Nari, Kamthi Road, PawangoanMahalgoan, Parsad and Shivani as shown in fig.3. Sources of organic matters include leaves and woody debris, dead plants and animals, animal manure, effluents from pulp and paper mills, wastewater treatment plants, feedlots, and food-processing plants, failing septic systems, and urban storm water runoff (USEPA,1997). If effluent with high BOD levels is discharged into a stream or river, it will accelerate bacterial growth in the river and consume the oxygen in the river. The oxygen may diminish to levels that are lethal for most fish and many aquatic insects.As per the Classification of Inland surface waters (IS:2296-1982) the BOD value should be maximum 3 mg/L. Hence the water of these locations is not fit as per class A, B, and C of waters.

Chemical Oxygen Demand:COD is a measure of the oxidation of organic compound in water. It is commonly used to indirectly measure the amount of organic compounds in water. The measure of COD determines the quantities of organic matter found in water. This makes COD useful as an indicator of organic pollution in surface water(King et al.,2003). In the conjunction with the BOD test, the COD test is helpful in indicating toxic conditions and the presence of organic substances (Clair et al.,2003).

The value of COD in Nag river basin is varying from 18 to 571 mg/L as shown in Table 2. The average COD is more than 200 mg/L in all locations of Nag river except Ambazari and Gorewada. The higher values of COD are observed atSangamwadi, Mokshdham, Hivarinagar, Nari, Kamthi Road, PawangoanMahalgoan, Parsad and Shivani as shown in fig.3.The high value of COD is due to high level of pollutants present in the river water.

Nitrate and Nitrite:Nitrate (NO_3) is found naturally in the environment and is an important plant nutrient. It is present at varying concentrations in all plants and is a part of the nitrogen cycle. Nitrite (NO_2) is not usually present in significant concentrations except in a reducing environment. Nitrate is the most stable oxidation state of N, it can be formed by the microbial reduction of nitrite. Nitrate can reach surface water as a consequence of agricultural activity, wastewater disposal and oxidation of nitrogenous waste products in human and animal excreta, including septic tanks. Surface water nitrate concentrations can change rapidly due to surface runoff of fertilizer, uptake by phytoplankton and de-nitrification by bacteria. The values of NO_3-Nin Nag river are varying from 0.19 mg/L to 14.23 mg/L and NO_2-Nare varying from 0.04 mg/L to 10.56 mg/L as shown in Table 2.The average value of NO_3-Nis varying from 2.37 to 17.71 mg/L and NO_2-Nfrom 1.05 mg/L to 10.45 mg/L as shown in fig 4. The limit of $NO_3$is 20 mg/L for class A and 50 mg/L for class C of water (8). The result shows that the value NO_3-N for all locations is low except Kamthiroad.Hence the water of Kamthi Road.

Total coliforms and Faecal coliforms: The purpose of the total coliform counts in water bodies is to estimate the number of coliforms in water samples as an index of magnitude of biological contamination. Total coliform count in water bodies is an important parameter for checking possible contamination. The Total coliform group comprises several types of bacteria. These bacteria reach water through faeces of humans and other warm-blooded animals, as well as through contaminated soils. This group of bacteria is widely used as a measure of health hazard from faecal contamination. The total coliform group comprises the aerobic and facultative, gram negative, nonspore-forming, rod shaped bacteria that ferment lactose with gas formation. The specific bacterium *Escherichia coli* is part of this group. The test for faecal coliform is at an elevated temperature of 44.5 °C, where growth of other non-faecal bacteria is suppressed.

The Faecal coliforms and total coliform in Nag river basin are varying in range 100 to <120000 MPN/100 from as shown in Table II. The average values of Faecal coliform are varying from 4171 to 29642 MPN/100 ml and total coliform from 39816 to 113917 MPN/100 ml as shown in Fig 5. The higher values of total coliform most probably arise from untreated wastewater discharged into river and animal activities. The presences of coliform organism are taken as an indication that pathogenic organism may also be

present. For C class of water, the total coliform should not be more than 5000 MPN/100 ml. Hence the water at most of the location in Nag river basin is highly polluted and not fit for class A,B and C.

Analysis of water at eleven locations in Nag river basin was carried out for the data of last one year from February 2012 to January 2013. The values of core parameters viz. pH, EC, DO, BOD, COD, NO3-N, NO2-N, Total Coliform (Tcol) &Faecal Coliform(Fcol) were analysed and compared with the standard values mentioned for classification of Inland Surface Waters (IS:2296-1982). The results show that the values of most of the important core parameters are well beyond the accepted norms for various classes of water. The average value of DO is less than 1.0 mg/L indicating that no aquatic life can sustain in the river water. BOD and COD values are also much higher. There is presence of Nitrates in the river water. Also, the faecal and total coliform count is very high. This indicates that the water of Nag river is highly polluted and not suitable for any beneficial uses.

Conclusion

Raw domestic and industrial waste water is discharged directly in the Nag river. Because of this, its water has been severely polluted. . The river looks like a 'sewerage drain' than a river. The observed values of most of the important water quality parameters also indicate that the river water is highly polluted. This is an alarming situation as the water is used for irrigating land on both the the banks of the river. The flows also contaminate ground water which are primary sources of domestic water supply in the nearby villages. The river further carries the polluted water to Gosikhurd dam which supply water for irrigation, domestic consumption and industrial uses. Visual observations indicates pollution in water of Gosikhurd dam also. This is an alarming situation and need to be tackled on priority. Nagpur Municipal Corporation has proposed some measures for purification of the river. However, they have to act fast so that the situation do not go out of control.

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Table 1 : The Designated Best Use Classification of Inland Surface Water -CPCB (IS:2296-1982)

Designated Best Use	Class of Water	Criteria
Drinking Water Source without conventional treatment but after disinfections	A	1. Total Coliforms Organisms MPN/100ml shall be 50 or less. 2. pH between 6.5 to 8.5 3. Dissolved oxygen 6 mg/l or more 4. Biochemical Oxygen Demand 5days 20 ^{0}C 2 mg/l or less
Outdoor bathing (Organized)	B	1. Total Coliforms Organisms MPN/100 ml, shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved oxygen 5 mg/l or more 4. Biochemical Oxygen Demand 5days 20 ^{0}C 3 mg/l or less
Drinking Water Source after conventional treatment and disinfection.	C	1. Total Coliforms Organisms MPN/100 ml, shall be 5000or less 2. pH between 6 and 9 3. Dissolved oxygen 4 mg/l or more 4. Biochemical Oxygen Demand 5days 20 ^{0}C 3 mg/l or less
Propagation of wild life, and fisheries.	D	1. pH between 6.5 and 8.5 2. Dissolved Oxygen 4 mg/l or more 3. Free Ammonia (as N) (max), 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal.	E	1. pH between 6 and 8.5 2. Electrical Conductivity at 25 ^{0}C micromhos/cm Max.2250 3. Sodium absorption ratio Max. 26 4. Boron Max.2 mg/l
	Below E	Not meeting A,B,C,D & E Criteria

Table 2: Water Quality Core Parameters Data of Nag river

PARAMETERS	Temp		pH		Conductivity		BOD3-27		DO		COD		NO3-N		NO2-N		Faecal Coliform		Total Coliform	
UNIT	^{0}C				(µmho/cm)		(mg/L)		(mg/L)		(mg/L)		(mg/L)		(mg/L)		(MPN/100 mL)		(MPN/100ml)	
NAME OF LOCATION	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
AMBAZARI	27.5	18.0	8.8	7.3	673	428	1.8	1.0	9.1	0.7	381	22	8.32	0.67	1.14	0.05	27100	100	<120000	100
SANGAMWADI	28.5	22.5	8.7	7.1	778	350	375	23.0	2.2	0.0	571	32	12.25	0.19	7.84	0.08	<120000	100	<120000	12000
MOKSHDHAM	30.0	24.0	8.7	7.2	980	288	377	9.0	2.2	0.0	508	40	12.11	0.52	8.73	0.1	27100	100	<120000	2450
HIVERINAGAR	30.0	24.0	8.8	7.2	960	550	370	18.0	1.7	0.0	550	37	13.69	0.35	44.39	0.09	<120000	100	<120000	100
GORWADA	29.5	17.0	8.7	7.5	653	254	1.9	1.0	9.0	1.8	383	18	1.77	0.87	33.71	0.04	11050	100	<120000	100
NARI	29.5	23.0	8.8	7.2	795	625	225	11.0	3.4	0.0	548	31	14.0	0.42	8.42	0.2	<120000	100	<120000	11050
KAMTHI ROAD	31.0	24.0	8.8	7.4	782	659	228	15.0	3.8	0.0	540	57	63.26	2.96	8.43	0.12	<120000	100	<120000	3950
PAWANGOAN	31.2	24.0	8.7	7.6	828	639	240	15.0	1.5	0.0	517	35	14.32	0.61	110.6	0.09	<120000	100	<120000	47000
MAHALGOAN	31.2	22.5	8.7	7.6	865	641	180	18.0	2.0	0.0	363	22	11.05	0.49	11.4	0.11	<120000	100	<120000	1350
PARSAD	31.3	23.0	8.6	7.5	807	480	246	16.5	3.0	0.0	455	64	10.45	0.48	53.38	0.07	<120000	100	<120000	350
SHIVANI	31.4	22.0	8.7	7.0	824	396	195	15.0	3.2	0.0	531	59	10.98	0.47	38.85	0.06	<120000	100	<120000	650

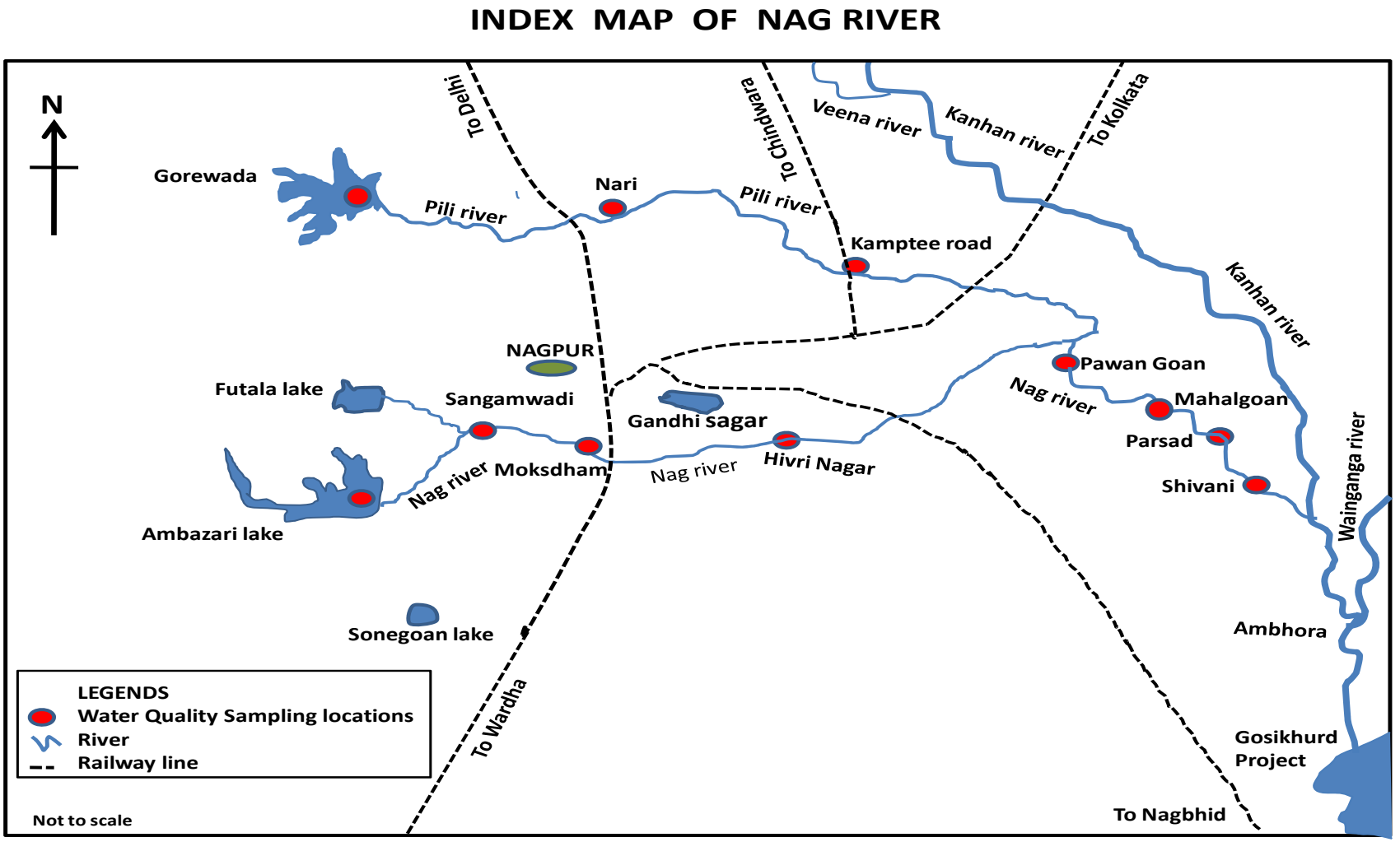

Figure.1 MAP showing various locations of Nag River ,Nagpur

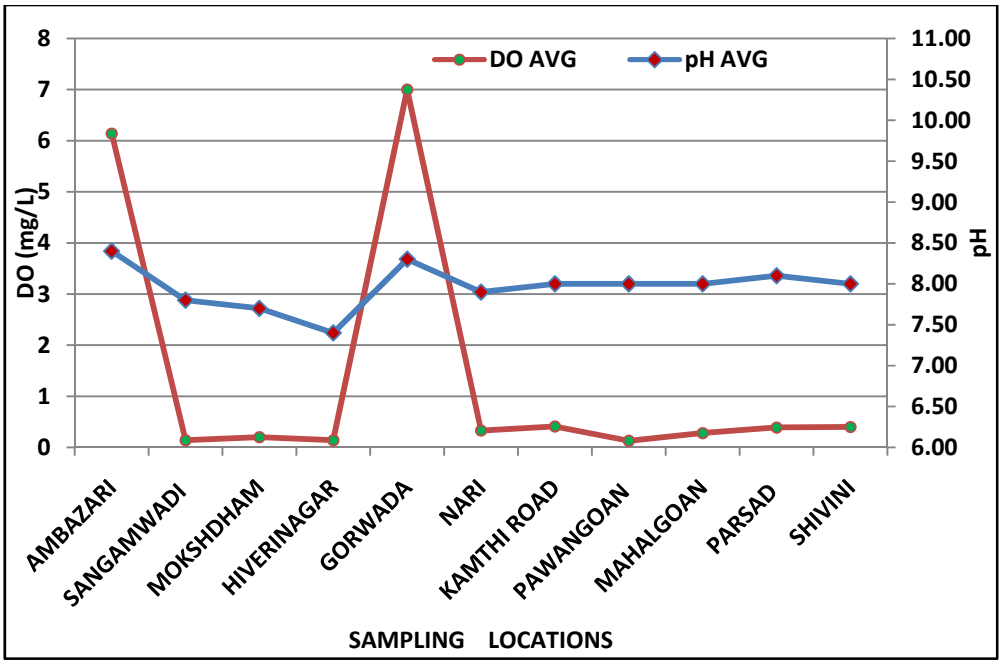

Figure 2. Location wise variation of pH and DO

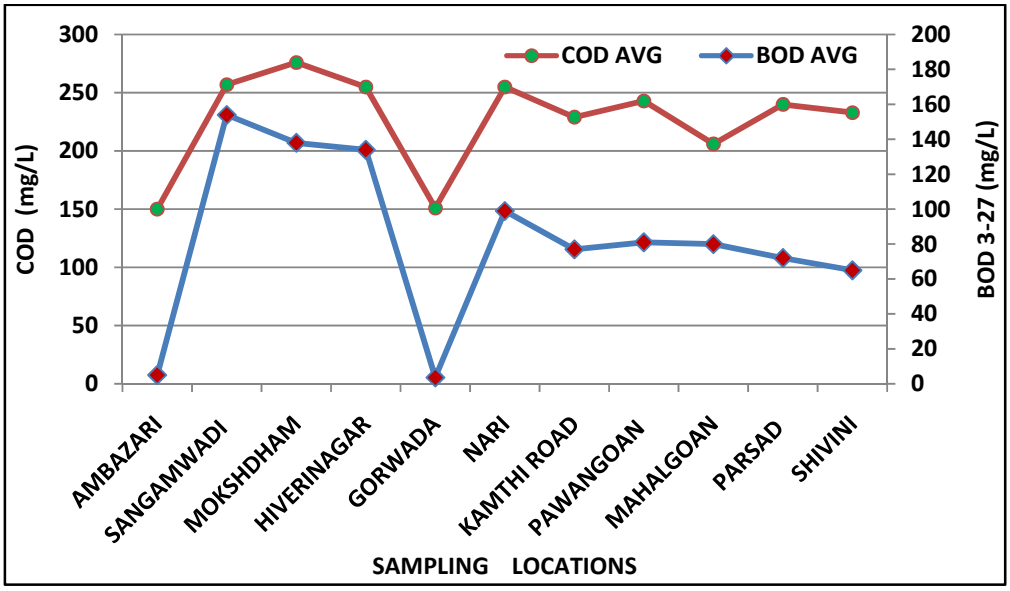

Figure.3 Location wise variation of COD and BOD

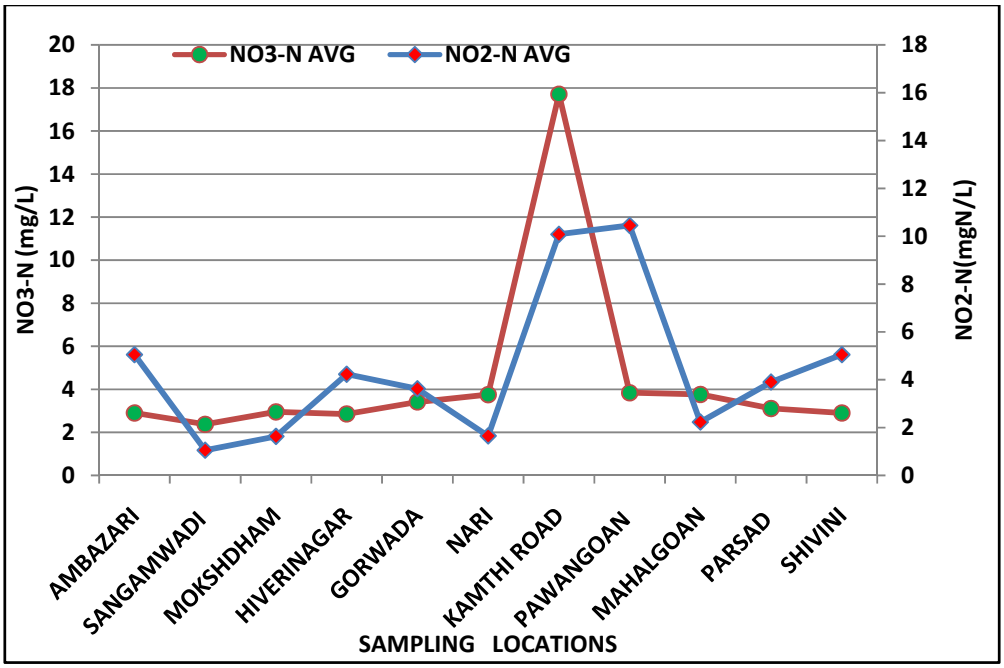

Figure.4 Location wise variation of NO3-N and NO2-N

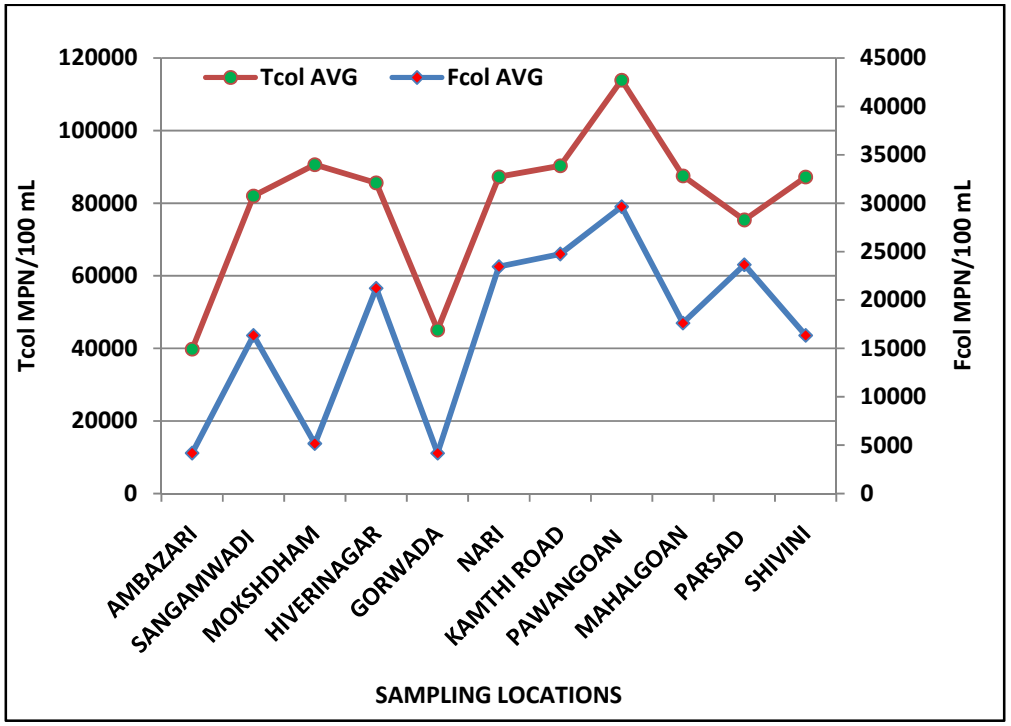

Figure.5 Location wise variation of Total and Faecal Coliform