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A Case Study of Water Quality Index of the Bellary Nala, Belgaum, Karnataka, India

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Abstract
Streams which are in many areas serving the basic needs of water, plays a significant role in shaping the environmental and ecological balance of the region through which it flows. Despite of all these versatile contributory roles, knowingly or unknowingly are being used as a dumping site for disposal of municipal and industrial waste waters with intention that streams will take care of these wastes. The main goal of this study was to characterize the combined industrial and municipal wastewater of Bellary Nala in terms of physico-chemical parameters. For this purpose, 10 sampling stations were selected. Parameters analyzed onsite included temperature, pH, turbidity, DO, BOD. Etc. All the collected samples were analyzed as per methods listed in the Standard Methods (APHA, 2005). The Bellary Nala was found significantly contaminated with pollutants and their concentrations were significantly higher as compared to General standards for discharge of Environmental Pollutants: Effluents. The study related to the assessment of water quality parameters of Bellary Nala was carried out to evaluate the various water quality parameters and to calculate water quality index.
Keywords: Bellary Nala, physicochemical parameters, pollution, water quality index.

1. Introduction

Earth, the Water planet is the only one in our solar system presently characterized and shaped by abundant liquid water - a necessity for life. Water in its purest form on Earth, comes from rain and snow. This water is available first in the form of surface water through streams, rivers and lakes. Thus we can say the journey of water on Earth starts in the shape of surface runoff. This surface water forms the lifeline of almost all the human activities as also most of nature's activities. It is the surface water which percolates down and recharges the aquifers and becomes part of groundwater. Therefore it can be easily said that contamination of surface water has a cascading effect and has far reaching implications throughout the reach of the stream, river, groundwater aquifers, flora and fauna, and human activities.

1.1 Water Quality Index

Water quality index provides a single number that expresses overall water quality at a certain location and time, based on several water quality parameters. The objective of water quality index is to turn complex water quality data into information that is understandable and usable by the public. A single number cannot tell the whole story of water quality; there are many other water quality parameters that are not included in the index. However, a water quality index based on some very important parameters can provide a simple indicator of water quality. In general, water quality indices incorporate data from multiple water quality parameters into a mathematical equation that rates the health of a waterbody with number.

2. Literature review

From the review, it is noted that the studies on water quality index of streams are quite limited in catchments. Water quality analysis helps in the determining the suitability of water for different usages. Application of water quality index in the study helps in the evaluation of self-purification capacity of a stream. Therefore, in the present study, the water quality index is used to ascertain the quality of surface water. The present study is a preliminary attempt in this direction to systematically determine the variation in surface water quality parameters which are found to vary with various man-made changes and agricultural practices.

3. Study Area

Belgaum is a city and a municipal corporation in the State of Karnataka, India. The Bellary Nala flows through Belgaum city originating from the hills of Belgaum (Yellur and Damne) and flowing eastwards towards the Markandeya River. Since there are no sewage treatment plants and recycling facilities within the city area, the entire sewage is directed to Bellary Nala by Lendi Nala (which comes from city area sewage form major part of the city joins this Nala) which is linked through gutters and sewer lines. It also becomes place for breeding Mosquitoes and flies, thereby creating unhygienic conditions. Physiographically, the area is in a depression with hill range surrounding it, open towards the east. The area consists of fertile agricultural land with seasonal streams joining the Nala.

4. Materials and Methodology

4.1 Selection of Sampling Sites

Sampling is one of the most important steps in collection of representative water samples for surface water quality studies. Standard procedures were adopted for sampling of the surface water. In the study area, a stream which is narrow and rapidly moving the water shall be thoroughly mixed laterally and vertically hence only one sampling point needed to be selected at each location along the stream. Bellary Nala is an organically polluted stream, two sites has been selected above the outfall of the wastes and three sites has been selected downstream. The sampling point should be accessible; bridges often serve as very good point of collection.

4.2 Sampling Methods

The quantity of samples to be collected varies with the extent of laboratory analysis, to be performed. Two liters of samples were collected from each location and suitable chemicals were added for preservation. To achieve the objectives of the study, the field study was carried out in January 2014 which was a dry season. The dry season is important because pollution has the highest impact on a receiving stream due to its dry weather flow. Ten sampling stations were chosen based on the peculiarity of the location rather than equidistance. Samples of surface water were collected from the study area by dip (grab) sampling method. The locations of surface water sampling stations are shown in the Figure 1 and Table 1, 2.

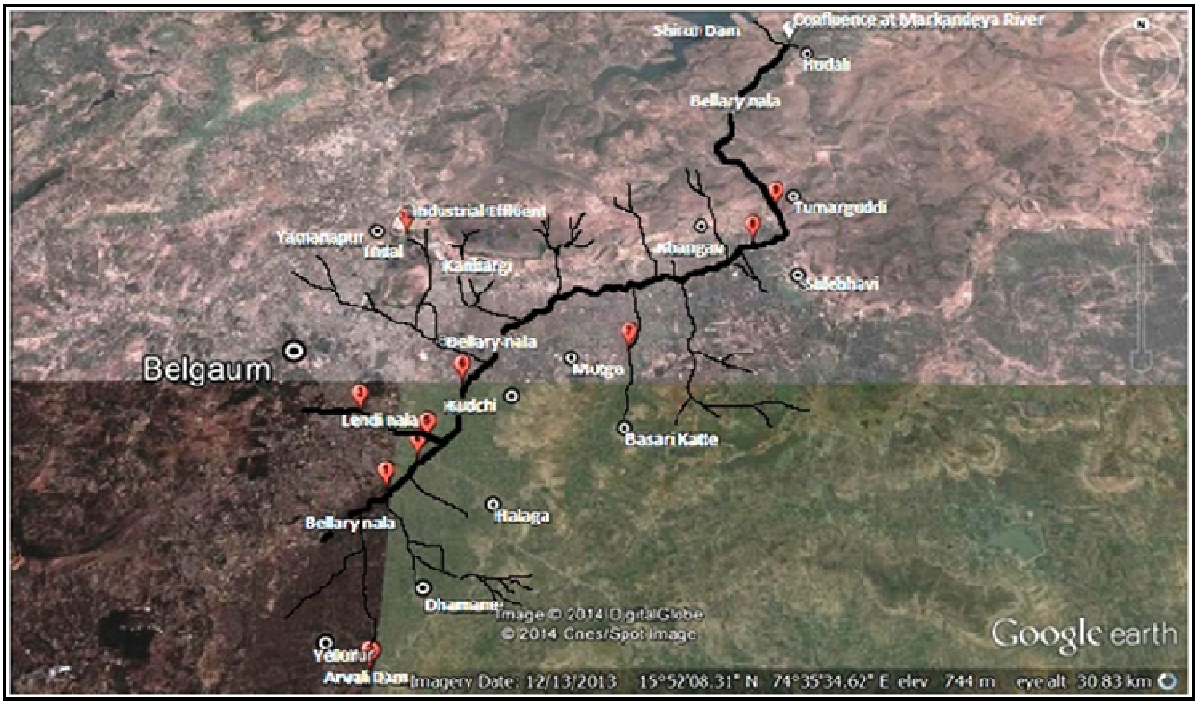

Figure 1: Location map of surface water sampling station

Table 1: Codes of sampling stations along with Bellary Nala

Code	Distance from point of origin (km)	Longitude	Latitude	Description
S1	2.5	15°49'27.55"N	74°31'53.92"E	The over bridge site on the way to Damne
S4	4.1	15°50'2.02"N	74°32'24.21"E	The over bridge site along the Old P.B. road near Halaga
S6	7.2	15°51'28.96"N	74°33'5.19"E	Kudachi over bridge is located after the lendi nala mixes with main channel
S8	24	15°54'30.31"N	74°38'33.30"E	The over bridge site after Sulebhavi village
S9	26.4	15°55'18.62"N	74°39'4.20"E	The Kaliyal bridge site along Gokak road near Tumarguddi

Table 2: Codes of sampling stations along the tributaries of Bellary nala

Code	Longitude	Latitude	Description
S2	15°46'26.59"N	74°31'57.01"E	The fresh water stream flowing from Arvali Dam, Yellur
S3	15°50'54.52"N	74°31'18.00"E	The over bridge site along the Dharwad road (Lendi nala)
S5	15°50'21.99"N	74°32'32.68"E	Wastewater outfall, The over bridge site along the bypass road (Lendi nala)
S7	15°52'8.81"N	74°36'7.12"E	The over bridge site after the Mutuga village (Seasonal fresh water stream)
S10	15°54'42.63"N	74°31'48.10"E	Industrial Effluent from INDAL (aluminum manufacturing factory)

4.3 Laboratory Analysis of Water Quality Parameters

In the present study, at each sampling station, chemical parameters such as, pH, Electrical Conductivity, Total Dissolved Solids, Chlorides, DO, BOD, etc were determined using the Standard Methods recommended in the manuals (APHA, 2005). Some of the parameters like pH and Temperature were measured in the field by using portable kits, at the time of sample collection. All water samples were analyzed for DO and BOD using titrimetric method (Azide Modification). BOD water samples were stored in an incubator at a controlled temperature of 20o C. All obtained laboratory data were entered into an excel spreadsheet. Basic data handling, statistical analysis and other calculations were done with the aid of excel spreadsheet.

4.4 Development of Water Quality Index

Water Quality Index (WQI) is calculated using NSF (National Sanitation Foundation) Water Quality Index. Water quality index is a 100 point scale that summarizes results from a total of seven different measurements when complete. Seven 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. When test results from fewer than all nine measurements are available, the relative weights are preserved for each factor and scale the total so that the range remains 0 to 100. After completing the seven tests, the results are recorded and transferred to a weighting curve chart where a numerical value (Q-value) is obtained. For each test, the Q-value is then multiplied by a "weighting factor." For example, dissolved oxygen has a relatively high weighting factor (0.17) because it is more significant in determining water quality than the other tests (Figure 2). The seven resulting values are then added to arrive at an overall water quality index (WQI). The 100 point index can be divided into several ranges corresponding to the general descriptive terms shown in the table 3,4.

Table 3: Water Quality Factors and Weights

Factor	Weight
Dissolved Oxygen	0.17
pH	0.11
Biochemical Oxygen Demand	0.11
Temperature change	0.10
Total Phosphate	0.10
Turbidity	0.08
Total Solids	0.07

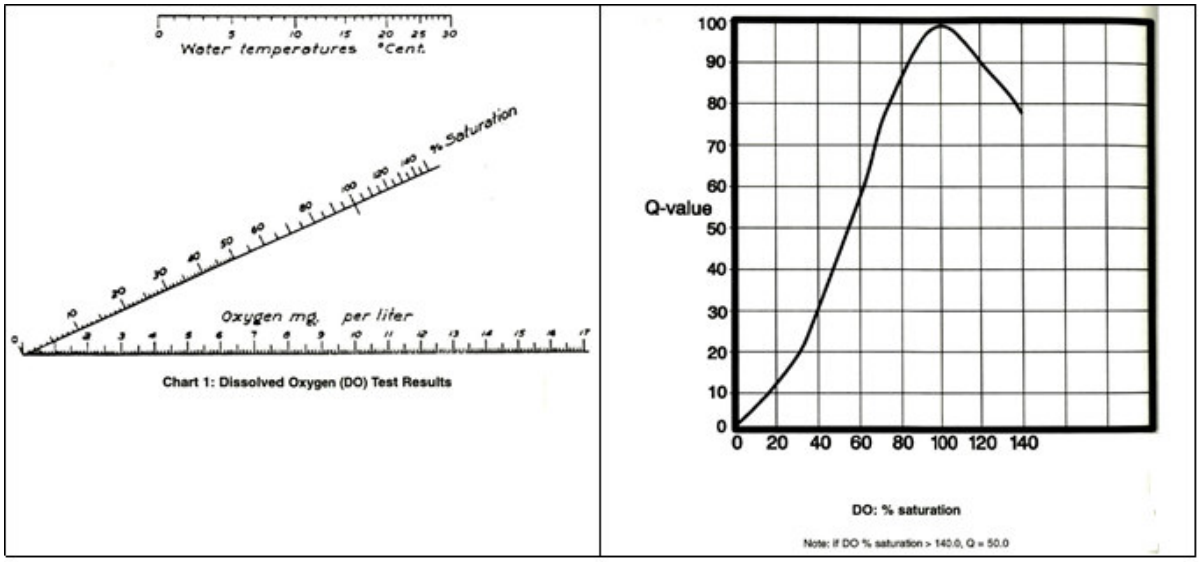

Figure 2: Weighting Curve Chart

Table 4: Water Quality Index Legend

Range	Quality
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very bad

5. Results and Discussion

Water quality index (WQI) is defined as a rating reflecting the composite influence of a number of water quality parameters. It provides a convenient means of summarizing complete water quality data. Water quality index developed for the surface water samples indicate that there is a wide variation from station to station. Calculation of WQI of water samples is furnished in Table 5 and 6. The WQI of all the locations is as shown in the Table 7.

Table 5: Calculation of Overall Water Quality Index of samples of Bellary Nala

Sl. No	Factor	DO	pH	BOD	Temp	Total phosphate	Turbidity	Total solids	WQI
	Weight	0.17	0.11	0.11	0.1	0.1	0.08	0.07	
S1	Damne bridge	13	87	47	20	7	77	20	37
S4	Old PB road	15	93	52	15	24	80	20	41
S6	Kudachi bridge	2	93	5	18	12	56	20	27
S8	Sulebhavi bridge	41	93	5	17	9	74	20	37
S9	Kaliyal bridge	42	91	5	16	9	86	20	38

Table 6: Calculation of Overall WQI of samples along the tributaries of Bellary Nala.

Sl. No	Factor	DO	pH	BOD	Temp	Total phosphate	Turbidity	Total solids	WQI
	Weight	0.17	0.11	0.11	0.1	0.1	0.08	0.07	
S2	Arvali dam	14	83	90	19	37	94	76	54
S3	Lendi DWD road	2	89	5	16	12	77	20	28
S5	Lendi Bypass	2	87	5	15	8	49	20	24
S7	Mutaga bridge	14	91	82	18	76	89	32	54
S10	Indal effluent	2	15	5	19	27	75	20	20

Table 7: WQI of samples in the study area

Code	Locations	WQI	Quality
S1	Bellary nala (Damne Bridge)	37	Bad
S2	Arvali Dam	54	Medium
S3	Lendi nala (Dharwad Road)	28	Bad
S4	Bellary nala (Old P.B.Road)	41	Bad
S5	Lendi nala (Bypass Road)	24	Very Bad
S6	Bellary nala (Kudachi Bridge)	27	Bad
S7	Mutaga	54	Medium
S8	Bellary nala (Sulebhavi Bridge)	37	Bad
S9	Bellary nala (Kaliyal Bridge)	38	Bad
S10	Indal Effluent	20	Very Bad

In case of surface water, the WQI values show variation between 20 and 54. In order to understand the status of water quality, observed parameters were compared with the index values. Accordingly five groups were identified. First category having index value varied from 90 to 100 is considered as excellent, with all parameters within the permissible ranges. None of the samples fall under this category. A second category, which has the index value varied from 25 to 50, is significant in number of locations, 6 samples show this characteristics. WQI is very low at S6 site (26) which shows the signs of pollution throughout the year. The index values lower than 25 are considered as unfit for use. Therefore, it is necessary to take appropriate measure to improve the water quality status at S6 site. It is also suggested to treat the wastewater effluent (S5) before disposing into Bellary Nala, otherwise, during the course of time the water will become unfit for usage.

5. Conclusions and Recommendations

From the present study the following conclusions are drawn:

1. The present study indicates the existing conditions of surface water quality index in selected parts of the Bellary Nala during the post-monsoon season of year 2014.
2. It is evident from the results obtained that the stream water, in its existing condition, cannot be utilized for any beneficial purpose.
3. It is observed that the indiscriminate discharge of municipal sewerage and industrial waste in to the stream has significant influence on the water quality of Bellary Nala.
4. Water Quality Index (WQI) shows a wide variation among all the water samples. For example: the water sample at Kudachi Bridge site has very low WQI making it unfit for usage.
5. This necessitates the undertaking of certain measures in this area to improve the water quality. Therefore, proper waste disposal technique and fertilizer usage is required to be diagnosed.

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