Research Paper Environment

Assessment of Water Quality of Nullahs From Kolhapur City-Maharashtra (India)

Mr. Mangalekar S. B.	Department of Environmental Science, Shivaji University,Kolhapur, Maharashtra, India- 416004.
Mrs. Jadhav A. S.	Department of Environmental Science, Shivaji University,Kolhapur, Maharashtra, India- 416004.
Prof. Dr. Raut P. D.	Department of Environmental Science, Shivaji University,Kolhapur, Maharashtra, India- 416004.

ABSTRACT

The increasing rate of human population and rapid pace of industrialization has created many problems of pollution in the rivers and streams. The domestic wastes and industrial effluents are being indiscriminately discharged in the nearby rivers, reservoirs, lakes and tanks. In Kolhapur city similar situation is observed in Panchganga river where tweleve nullahs directly release effluents into the river. As the pollutants are discharged in the river through these nullahs, the intensity of river pollution is increasing highly. Present study was carried out by selecting four major nullahs in Kolhapur city. The water samples were collected at four different sampling sites during summer, monsoon and winter. The parameters selected for analysis were Temperature, pH, Turbidity, Dissolved Oxygen, Total Dissolved Solids, Hardness, Alkalinity, Chloride, BOD, COD and MPN. The study showed reduced DO and increased levels in all other parameters studied. This study refects status of four nullahs, it's adverse impact on water quality of Panchganga river .

KEYWORDS Kolhapur, water quality monitoring, nullahs, domestic waste.

1. Introduction

Water is a key driver of social and economic development. It also plays fundamental role in maintaining the integrity of the natural environment (UN-Water, 2008). With increased human actions deterioration of rivers is rising and this condition over the years has reached a ruin point all over the globe. During previous few decades man have been eternally interfering with water wealth and is on the verge of rendering them inappropriate for his own living. One of the most dynamic alterations responsible for change in river water quality is urbanisation (Grimm et al. 2000). Tremendous increase in population, industrialisation, agriculture run off is adding to the pollution of available water resources (Ingawale et al. 2013). The marked effects are change in physical, chemical and biological properties of streams. The rising contamination sources in urban systems results in chemical pressures often manifested as elevated pollution load, which in turn have damaging impacts on human health (Taylor, 2009).

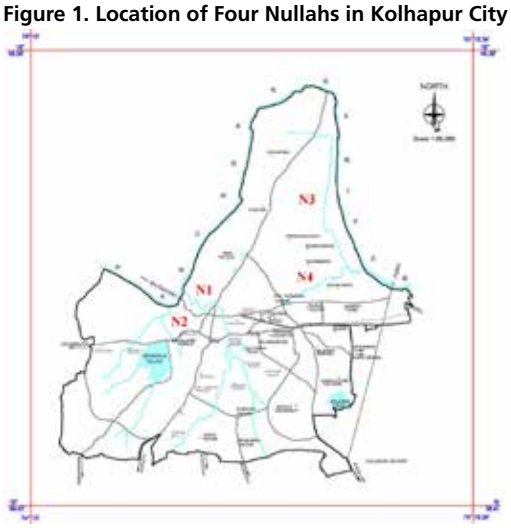
Kolhapur city is located on the bank of perennial river Panchaganga, which originates in the Western Ghats. It is referred as life line of Kolhapur city. It supplies water to the city for drinking, domestic, irrigation and industrial uses. Topographically, there are four major natural drainage basins carring run off to the river Panchganga which are Jayanti nullah, Dudhali nullah, Line bazaar nullah and Bapat Camp nullah. Currently, with amplified population these streams have been converted into nullahs collecting sewage from the city, flowing and opening into river Panchaganga at different sites. The nullahs basins are divided by spurs forming a natural drainage area carrying sewage to the river . Areas under drinage basins are Jayanti nullah basin – 2357 hector, Dudhali nullah basin-1650 hector, Line Bazar nullah basin 1004 hector and Bapat Camp nullah basin – 1671 hector (Kolhapur Municiple Corporation [KMC], 2009).

Panchganga river receives huge quantity of domestic sewage, industrial waste with higher physico-chemical characteristics. River is polluted due to the discharge of domestic sewage and industrial effluent through nullahs (Mulani et al. 2009). As these nullahs directly or indirectly confluence into the Panchganag river, which is one of the reason of pollution of the river. This gives negative effects on the riverine ecosystem. Also, at the same time the river water is becoming inappropriate for drinking purpose.

2. Material and methods

Sampling was done from four different nullhas namely Jayanti, Dudhali, Line bazar and Bapat camp during summer, monsoon and winter seasons of the year 2013. Wastewater samples were analysed for physico-chemical parameters like Temperature, pH and TDS which were measured with portable devices. The other parameters like Turbidity, D.O., BOD, COD, Alkalinity, Total Hardness and Chlorides were analyzed as per standard method (American Public Health Association [APHA], 1998).

Figure 1. Location of Four Nullahs in Kolhapur City



N1- Jayanti nullah, N2- Dudhali nullah, N3- Line Bazar nullah, N4- Bapat Camp nullah

Table No. 1 Water quality of four nullahs in the summer, monsoon and winter season

Sr. No.	Parameters Seasons	Jayanti nullah			Dudhali nullah			Line Bazar nullah			Bapat Camp nullah		
		Summer	Monsoon	Winter	Summer	Monsoon	Winter	Summer	Monsoon	Winter	Summer	Monsoon	Winter
1.	pH	8.00 ±0.08	7.80 ±0.16	8.10 ± 0.09	7.90 ± 0.08	7.70 ±0.08	8.00 ±0.07	7.80 ±0.04	7.60 ±0.05	8.00 ±0.07	7.80 ±0.07	7.70 ±0.05	7.90 ±0.04
2.	Temperature (°C)	26.00 ±0.57	25.02 ±0.61	26.58 ±0.24	25.38 ±0.43	24.58 ±0.45	25.56 ±0.38	24.98 ±0.36	24.20 ±0.45	25.06 ±0.21	24.98 ±0.36	24.34 ±0.38	25.02 ±0.16
3.	Turbidity (NTU)	31.26 ±4.67	31.02 ±3.52	33.36 ±5.23	31.34 ±2.50	30.06 ±3.27	32.52 ±4.46	30.78 ±2.19	29.44 ±3.23	31.60 ±2.30	30.66 ±2.21	29.28 ±3.15	31.40 ±3.41
4.	D.O (mg/lit)	0.96 ±0.11	1.16 ±0.17	0.50 ±0.16	1.12 ±0.08	1.32 ±0.08	0.66 ±0.13	1.18 ±0.07	1.52 ±0.06	0.72 ±0.16	1.22 ±0.11	1.56 ±0.05	0.78 ±0.19
5.	TDS (mg/lit)	2076.00 ±199.70	880.40 ±104.19	2748.60 ±145.30	1938.00 ±125.58	788.20 ±85.57	2580.40 ±118.32	1788.00 ±163.49	711.80 ±83.25	2496.60 ±114.55	1740.00 ±188.02	682.00 ±78.55	2371.20 ±106.93
6.	Alkalinity (mg/lit)	241.60 ±27.34	164.60 ±28.90	330.20 ±16.21	198.80 ±11.71	139.40 ±34.33	282.40 ±14.50	178.80 ±9.26	128.00 ±28.57	226.80 ±20.69	162.80 ±7.05	120.40 ±26.28	221.40 ±20.85
7.	Hardness (mg/lit)	765.80 ±37.61	617.60 ±75.35	844.20 ±29.51	702.80 ±35.91	579.40 ±81.22	750.40 ±32.42	660.60 ±31.77	554.40 ±79.54	711.60 ±90.32	630.40 ±65.36	538.60 ±76.41	647.60 ±70.68
8.	Chloride (mg/lit)	174.60 ±18.38	133.00 ±16.91	190.20 ±15.47	132.20 ±11.89	108.20 ±14.38	170.00 ±9.05	120.60 ±11.24	98.80 ±17.29	158.60 ±10.60	108.80 ±13.99	86.00 ±14.73	145.20 ±8.11
9.	BOD (mg/lit)	629.60 ±172.15	542.00 ±137.00	877.40 ±129.67	578.00 ±150.53	515.60 ±133.08	778.20 ±119.13	550.00 ±126.37	472.40 ±136.73	694.00 ±113.78	503.80 ±118.22	509.20 ±104.57	643.60 ±111.40
10.	COD (mg/lit)	926.00 ±201.39	681.20 ±228.77	1321.00 ±194.15	844.20 ±185.00	627.00 ±165.20	1257.60 ±161.23	798.60 ±155.52	565.60 ±154.21	1099.80 ±148.92	749.00 ±141.15	537.00 ±144.42	1052.40 ±133.54
11.	MPN per100 ml	>2400	>2400	>2400	>2400	>2400	>2400	>2400	>2400	>2400	>2400	>2400	>2400

Values are expressed as Mean ± S.D. in its own unit except MPN.

Table 2. Maximum, Minimum, and Average of physico-chemical parameters of water of four nullahs from Kolhapur city during summer, monsoon and winter season.

Sr. No.	Nullahs	Jayanti nullah			Dudhali nullah			Line Bazar nullah			Bapat Camp nullah		
	Parameters	MAX	MIN	Average	MAX	MIN	Average	MAX	MIN	Average	MAX	MIN	Average
1.	pH	8.10	7.80	7.97	8.00	7.70	7.87	8.00	7.60	7.80	7.90	7.70	7.80
2.	Temperature (°C)	26.58	25.02	25.87	25.56	24.58	25.17	25.06	24.20	24.75	25.02	24.34	24.78
3.	Turbidity (NTU)	33.36	31.02	31.88	32.52	30.06	31.31	31.60	29.44	30.61	31.40	29.28	30.45
4.	D.O (mg/lit)	1.16	0.50	0.87	1.32	0.66	1.03	1.52	0.72	1.14	1.56	0.78	1.19
5.	TDS (mg/lit)	2748.60	880.40	1901.67	2580.40	788.20	1768.87	2496.60	711.80	1665.47	2371.20	682.00	1597.73
6.	Alkalinity (mg/lit)	330.20	164.60	245.47	282.40	139.40	206.87	226.80	128.00	177.87	221.40	120.40	168.20
7.	Hardness (mg/lit)	844.20	617.60	742.53	750.40	579.40	677.53	711.60	554.40	642.20	647.60	538.60	605.53
8.	Chloride (mg/lit)	190.20	133.00	165.93	170.00	108.20	136.80	158.60	98.80	126.00	145.20	86.00	113.33
9.	BOD (mg/lit)	877.40	542.00	683.00	778.20	515.60	623.93	694.00	472.40	572.13	643.60	503.80	552.20
10.	COD (mg/lit)	1321.00	681.20	976.07	1257.60	627.00	909.60	1099.80	565.60	821.33	1052.40	537.00	779.47
11.	MPN per 100 ml	>2400	>2400	>2400	>2400	>2400	>2400	>2400	>2400	>2400	>2400	>2400	>2400

Values are expressed as Maximum, Minimum and Average in its own unit except MPN.

3. Results and discussion

Seasonal variations (Summer, Monsoon and Winter) in water quality of four nullahs are tabulated in Table 1. Range of variation i.e. maximum and minimum and their annual average of various physico-chemical characters of water of four nullahs are given in Table 2 . It is seen that among the four nullahs Jayanti nullah showed results beyond standards as compared to other three nullahs.

pH is the scale of intensity of acidity and alkalinity of water and measures concentration of hydrogen ions (Kaur & Malik, 2012). Fluctuations in the pH mostly depend upon ingredient input in the water bodies (Mathur et al. 2007). The variation in pH in four nullahs were in the range of 7.80 - 8.10 (Jayanti nullah), 7.70 – 8.0 (Dudhali nullah), 7.60 - 8.0 (Line Bazar nullah) and 7.70 - 7.90 (Bapat Camp nullah) which were slightly basic. In all the nullahs, the water temperature increased during summer and decreased during monsoon and winter sea-

son. Similar seasonal variations were also observed by Garg et al. (2010).

Turbidity in water is caused by suspended and colloidal matter, such as clay, silt, finely divided organic and inorganic matter, plankton and other microscopic organisms (Allen et al. 2008). Water was turbid in all seasons with black colour, while yellowish black colour in monsoon. The turbidity of water is mainly affected by factors such as, suspended particles and dissolved solids. The turbidity in four nullahs was ranged from 33.36 NTU – 31.02 NTU (Jayanti nullah), 32.52 NTU - 30.06 NTU (Dhudhali nullah), 31.60 NTU - 29.44 NTU (Line Bazar nullah) and 31.40 NTU – 29.28 NTU (Bapat camp nullah) with low value during monsoon season due to the rain water dilution.

At high temperature, which is usually observed in dry season, the solubility of oxygen decreases while at lower temperature (wet season) it increases (Abowei et al. 2010). In all the four nullahs the DO was found decresed in all the seasons. Low dissolved oxygen concentration (< 3 mg l lit.) in aquatic system indicates higher pollution causing serious impacts on aquatic ecosystem (Jadhav et al. 2012). Less Dissolved oxygen concentration suggest worst condition of the nullahs which are responsible for serious river pollution. Similarly, the findings of Egborge (1971), who reported that dissolved oxygen is generally higher in the wet season in the tropics. The dissolved oxygen found to be 1.16 - 0.5 mg/lit. (Jayanti nullah), 1.32 mg/lit - 0.66 mg/lit (Dudhali nullah), 1.52 mg/lit -0.72 mg/lit (Line Bazar nullah) and 1.56 mg/lit - 0.78 mg/lit (Bapat Camp nullah).

Total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles (Mahananda et al. 2010). In the present study, TDS was 2748.60 mg/lit - 880.40 mg/lit (Jayanti nullah), 2580.40 mg/lit - 788.20 mg/lit (Dudhali nullah), 2496.60 mg/lit - 711.80 mg/lit (Line Bazar nullah) and 2371.20 mg/lit - 682.0 mg/lit (Bapat Camp nullah). The excess amount of TDS in water disturb ecological balance and cause suffocation of aquatic fauna (Pushpam, 2013).

Alkalinity is due to presence of salts of weak acids, carbonates, bicarbonates, hydroxides, phosphates and organic sulphates (Kaur & Malik, 2012). Alkalinity represents the buffering capacities of water, high alkanity values are indicative of the entropic nature of water bodies and unsafe for ecosystems as well as for potable use (Patil et al. 2011). The total alkalinity for four nullahs was ranged from 330.20 mg/lit to 164.60 mg/lit (Jayanti nullah), 282.40 – 139.40 mg/lit (Dudhali nullah), 226.80- 128 .0 mg/lit (Line Bazar nullah) and 221.40-120.40 mg/lit (Bapat Camp nullah) which makes the reservoir as nutrient rich and highly productive water body as suggested by Munawar (1970) but the lowest DO in water will not support it.

The principal natural sources of hardness in water are dissolved polyvalent metallic ions from sedimentary rocks, seepage and runoff from soils. Calcium and Magnesium, the two principal ions, are present in many sedimentary rocks. Inadequate intake of either nutrient can result in adverse health consequences (World Health Organization [WHO], 2011). High hardness of aquatic ecosystem points out towards eutrophication (Sawyer, 1960) classified water on the basis of hardness into three categories i.e., soft (0 mg/lit - 75 mg/lit), moderately hard (75 mg/lit - 150 mg/lit) and hard (151 mg/lit - 300 mg/lit) (Garg et al., 2009). Accordingly, four nullahs fall in the category of hard water body with hardness ranging from 617.60 mg/lit - 844 mg/lit (Jayanti nullah), 579.40 mg/lit - 750.40 mg/lit (Dudhali nullah), 554.40 mg/lit -711.60 mg/lit (Line Bazar nullah) and 538.60 mg/lit – 647.60 mg/lit (Bapat Camp nullah).

The salts of sodium, potassium and calcium contribute chlorides in water. Large contents of chloride in freshwater is an indicator of organic pollution (Venkatasubramani & Meenambal, 2007). In the present study, chloride concentration varied from 190.20 mg/lit - 133.0 mg/lit (Jayanti nullah), 170.0 mg/lit - 108.20 mg/lit (Dudhali nullah), 158.60 mg/lit - 98.80 mg/lit (Line Bazar nullah) and 145.20 mg/lit - 86.00 mg/lit (Bapat Camp nullah). Chlorides are found higher in winter season and lower in monsoon season but these are above limits suggesting very high organic material in water.

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. 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 levels in the river. The oxygen may diminish to levels that are lethal for most fish and many aquatic insects (www.gaepd.org).

BOD in four nullahs was recorded in the range of 877.40 mg/lit - 542 mg/lit (Jayanti nullah), 778.20 mg/lit - 515.60 mg/lit (Dudhali nullah), 694.00 mg/lit - 672.40 mg/lit (Line Bazar nullah) and 643.60 mg/lit - 503.80 mg/lit (Bapat Camp nullah) with low values in monsoon and high values in summer season.

The COD in conjugation with BOD is helpful in knowing the toxic conditions and presence of biologically resistant organic substances as also reported by (Rajkumar et al. 2003). Chemical oxygen demand (COD) is a measure of the oxygen equivalent of the organic matter content of water that is susceptible to oxidation by a strong chemical oxidant. Thus, COD is a reliable parameter for judging the extent of pollution in water (Amirkolaie, 2008). In the present study, COD ranged from (1321 mg/lit - 681.20 mg/lit (Jayanti Nala nullah), 1257.60 mg/lit - 627 mg/lit (Dudhali nullah), 1099.80 mg/lit -565.60 mg/lit (Line Bazar nullah) and 1052.40 mg/lit – 537 mg/lit (Bapat Camp nullah) least values during monsoon season. The highest COD of water shows extent of pollution of water. MPN of all four nullahs studied were found to be more than 2400 microbes per 100 ml.

Monitoring for the presence of pathogenic bacteria is an essential part of any water quality assessment where direct or indirect water use leads to human contact (http://nerrs.noaa.gov). Most Probable Number is found to be more than 2400 per 100 ml for all the nallahs in all the seasons which showed bactrial contamination of the water of the nullahs. It becomes very dangerous to release these waters to rivers which also get contaminated.

Pollution of waterways with toxic substances and excessive nutrients, as well as destructive land use practices in areas surrounding freshwater ecosystems, lead to deterioration of water quality. Due to non-availability of the adequate land for full fledged treatment facilities, large quantity of agricultural, municipal and industrial wastewater enters into river Panchganga through these nullahs directly or indirectly which detoriates the quality of Panchganga river water. There is a gradual increase in the BOD from upstrem to downstrem of these nullahs which ultimately open in Panchganga river. The study showed that the treatment of nullah water is neccessary before it is to be released into the river . There are number of factors such as restriction of encrochment in nullahs and appropriate water treatment method is need to be balanced against each other in order to develop an appropriate solution. There is also need of public education and awareness to decentralise treatment of sewage at household and apartment level which can be useful to reduce pollution of river.

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