Water Quality Assessment of Kham River, Aurangabad, Maharashtra

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***Abstract*—Kham River is major river in Aurangabad city. In This paper water quality assessment of Kham River, Aurangabad is presented along with the Water Quality Index. The ten months study from May 2013 to February 2014 is done on six locations of Kham River in order to achieve Water Quality Assessment for future use of Kham River. Major water quality parameters like pH, Turbidity, Dissolved Oxygen, Biochemical Oxygen Demand, Total Suspended Solids, Total Dissolved Solids, Total Alkalinity, Total Hardness and Electrical Conductivity are analyzed in order to assess water quality and to obtain Water Quality Index. Water Quality Index for each selected sampling station is find out by using Modified Mishra and Tiwari method (1985) and Weighted Arithmetic Mean Method. From this Ten months water quality study, it is observed that Kham River is heavily polluted due to presence of untreated sewage and some amount of industrial wastewater. It is concluded that Kham River water is not fit for domestic and drinking purpose.**

Keywords - Water Quality Assessment, Water Quality Index, Kham River.

I. INTRODUCTION

Aurangabad city is spread over on area of about 137.40 Sq.Kms. with over 10 lakhs population (2010). Aurangabad city is the major district of Marathwada region of Maharashtra and it is situated on the banks of Kham River in latitude 19° 53 ' 59" north and longitude 75° 20' east. The city stands in the Dudhana valley between the Lakenvara range on the north and the Satara hills on the south.

Water Quality Index (WQI) provides a single number that express 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 useful for public [1]. 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 water body with number [3].

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. However, WQI depicts the composite influence of different water quality parameters and communicates water quality information to the public and legislative decision makers. In spite of absence of a globally accepted composite index of water quality, some countries have used and are using aggregated water quality data in the development of water quality indices [4]. Attempts have been made to review the WQI criteria for the appropriateness of drinking water sources.

In this project Following two methods were used to find out WQI:

1) Modified Tiwari and Mishra method of calculating WQI (1985) [5] to Assess water Quality.

2) Weighted Arithmetic Water Quality Index Method to Assess Suitability for Drinking Purpose [3].

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II. MATERIALS AND METHODS

Preliminary survey is carried out, Accessibility for Sampling and Collection is determined, Points at which major Contamination of Kham River find out and then only following stations were selected:

Station A - Barapulla Gate
Station B - Makai Gate
Station C - Near Income Tax Office
Station D - Banewadi
Station E - Waladgaon
Station F – Patoda

The points at which major Contamination of Kham River takes place are taken as sampling stations The water samples were collected for water quality assessment from Kham River and analyzed at regular intervals of one month for a period of ten months from May 2013 to February 2014. The samples were well mixed and stored in 1.5 liter plastic cans for the analysis work. Sample collection was usually completed during morning hours between 6.00 am to 9.00 am every for further analysis. The Parameters like Temperature, pH and EC are tested on the spot, D.O fixation is done on the spot and other parameters were tested in ISO standard Environmental Engineering Laboratory. Standard methods as prescribed by IS 10500 were followed for examination of various physical and chemical parameters of water.

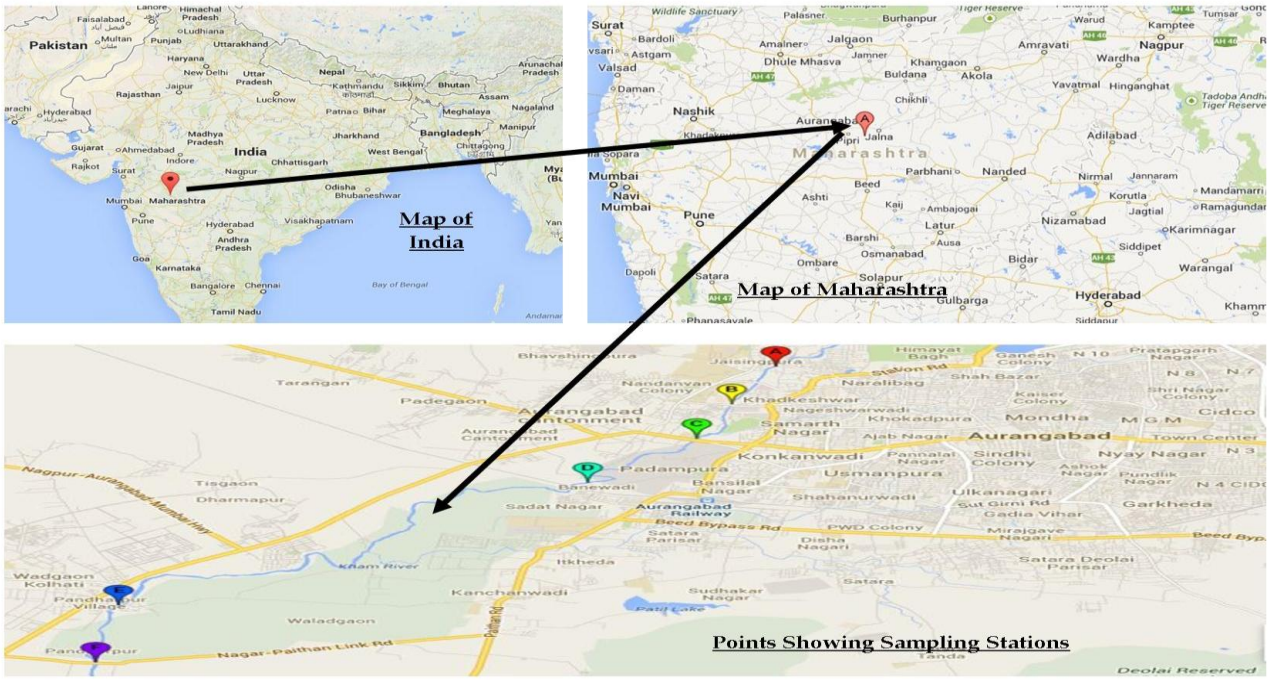

Figure No. 1. General View Of Sampling Stations.

III. RESULTS AND DISCUSSION

Water Quality assessment of Kham River is done for the ten months i.e. from May 2013 to February 2014. In table number 1, mean values of all parameters for each station is represented. From these values WQI is carried out.

Table No.1 Mean Values of all Parasmeters for each Station.

Sr. No	Parameter	Station-A	Station-B	Station-C	Station-D	Station-E	Station-F
		Mean	Mean	Mean	Mean	Mean	Mean
1	Temperature (° C)	23.84	23.84	24	23.88	23.89	23.89
2	pH	7.438	7.579	7.658	7.751	7.962	8.016
3	Turbidity (NTU)	27.66	34.61	38.56	54.38	57.99	62.99
4	Dissolved Oxygen (mg/l)	2.077	2.03506	1.98347	1.962693	1.94012	1.92682
5	Biochemical Oxygen Demand (mg/l)	123.3268	125.9345	130.3982	135.2437	139.7369	143.36
6	Chemical Oxygen Demand (mg/l)	204.9087	209.043	216.278	221.154	277.258	288.205
7	Total Solids (mg/l)	812.8	833.6	852	866	876.4	885.2
8	Total Suspended Solids (mg/l)	82.8	89.6	94	95.6	96.4	98
9	Total Dissolved Solids (mg/l)	730	744	758	770.4	780	787.2
10	Total Alkanity (mg/l)	331.52	336.88	342.08	345.16	350.28	358.81
11	Total Hardness (mg/l)	341.0255	346.8052	351.8818	370.9093	419.22	436.65
12	Electrical Conductivity (µmhos/cm)	1025.1	1041.5	1051.6	1091	1106.6	1108.4

A. Water Quality Index Of Kham River By using Modified Mishra and Tiwari Method:

Factors which have higher permissible limits are less harmful because they can harm quality of river water when they are present in very high quantity. So weightage of factor has an

inverse relationship with its permissible limits. Weightage (Wi) for each parameter is given in Table2 [5].
Therefore Wi = k/Si
Where, k = constant of proportionality
Wi = unit weight of factor
Si = maximum permissible limits as recommended by Indian Council of Medical Research / Public Health Environmental Engineering Organization Values of k were calculated as:

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

Rating scale (Table 3) was prepared for range of values of each parameter. The rating varies from 0 to 100 and is divided into five intervals. The rating Vr = 0 implies that the parameter present in water exceeds the standard maximum permissible limits and water is severely polluted. On the other hand Vr= 100 implies that the parameter present in water has the most desirable value. The other ratings fall between these two extremes and are Vr = 40, Vr = 60 and Vr = 80 standing for excessively polluted, moderately polluted and slightly less polluted respectively. This scale is modified version of rating scale given by Tiwari and Mishra (1985) [5].

Essentially, a WQI is a compilation of a number of parameters that can be used to determine the quality of a river. WQI is calculated for each station and is given in Table 4. The parameters involved in the WQI are pH, Dissolved Oxygen, Electrical Conductivity, Total Dissolved solids, Total alkalinity, Total Hardness. The numerical value is then multiplied by a weighting factor that is relative to the significance of the test to water quality. The sum of the resulting values is added together to arrive at an overall water quality index.

$$WQI = \sum Wi \times Vr$$

i.e. Water Quality Index is equal to the product of rating (Vr) and unit weight (Wi) of all the factors. Wi x Vr = Wi(pH) x Vr(pH) + Wi(DO) x Vr(DO) + Wi(EC) + Vr (EC) + Wi(TDS) x Vr(TDS) + Wi(Total Alkalinity) x Vr(Total Alkalinity) + Wi(Hardness) x Vr(Hardness).

Table No.2 WQI Quality Factors : the ICMR/CPHEEO standards assigned unit Weights

Water Quality Factors	ICMR/CPHEEO STANDARDS (Xi)	Unit Weight (Wi)
pH	7.0 - 8.5**	0.355
Dissolved Oxygen (mg/l)	>5*	0.603
Electrical Conductivity (µmhos/cm)	<300*	0.01
Total Dissolved Solids (mg/l)	<1500**	0.002
Total Alkalinity (mg/l)	<120*	0.025
Total Hardness (mg/l)	<600**	0.005

*ICMR Standards (1975)

**CPHEEO Standards (1991)

Table No.3 Rating Scale for Quality of Water

Sr. No	Parameters	RANGES					Unit Weights (Wi)
		Class-1	Class-2	Class-3	Class-4	Class-5	
1	pH	7.0-8.5	8.6-8.7	8.8-8.9	9.0-9.1	> 9.2	0.355
			6.8-6.9	6.7-6.8	6.5-6.7	< 6.5	
2	Dissolved Oxygen	> 7.0	5.1-7.0	4.1-5.0	3.1-4.0	< 3.0	0.603
3	Electrical Conductivity	0-75	75.1-150	150.1-225	225.1-300	> 300	0.01
4	Total Dissolved Solids	0-375	375.1-750	750.1-1125	1125.1-1500	> 1500	0.002
5	Total Alkalinity	21-50	50.1-70	70.1-90	90.1-120	> 120	0.025
6	Total Hardness	0-150	150.1-300	300.1-450	450.1-600	> 600	0.005
7	Rating Scale (Vr)	100	80	60	40	0	
8	Extent Of Pollution	Clean	Slight Pollution	Moderate Pollution	Excess Pollution	Severe Pollution	

Table No.4 Rating Scale for Quality of Water

Range of Rating Scale (Vr)	Quality Of Water
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very Bad

Table No.5 Water Quality index (WQI) for the Kham River water Sampling stations.

Sr.No	Station No.	Water Quality Index $WQI = \sum Wi \times Vr$	Water Quality
1	Station- A	35.76	Bad
2	Station- B	35.76	Bad
3	Station- C	35.72	Bad
4	Station- D	35.72	Bad
5	Station- E	35.72	Bad
6	Station- F	35.72	Bad

B. Water Quality Index of Kham River By using Weighted Arithmetic Mean Method:

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:

$$WQI=\sum Qi/Wi$$

The unit weight (Wi) for each water quality parameter is calculated by using the following formula[3]:

$$Wi= K/Si$$

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

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

Where, Vi is estimated concentration of ith parameter in the analyzed water

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

Si is the recommended standard value of ith parameter.

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

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

Table No.6 Drinking Water Standards, Recommending Agencies and Unit Weights

Sr.No	Parameters	Standards	Recommended Agency	Unit Weight (Wi)
1	pH	6.5-8.5	ICMR/BIS	0.1597
2	Turbidity (NTU)	10	BIS	0.136
3	Dissolved Oxygen (mg/l)	5	ICMR/BIS	0.2715
4	Biochemical Oxygen Demand (mg/l)	5	ICMR	0.2715
5	Chemical Oxygen Demand (mg/l)	10	WHO	0.1357
6	Total Suspended Solids (mg/l)	500	WHO	0.00271
7	Total Dissolved Solids (mg/l)	500	ICMR/BIS	0.00271
8	Total Alkalinity (mg/l)	120	ICMR	0.01131
9	Total Hardness (mg/l)	300	ICMR/BIS	0.004525
10	Electrical Conductivity (μmhos/cm)	300	ICMR	0.004525

Table No.7 WQI and Status of Water Quality

WQI Level	**Water Quality Status**
0-25	Excellent Water Quality
26-50	Good Water Quality
51-75	Poor Water Quality
76-100	Very Poor Water Quality
Above 100	Unsuitable For Drinking

Table No.8 WQI for Station A by Weighted Arithmetic Mean Method

Sr.No	Parameters	Standards (Si)	Observed Values (Vi)	Unit Weight (Wi)	Quality Rating (Qi)	WiQi
1	pH	6.5-8.5	7.438	0.1597	29.2	4.66
2	Turbidity (NTU)	10	27.66	0.136	276.6	37.617
3	Dissolved Oxygen (mg/l)	5	2.077	0.2715	130	35.295
4	Biochemical Oxygen Demand (mg/l)	5	123.3268	0.2715	2466.536	669.66
5	Chemical Oxygen Demand (mg/l)	10	204.9087	0.1357	2049.087	278.061
6	Total Suspended Solids (mg/l)	500	82.8	0.00271	16.56	0.04487
7	Total Dissolved Solids (mg/l)	500	730	0.00271	146	0.39566
8	Total Alkalinity (mg/l)	120	331.52	0.01131	276.27	3.1246
9	Total Hardness (mg/l)	300	341.0255	0.004525	113.675	0.51437
10	Electrical Conductivity (µmhos/cm)	300	1025.1	0.004525	341.66	1.546
			Total Sum	1.00018	5845.588	1030.92
WQI= ∑ QiWi/∑Wi= 1030.733						

Table No.9 WQI for Station B by Weighted Arithmetic Mean Method

Sr.No	Parameters	Standards (Si)	Observed Values (Vi)	Unit Weight (Wi)	Quality Rating (Qi)	WiQi
1	pH	6.5-8.5	7.579	0.1597	38.6	6.1644
2	Turbidity (NTU)	10	34.61	0.136	346.1	47.0696
3	Dissolved Oxygen (mg/l)	5	2.03506	0.2715	130	35.295
4	Biochemical Oxygen Demand (mg/l)	5	125.9345	0.2715	2518.69	683.824
5	Chemical Oxygen Demand (mg/l)	10	209.043	0.1357	2094.3	284.196
6	Total Suspended Solids (mg/l)	500	89.6	0.00271	17.92	0.04856
7	Total Dissolved Solids (mg/l)	500	744	0.00271	148.8	0.40325
8	Total Alkalinity (mg/l)	120	336.88	0.01131	280.733	3.175
9	Total Hardness (mg/l)	300	346.8052	0.004525	115.6	0.52309
10	Electrical Conductivity (µmhos/cm)	300	1041.5	0.004525	347.166	1.5709
			Total Sum	1.00018	6037.909	1062.27
WQI= ∑ QiWi/∑Wi= 1062.0788						

Table No.10 WQI for Station C by Weighted Arithmetic Mean Method

Sr.No	Parameters	Standards (Si)	Observed Values (Vi)	Unit Weight (Wi)	Quality Rating (Qi)	WiQi
1	pH	6.5-8.5	7.658	0.1597	43.866	7.005
2	Turbidity (NTU)	10	38.56	0.136	385.6	52.44
3	Dissolved Oxygen (mg/l)	5	1.98347	0.2715	131.422	35.68
4	Biochemical Oxygen Demand (mg/l)	5	130.3982	0.2715	2607.964	708.0622
5	Chemical Oxygen Demand (mg/l)	10	216.278	0.1357	2162.78	293.489
6	Total Suspended Solids (mg/l)	500	94	0.00271	18.8	0.050948
7	Total Dissolved Solids (mg/l)	500	758	0.00271	151.6	0.410836
8	Total Alkalinity (mg/l)	120	342.08	0.01131	285.06	3.224
9	Total Hardness (mg/l)	300	351.8818	0.004525	117.29	0.5307
10	Electrical Conductivity (µmhos/cm)	300	1051.6	0.004525	350.533	1.58616
			Total Sum	1.00018	6254.915	1102.4788
WQI= ∑ QiWi/∑Wi= 1102.264						

Table No.11 WQI for Station D by Weighted Arithmetic Mean Method

Sr.No	Parameters	Standards (Si)	Observed Values (Vi)	Unit Weight (Wi)	Quality Rating (Qi)	WiQi
1	pH	6.5-8.5	7.751	0.1597	50.066	7.995
2	Turbidity (NTU)	10	54.38	0.136	543.8	73.956
3	Dissolved Oxygen (mg/l)	5	1.962693	0.2715	131.638	35.739
4	Biochemical Oxygen Demand (mg/l)	5	135.2437	0.2715	2704.874	734.37
5	Chemical Oxygen Demand (mg/l)	10	221.154	0.1357	2211.54	300.106
6	Total Suspended Solids (mg/l)	500	95.6	0.00271	19.12	0.05182
7	Total Dissolved Solids (mg/l)	500	770.4	0.00271	154.08	0.41756
8	Total Alkalinity (mg/l)	120	345.16	0.01131	287.633	3.25312
9	Total Hardness (mg/l)	300	370.9093	0.004525	123.636	0.55945
10	Electrical Conductivity (µmhos/cm)	300	1091	0.004525	363.66	1.6455
			Total Sum	1.00018	6590.047	1158.09
WQI= ∑ QiWi/∑Wi= 1157.884						

Table No.12 WQI for Station E by Weighted Arithmetic Mean Method

Sr.No	Parameters	Standards (Si)	Observed Values (Vi)	Unit Weight (Wi)	Quality Rating (Qi)	WiQi
1	pH	6.5-8.5	7.962	0.1597	64.133	10.242
2	Turbidity (NTU)	10	57.99	0.136	579.9	78.8664
3	Dissolved Oxygen (mg/l)	5	1.94012	0.2715	131.87	35.8027
4	Biochemical Oxygen Demand (mg/l)	5	139.7369	0.2715	2794.738	758.77
5	Chemical Oxygen Demand (mg/l)	10	277.258	0.1357	2772.528	376.232
6	Total Suspended Solids (mg/l)	500	96.4	0.00271	19.28	0.05225
7	Total Dissolved Solids (mg/l)	500	780	0.00271	156	0.42276
8	Total Alkalinity (mg/l)	120	350.28	0.01131	291.9	3.30139
9	Total Hardness (mg/l)	300	419.22	0.004525	139.74	0.63232
10	Electrical Conductivity (µmhos/cm)	300	1106.6	0.004525	368.866	1.66911
Total Sum				1.00018	7318.955	1265.99
WQI= ∑ QiWi/∑Wi= 1265.762						

Table No.13 WQI for Station F by Weighted Arithmetic Mean Method

Sr.No	Parameters	Standards (Si)	Observed Values (Vi)	Unit Weight (Wi)	Quality Rating (Qi)	WiQi
1	pH	6.5-8.5	8.016	0.1597	67.733	10.816
2	Turbidity (NTU)	10	62.99	0.136	629.9	85.66
3	Dissolved Oxygen (mg/l)	5	1.926822	0.2715	132.012	35.8412
4	Biochemical Oxygen Demand (mg/l)	5	143.3595	0.2715	2867.19	778.44
5	Chemical Oxygen Demand (mg/l)	10	282.2054	0.1357	2822.054	382.953
6	Total Suspended Solids (mg/l)	500	98	0.00271	19.6	0.05312
7	Total Dissolved Solids (mg/l)	500	787.2	0.00271	157.44	0.4266
8	Total Alkalinity (mg/l)	120	358.81	0.01131	299.008	3.3817
9	Total Hardness (mg/l)	300	436.65	0.004525	145.55	0.6586
10	Electrical Conductivity (µmhos/cm)	300	1108.4	0.004525	369.466	1.6718
Total Sum				1.00018	7493.353	1299.9
WQI= ∑ QiWi/∑Wi= 1299.66						

IV. CONCLUSION AND FUTURE SCOPE

As WQI of Kham River at Respected Stations is calculated, study reveals that Kham River is heavily polluted due to continuous discharge of untreated domestic sewage and mixing of industrial wastewater. From this WQI study it is noted that Kham River Water comes in to Bad Quality of Water and unsuitable for drinking and domestic purpose.

In this paper WQI is used to evaluate water quality and its suitability for drinking and domestic purpose, so there is future scope is that to carry out WQI to find out irrigation perspective suitability of Kham River.

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