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Materials Today: Proceedings XX (2016) XXX–XXX

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PMME 2016

Assessment of wastewater quality of Kham river for Irrigation*

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Abstract

Aurangabad being one of the fastest developing cities in the entire continent, there is a rapid increase in population and industries. This sudden growth also comes with sudden increase of wastewater production from both residential and industrial sectors. Up until 2015-2016 there have been hardly any operational sewage treatment plants in Aurangabad this led to dumping of raw sewage in rainwater drains, kham river being the major river basin of Aurangabad carries most of the sewage of the city. This study was conducted to Assess the Quality of water in the drain, the Assessment was done from October 2015 to March 2016 (6 months). Major water quality parameter like pH, BOD, TSS, TDS, EC, Ca, Mg, Cl, B and SO_4, water quality Index was also computed. The result showed that the stream is heavily polluted throughout the process and unfit for human contact. Regular treatment of waste water was required before discharging into the stream to make the stream water less hazardous for Soil or human contact.

Selection and Peer-review under responsibility of International Conference on Processing of Materials, Minerals and Energy (July 29th – 30th) 2016, Ongole, Andhra Pradesh, India.

Keywords: Water Quality, Pollution, River Kham, WQI, Physico-chemical parameters, Irrigation.

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1. Introduction

Aurangabad has a population of 10 lakh and is spread over an area of 137.40 Sq. Kms. It is located latitude 19˚53'59" north and longitude 75˚20' east. The city lies on the bank of river Kham. Kham River flows through Aurangabad city, Maharashtra, India[10][11]. This river flows with freshwater in monsoon only. Rest of the year it receives wastewater from the city. The Kham River receives sewage from the nallas flowing through densely populated areas. Near the Holy Cross School, the river crosses the city boundary and receives a nalla coming from the Station area MIDC. Kham River passes through Himayat baugh, Padampura, Chawni, Banewadi, Pandharpur, Waluj and usually the Wastewater stream is utilized at Pimparkheda village.

Kham River being the major drain basin receives rainwater in monsoon and wastewater throughout the year.

2. Material and Methods:

2.1. Location:

In the current study three sampling stations were selected they are,

a) Banewadi: Banewadi lies on the outskirts of Aurangabad city just beyond Railway station. It consists of small agricultural fields, Buffalo stables and residential areas. Here wastewater carried by the Kham river stream is being utilised for irrigation. It was selected to provide information about the domestic sewage loading of the city.
b) Waluj: Waluj is major Industrial sector of Aurangabad district. To verify whether there are untreated Industrial Effluents discharge in the stream the site was selected which lies on the downstream of industrial sector. This station was selected with view to verify the status of Industrial effluent in the kham river. The station was selected where water was being drawn for Irrigation.
c) Pimparkheda: Pimperkheda is a village that lies just beyond Waluj and is also the last village that the Kham river stream visits before it dries up. Here the water is less polluted as compared to other stations as the waste water discharge in the stream is stopped for a long length giving the stream chance to self pirify and stabilise. This village contains Agricultural fields and a large no. of villagers engaged in Animal husbandry.This is the station where the kham river dries. Here the stream is being obstructed to recharge ground water level so as to utilise filter water by ground media for Irrigation and animal husbandry. Monthly water samples were collected from October 2015 to March 2016 (6 months), covering three seasons.

Fig.1. Pictures of Kham river at Banewadi (left) and Waluj(right).

2.2. Purpose:

As mentioned above the river water being use for Irrigation, Animal Husbandary and often comes in human contact it is necessary to monitor the quality of the stream to so as to provide proper warning to the population when necessary. It is also required so as to monitor and detect the presence of heavy industrial effluent. It is also required to design minimum or adequate treatment to the water to be used for Irrigation. For this purpose major water quality parameter like pH, BOD, TSS, TDS, EC, Ca, Mg, Cl, B, SO_4, Sodium adsorbtion Ratio and Residual sodium carbonate.

The water parameters are compared to both standard drinking parameters and Irrigational parameters. The drinking parameters are as shown in the table below and the water quality in index of the water is calculated using this standard values.

Table 1: Standard values for water quality Parameters for drinking and irrigational purposes [5][6][9][11]

Sr.No	Parameters	Drinking Standards (Si)	Recommended Agency	Irrigation Sandards (Ci or Vi)	Recommended Agency
1	pH	6.5-8.5	ICMR/BIS	6.5-8.5	ICAR
2	DO(mg/l)	5	ICMR/BIS	-----	------
3	BOD (mg/l)	5	ICMR	100	CPCB
4	COD (mg/l)	10	WHO	-----	------
5	TSS (mg/l)	500	WHO	200	CPCB
6	TDS (mg/l)	500	ICMR/BIS	1500	ICAR
7	EC (µmhos/cm)	300	ICMR	2250	ICAR
8	Ca (mg/l)	75	BIS	0-400	FAO
9	Mg (mg/l)	30	BIS	0-60	FAO
10	Cl (mg/l)	250	BIS	600	ICAR
11	Boron (mg/l)	0.3	BIS	2	ICAR
12	Sulphate (mg/l)	200	BIS	1000	ICAR

2.3. Water Quality Index:

Water quality index (WQI) is valuable and unique rating to depict the overall water quality status in a single term that is helpful for the selection of appropriate treatment technique to meet the concerned issues[11][12].

Weighted Arithematic Water Quality Index method: The WQI has been calculated by using the standards of FAO, WHO, BIS and ICMR. The weighted arithematic index method has been used for calculation of WQI of the waterbody.

Weighted arithmetic water quality index method classified the water quality according to the degree of purity by using the most commonly measured water quality variables. The method has been widely used by the various scientists and the calculation of WQI was made by using the following equation:

$$WQI = \sum QiWi / \sum Wi \quad (1)$$

The quality rating scale (Qi) for each parameter is calculated by using this expression:

$$Qi = 100 [(Vi-Vo/Si-Vo)] \quad (2)$$

Where,

'Vi' is estimated concentration of ith parameter in the analysed water.

'Vo' is the ideal value of this parameter in pure water = 0 (except pH =7.0 and DO = 14.6 mg/l)

'Si' is recommended standard value of ith parameter

The unit weight (Wi) for each water quality parameter is calculated by using the following formula:

$$Wi = K/ Si \quad (3)$$

Where, K = proportionality constant and can also be calculated by using the following equation:

$$K= 1/\sum(1/Si) \quad (4)$$

The rating of water quality according to this WQI is given in Table

Table 2: Water Quality Rating as per Weight Arithmetic Water Quality Index Method[11][12]

WQI value	Rating of Water Quality	Grading
0-25	Excellent Water Quality	A
26-50	Good Water Quality	B
51-75	Poor Water Quality	C
76-100	Very Poor Water Quality	D
Above 100	Unsuitable for drinking	E

2.4. Irrigational Parameters:

Indian Standards for Water Quaity for Irrigational Use:

This Indian Standard was adopted by the Indian Standards Institution on 27 March 1986, after the draft finalized by the Irrigation Equipment and Systems Sectional Committee had been approved by the Agricultural and Food Products Division Council.

The quality of Irrigation water is to be evaluated in terms of degree of harmful effects on soil properties with respect to the soluble salts it contains in different concentrations and crop yield. To evaluate the quality of irrigation water, this standard has been prepared as a guideline for advisory purposes.[4]

Water quality Criteria for Irrigation: The following chemical properties shall be considered for developing water quality criteria for irrigation:

a) Total salt concentration (Electrical Conductivity) ,
b) Sodium adsorption ratio(SAR),
c) Residual sodium carbonate or bicarbonate ion concentration(RSC)&
d) Boron content.

Table 3: Water Quality rating in relation to its hazardous effect on soil, based on the Total Salt Concentration, Sodium adsorption ratio, Residual sodium carbonate and Boron's toxicity.[4]

Sr. No.	Class	Range of EC (Micromhos/cm)	SAR Range √(millimole/litre)	RSC Range (me/l)	Boron (ppm)
1	Low	Below 1500	Below 10	Below 1.5	Below 1.0
2	Medium	1500-3000	10-18	1.5-3.0	1.0-2.0
3	High	3000-6000	18-26	3.0-6.0	2.0-4.0
4	Very high	Above 6000	Above 26	Above 6.0	Above 4.0

Though all the chemical characteristics have been classified separately, they are present in all irrigation water, and the chemical characteristics of a particular class of water are independent of the chemical characteristics of different classes of water. [4]

3. Result & Discussion:

In the tables below are the value of parameters analysed in laboratory, with station represented by B-Banewadi,W-Waluj, P-Pimparkheda. Along the analysis period of six months. It should be noted that during summer the river at station Pimperkheda dried up hence no values for "P" during summer.

Table 4: Values of parameters tested from October to March 2015-16, B- Banewadi,W-Waluj, P-Pimparkheda

Month	October			November			December			January		Febuary		March	
Parameter	B	W	P	B	W	P	B	W	P	B	W	B	W	B	W
pH	7.2	7.3	7.5	7.1	7.7	7.7	7.3	7.76	7.84	7.6	7.82	7.7	7.7	8.2	8.01
BOD (mg/l)	51	24	20	52	22	18	50	48	40	42	45	53	62	70	80
TSS (mg/l)	289	146	95	280	140	90	132	40	55	108	128	122	443	132	980
TDS (mg/l)	790	896	1037	787	906	1034	1030	1008	1020	1062	1049	1078	1092	1190	1148
EC (μmhos/cm)	1201	1366	1568	1213	1394	1591	1329	1425	1518	1360	1440	1396	1522	1587	1640
Ca (mg/l)	104	174	78	102	160	82	88.2	80.2	84.2	132	116	136	102	116	144.3
Mg (mg/l)	26.9	38	36	26.3	44	39	43.7	46.2	48.6	19.4	22	32.2	26	48.6	29.2
Cl (mg/l)	210	222	288	200	256	284	290	260	280	195	265	198	268	250	260
B (mg/l)	0.41	0.42	0.41	0.4	0.43	0.4	0.43	0.42	0.43	0.42	0.39	0.44	0.41	0.42	0.44
SO4 (mg/l)	169	162	166	166	158	160	158	153	155	158	156	140	160	159	162
COD (mg/l)	163	80	55	188	84	62	310	180	160	270	210	266	240	290	300

pH: As shown in the tables the pH value of the stream ranges from 7.1 to 8.2. Thus it is alkaline in nature. Since the permissible range for pH is 6.5-8.5, the pH value of the river is in permissible range for both drinking and irrigational standard.

Biochemical Oxygen Demand (B.O.D.): The BOD is an indication of the organic load of municipal wastewater. In Banewadi during rainy and winter its value ranges from 42 mg/l to 53 mg/l and increased to 70mg/l during summer. At Waluj it value remained low in rainy i.e. 24-22 mg/l and during winter it increased to 45-48 mg/l and in summer it again raised to 62-80 mg/l. This steady increase is due to decrease in dilution of stream. At Pimparkheda the vles ranged from 18-40 mg/l, the stream dried at this station during summer. Since the permissible limit for drinking for BOD is 5 mg/l the stream is unfit for potable use. While the permissible limit for Irrigation is 100 mg/l hence the stream water lies within range for irrigational purpose.

Total Suspended Solids (TSS): TSS is the amount of suspended solids in mg present in per litre of water sample. As shown in the graph the TSS at banewadi ranges from 108-289 mg/l. The value TSS kept on decreasing from rainy to summer. Waluj showed the range of TSS i.e. from 40 to 980 mg/l. While pimparkheda showed values of 95,90 & 55 mg/l respectively.

Total dissolved solids (TDS): Total dissolve solids expresses the amount of soluble solids present in mg in per litre of water sample. At both Banewadi and Waluj TDS kept on steadily increasing from rainy to summer season, at banewadi from 790 to 1190 mg/l and at Waluj from 896 to 1148 mg/l, while the rainy and winter values at pimperkheda were 1037,1034 and 1020 mg/l respectively.

Water quality Index (WQI): The WQI vales calculated showed that no station throughout the research shows WQI less than 100 show in the stream is not fit for drinking and should not be considered for domestic purposes.

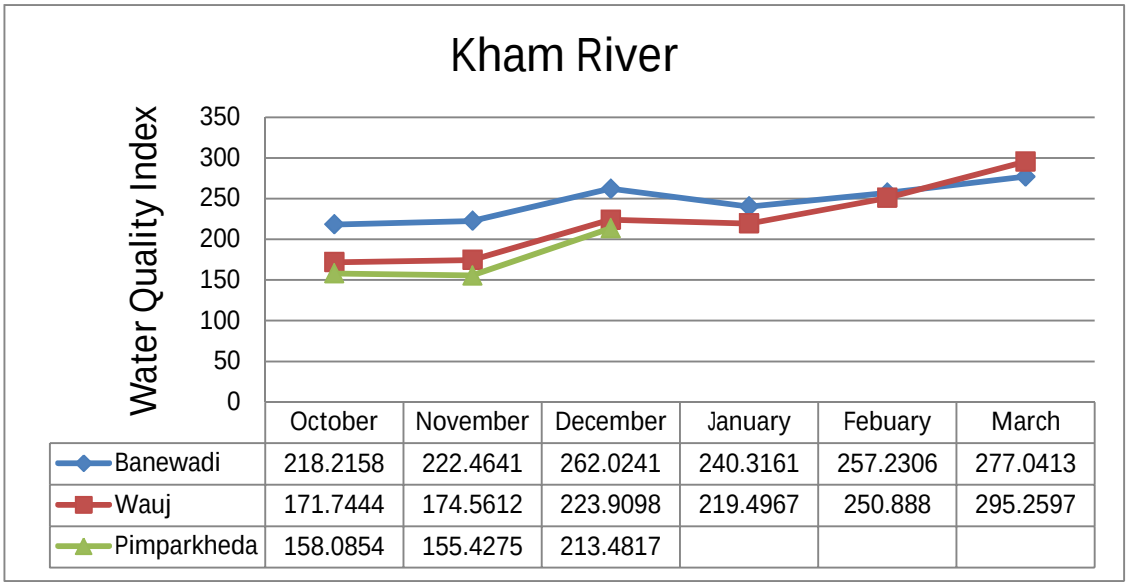

Fig.2. Graph showing the nature of WQI for different stations from October to March.

Table 5: Calculated values of WQI by weighted arithmetic index method and the irrigational parameters for Kham river at Banewadi, Waluj and Pimparkheda.

Station	Month	WQI	Irrigational Parameter			
			EC	SAR	RSC	Boron
Banewadi	October	218.2159	1201	3.45	1.44	0.41
	November	222.4642	1213	3.36	0.94	0.4
	December	262.0242	1329	3.52	0.84	0.43
	January	240.3162	1360	2.95	**1.9**	0.42
	Febuary	257.2307	1396	3.12	**1.95**	0.44
	March	277.0414	**1587**	3.23	**1.85**	0.42
Waluj	October	171.7445	1366	2.94	**1.75**	0.42
	November	174.5613	1394	3.46	**1.94**	0.43
	December	223.9099	1425	3.75	**1.74**	0.42
	January	219.4968	1440	2.97	**1.8**	0.39
	Febuary	250.8881	**1522**	3.11	**2.15**	0.41
	March	295.2598	**1640**	3.05	**2.2**	0.44
Pimparkheda	October	158.0855	**1568**	2.96	1.44	0.41
	November	155.4276	**1591**	3.24	**1.76**	0.4
	December	213.4818	**1518**	3.73	**1.62**	0.43

The table above gives us quality of water calculated values of WQI by weighted arithmetic index method with keeping drinking water standards as threshold, the values range from155 to 295 while the maximum acceptable vale of WQI is 100. The table also provides us with irrigationable parameters i.e. EC(µmhos/cm), SAR[√(millimole/litre)], RSC(me/l), Boron(mg/l) that are used in BIS for irrigation standards and their values. The values in bold represent the parameters that in medium hazardous effect range for soil while the rest are in low hazardous to soil range.

Thus from the result obtained it can be concluded that the water quality of the stream is too degraded similar to that of sewage. But the it lies well in the permissible limits of irrigation limits.

4. Conclusion:

The Kham river water is heavily polluted at all stations and cannot be considered for domestic purposes, where as for Irrigational purpose it ranges from low to medium hazardous effect on soil by BIS for irrigation and can be utilised for irrigation. The irrigational parameter recommended by the other agencies like FOA, CPCB and ICAR showed that the stream water was considerable for irrigation.

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