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Short Communication

A Study on the Physico-Chemical Characteristics of Panchaganga River in Kolhapur City, MS, INDIA

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Abstract

In the present work river water samples are collected from four different stations of Panchaganga river in Kolhapur city and water quality assessment is carried out from october 2009 to March 2010 on weekly basis in order to assess the environmental impact of disposal of domestic, industrial, household and agricultural waste into the river. Then water quality index (WQI) study is carried out to assess the environmental impact on the water quality of the Panchaganga river and to arrive at the level of pollution. From the study it is observed that station-1 is moderately polluted and need to be treated before its use, whereas station-2, station-3 and station-4 are found to be excessively polluted and are totally unfit for drinking purpose. This is mainly due to regular addition of domestic sewage, agricultural runoff, industrial wastes and other wastes that are let into the river through drains, nallahs in each station and it may lead to excessive pollution.

Keywords: Physico-chemical, coefficient of variation, water quality index.

Introduction

Water is essential to the existence of man and all living things[1]. The riverine system is one of the most important resources of water supply in different countries of the world. It provides water for drinking, agricultural, industrial and other purposes[2]. At the source of a river, the water is relatively pure. Changes took place in water use, land use, and hydrological conditions due to abstractive uses of water, growth of urban population, growth in industrialization, increase in agriculture activities, increase in use of chemicals in agriculture; and increase in use of chemicals at household level. There is an increasing measure of water pollution through out the globe.

In India the riverine systems are getting polluted day by day. Today acute pollution prevails in many rivers such as Krishna, Tapti, Bramhaputra, Ganga, Hoogly and Brahmani etc. As the water flows downstream, it picks up silt, minerals and mineral salts from the soil and rock in the river bed. Many other pollutants enter river water as it flows downstream, including animal waste, human sewage, agricultural runoff, urban runoff, industrial effluents, and mining effluents, due to which unfortunately, most of the rivers are facing pollution problem or under threat of pollution[3]. Hence there is an increasing upkeep interest to clean river water. Pathogenic water pollution due to domestic and human waste causes many water born diseases. Water quality degradation also leads to increased conflict between downstream and upstream users.

Kolhapur city is located on the bank of Panchaganga river which is the main source of water for various purposes. Increased developmental activities due to urbanization and industrialization are greatly responsible for water pollution in Kolhapur city. The estimated municipal wastewater is to the tune of 90 million liters per day (MLD) which reaches the river Panchaganga through two natural nallahs, namely Jayanti nallah and Dudhali nallah. The discharge locations are about 500 m upstream the Bawada water works which supplies more than 50 percent of municipal water to the city[4]. Due to the water pollution, there is a problem of adequate supply of potable drinking water. Water pollution has created serious impact on human life due to various water borne diseases leads to decreased food intake and nutrients absorption, malnutrition, reduced resistance to infection, and impaired physical growth and cognitive development Thus it is worthwhile to assess the quality of the Panchaganga river water to study its possible environmental impacts and level of pollution.

Study Area: The geographical area of Kolhapur district is about 7685 Sq. km, and the population of the district is about 35,15,413 of which Kolhapur city's population is about 5 lakh. There are 12 Tahasils, 09 municipal councils, one municipal corporation and 1200 villages in Kolhapur district. There are 18 sugar factories, 07 distilleries and 06 major dairy projects [5-6]. Kolhapur City (16° 42' N; 74° 14' E, height: 570 m), stands on rising ground on the south bank of the river Panchaganga. The river Bhogawati is renamed as Panchaganga from Prayag Chikhali, after the confluence with 5 rivers namely Kumbhi, Kasari, Tulshi, Dhamani and Bhogawati. The river flows towards south-north side and meets river Krishna at Narsinhwadi, Tal: Shirol, Dist: Kolhapur[7]. Sampling of water from Panchaganga river at selected 4 stations is being done on a weekly basis. Manual method of sample collection is preferred considering all site conditions. Station-1 is located near Balinga pumping station (Nagdevwadi) upstream of river, away from

city; station-2 is located near Mahadev temple, Shivaji pool naka which is 15 km downstream of station-1. Station-3 is located near Kasaba Bawada 8 km downstream of station-2. This site receives effluents from large number of small scale industrial units situated at Shivaji Udyam nagar. Large stream carrying city sewage namely Jayanti nallah, which passes through the central areas of the city, and is discharged into station-3 and station-4, is located near NH-4 Highway Bridge (Shiroli naka). This site receives industrial waste from MIDC, Shiroli and civic population[8].

Materials and Methods

The total quantity of water used is about 198.67 MLD; out of which around160.94 MLD of wastewater is discharged into river as it is without any further treatment. In Kolhapur district there are more than 3000 industries discharging 18.59 MLD of wastewater. There are 42 government and 1500 private hospitals and clinics generating about 23.10 MLD of wastewater. Hotels and restaurants: 18.217 MLD, chemicals: 78,427 liters per year discharging 45,560 liters of waste into the river. Immersion of Ganesh idols during Ganesh festival and Durga idols during Navaratri festival into river is also one of the reasons of river pollution[9-10].

In Kolhapur city the total quantity of water used is about 120 MLD. The estimated municipal wastewater for Kolhapur city is approximately 90 MLD. The Kolhapur municipal corporation (KMC) has provided primary treatment of the capacity 43.5 MLD. It is observed that about 50% effluent is directly used for irrigation by the farmers and 10% evaporation losses and 10% percolation losses. There is no underground drainage in the city and drainage is mainly by surface drains. Drainage of 'A' and 'D' wards is mainly let into Panchaganga river. Drainage of Shahupuri, Rajarampuri, Laxmipuri, Khasbag, 'C' Ward and 'B' Ward is mainly let into Jayanti nallah having capacity of 49 MLD is the main source of Panchaganga river pollution[11-13]. In order to assess the environmental impact on the Panchaganga river water quality four stations are selected and 4 river water samples are collected for the laboratory analysis and physico-chemical water quality analysis is carried out. The Temperature, pH, electrical conductivity (EC), total dissolved solids (TDS), turbidity, dissolved oxygen (DO), biochemical oxygen demand (BOD), Chemical Oxygen Demand (COD)[14-15] are measured in the laboratory. Because the preservatives interferes the chemical processes, no preservatives are used. Only in case of samples for DO tests, the DO is fixed at site and temperature is recorded on site only. In order to check the level of the pollution at each station the drinking water quality standards (desirable limits) as prescribed by IS-10500, (1991) are selected for the determination of water quality index (WQI) in the present study. To calculate WQI, the product of rating scale (Vr) and unit weights (Wi) are summated.

$$WQI = \sum Wi \; X \; Vr$$

Water quality index is calculated in this way for each station. WQI falling within the range 0-39.99 stood for severely polluted water; between 40-59.99 for excessively polluted water; between 60-79.99 for moderately polluted water; between 80-99.99 for slightly polluted, and 100 for absolutely clean water[16].

Results and Discussion

The water quality analysis of Panchaganga river water has been carried out from the month of October, 2009 to March 2010 for the predefined four sampling stations. It is observed that the physico-chemical and biological parameter features of this river fluctuate from place of place due to discharge of agricultural, municipal as well as industrial wastes into it. The mean values of the water quality parameters at four different stations with their desirable limits as per IS 10500, (1991) and coefficient of variation (CV %) obtained in the statistical analysis is shown in table-1. Temperature values are ranging from 29^{o}C to 39^{o}C. It is observed that the water temperature is within the desirable limit and the CV is very low and there is a very small variation in the temperature. The pH values vary from 5.3 to 8.3. Here it is observed that the pH values for Station-2, 3 and 4 fall within the desirable limit, whereas at Station-1 the water is slightly acidic in nature. The CV for pH indicates that the range of variation is narrow. Electrical conductivity values fluctuated in the range 140 to 772 µmhos/cm. The CV for EC is high and the variation is also high. Turbidity values fluctuated in the range of 4.0 to 28.0 NTU. It is observed that in the month of February the turbidity values at station-3 and in the month of January and February at station-4 are more than the desirable limit and CV is also high. The TDS values are ranging from 46 to 476 mg/l and these values fall within the desirable limit. The CV for TDS indicates that the variation is high. The dissolved oxygen values fluctuated from 3.0 to 7.9 mg/l. It is observed that DO levels at station-3 and 4 are very less with the CV very less which shows that there is a narrow range of variation. The biochemical oxygen demand values are fluctuating from station to station and are ranging from 2.40 to 11.60 mg/l. It is observed that the BOD values are more than the desirable limit and the CV reveals that the variation in BOD is slightly higher. The chemical oxygen demand values are ranging from 13.0 to 58.0 mg/l and it is observed that the COD values are more than the desirable limit and the CV obtained is slightly higher and there is a slight variation in COD values.

The water quality index (WQI) of the collected water samples is calculated to arrive at the level of pollution. However, the WQI depends on the intended use of the water. Rating scale (Vr) and unit weights (Wi) are shown in table-2. Then the range of rating scale (Vr) and its significance for the physico-chemical parameters of river water is tabulated in table-3 and the WQI of river water samples at 4 stations of Panchaganga river are presented in table-4. From the study it is observed that station-1 (WQI = 77.036) is moderately polluted and need to be treated before its use, whereas station-2 (WQI = 51.616), station-3 (WQI = 48.172) and station-4 (WQI = 45.712) are found to be excessively polluted and are totally unfit for drinking purpose. This is mainly due to regular addition of domestic sewage, agricultural runoff, industrial wastes and other wastes that are let into the river through drains, nallahs in each station and it may lead to excessive pollution.

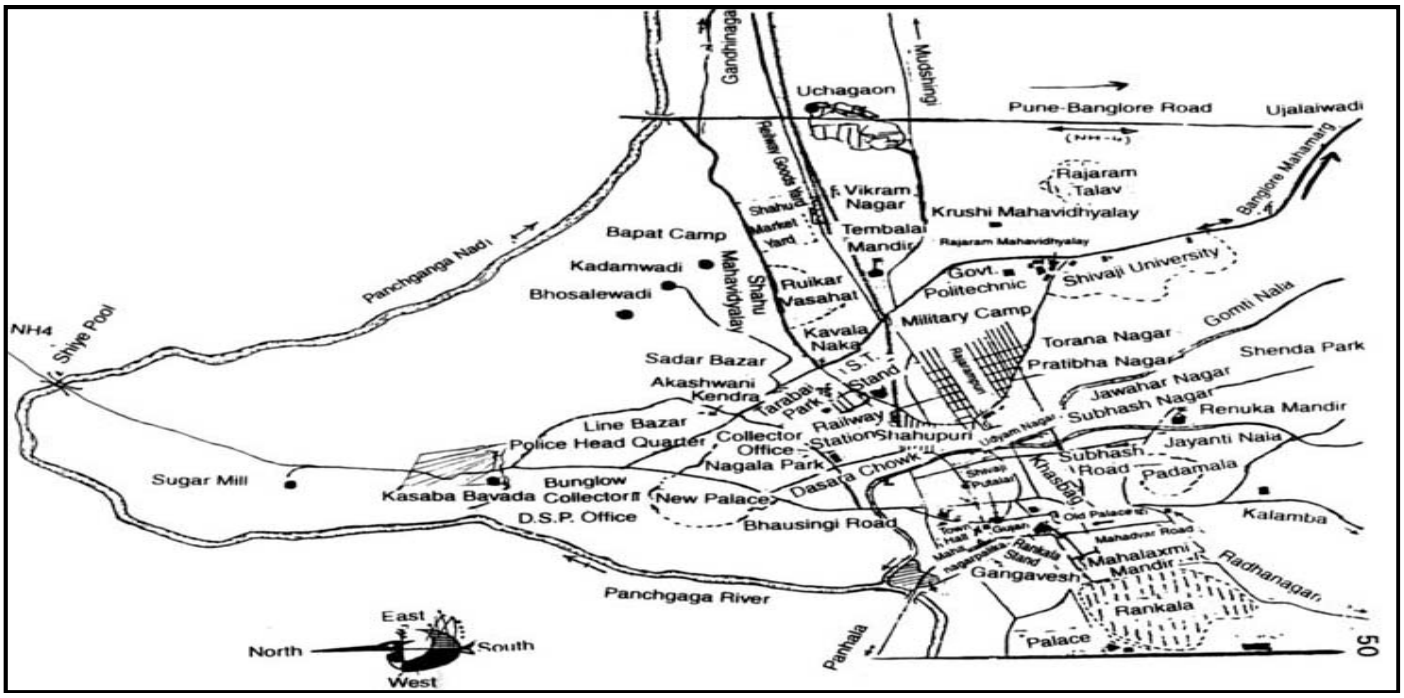

Figure-1
Map of Kolhapur city

Table-1
Coefficient of variation (CV %) for the river water samples

Parameter	Desirable Limit as per IS-10500,(1991)	Station-1		Station- 2		Station- 3		Station- 4	
		Mean	CV %	Mean	CV %	Mean	CV %	Mean	CV %
Temperature ^{o}C	Maximum 40^{o}C	33.75	8.54	32.80	8.6	34.25	6.89	34.05	6.84
pH	6.5-8.5	6.38	11.66	7.29	7.23	7.36	8.63	7.44	6.18
EC µmhos/cm	---	411.99	40.24	409.56	43.17	458.31	30.77	466.94	32.61
TDS mg/l	Maximum 500 mg/l	225.05	47.8	202.25	42.59	198.05	26.22	155.30	48.03
Turbidity NTU	25 NTU	7.18	27.5	7.68	17.12	10.83	35.88	12.79	47.29
DO mg/l	Minimum 5.0 mg/l	5.75	8.74	6.22	14.21	5.78	14.26	4.92	23.18
BOD mg/l	Maximum 3.0 mg/l	3.75	17.32	6.64	20.19	6.84	17.71	8.16	17.34
COD mg/l	Maximum 10 mg/l	37.40	27.49	18.55	12.18	22.53	16.99	18.70	15.14

Table-2
Rating scale (Vr) and unit weights (Wi) for the physico-chemical parameters

Parameter	Class-1	Class-2	Class-3	Class-4	Class-5	Unit Weights (Wi)
pH	6.5-8.5	8.6-8.7	8.8-8.9	9.0-9.1	> 9.1	0.1447
		6.3-6.4	6.1-6.2	5.9-6.0	< 6.0	
TDS	0-250	251-500	501-750	751-1000	> 1000	0.00246
Turbidity	0-10	11-20	21-30	31-40	> 40	0.0492
DO	> 5.0	4.6-5.0	4.1-4.5	3.0-4.0	< 3.0	0.246
BOD	0-3.0	3.1-4.0	4.1-5.0	5.1-6.0	> 6.0	0.410
COD	0-10	11-15	16-20	21-25	> 25	0.123
Rating Scale (Vr)	100	80	60	40	0	

Table-3
Range of rating scale (Vr) and significance for the physico-chemical parameters

Range of Rating Scale (Vr)	Significance
100	Clean
80-99.99	Slightly Polluted
60-79.99	Moderately Polluted
40-59.99	Excessively Polluted
0-39.99	Severely Polluted

Table-4
Water quality index (WQI) for the river water sampling stations

Station No.	Water Quality Index (WQI) = Wi X Vr	Water Quality
Station-1	77.036	Moderately Polluted
Station-2	51.616	Excessively Polluted
Station-3	48.172	Excessively Polluted
Station-4	45.712	Excessively Polluted

Conclusion

The present study is aimed to assess the environmental impacts on the Panchaganga river water quality and to check the level of pollution at the located stations. From the results of present investigation it is concluded that due to non-availability of the adequate land and full-fledged treatment facilities, large quantity of agricultural, municipal and industrial wastewater enters into river Panchaganga through various drains and nallahs which deteriorate the quality of river water. The 'coefficient of variation (CV %)'on water quality parameters revealed that the variation in most of the parameters is high and which do not fall within the desirable limit range. As per table-4, the water quality index study revealed that the water quality index (WQI) for station-1 is 77.036 which indicate that water is moderately polluted and needs to be treated before drinking. For station-2, 51.616, for Station-3, 48.172 and for Station-4, 45.712 are found to be excessively polluted and are totally unfit for drinking purpose.

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