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ASSESSMENT OF THE WATER QUALITY INDEX OF WETLAND KALAKHO LAKE, RAJASTHAN, INDIA

Rashmi Sisodia
Chaturbhuj Moundiotiya

Department of Zoology
University of Rajasthan
Jaipur, India

The present study calculates the Water Quality Index (WQI) of Kalakho Lake and assesses the impact of industries, agriculture and human activities. Physicochemical parameters were monitored for the calculation of WQI for the summer, monsoon and winter seasons. The results revealed that the WQI of the lake exceeded acceptable levels at all the sampling stations due to the dumping of wastes from municipal and domestic sources and agricultural runoff. The lake water is unsuitable for drinking and propagation of wildlife and fish culture. If the present state of affairs continues for long, Kalakho Lake may soon become an ecologically dead lake. We advocate habitat conservation and ecological studies with special reference to restoring the quality of lake waters.

INTRODUCTION

Wetlands are vital water bodies, as crucial in a natural ecosystem as a kidney in a human body. Their role is complex and varied. Apart from being highly productive as the habitat of birds, fishes and a variety of other aquatic life forms, including microorganisms, wetlands provide other ecosystem services, from maintaining the natural balance to sustaining human livelihoods. Unfortunately, there has been much neglect of wetlands in recent times through lack of appreciation of their role and the pressures of growing human needs (agriculture, urbanization) and sheer mismanagement of land resources. There is also a misconception that wetlands are only wastelands. As a result, many precious wetlands have been sacrificed and converted to other uses throughout India and elsewhere in the world. This trend has to be checked and reversed for the greater good.

This problem assumes added significance, especially in a water stressed region such as Rajasthan, where it is vitally important to conserve every drop of rain and to preserve every bit of a water body. Rajasthan State is endowed with rich wetland resources that are also facing degradation by the aforementioned threats. The degradation in the water quality affects the floral and faunal population along with the people dependent on these ecosystems. Hence, the conservation of wetlands deserves the utmost attention.

Srivastava et al. (2003) reported that Jal Mahal Lake water was most polluted due to high pH, hardness, alkalinity, free carbon dioxide, zinc content, and a low level of dissolved oxygen, contrarily to Ramgarh Lake which was least polluted. Study of physicochemical properties of the Jamwa Ramgarh wetland water in Jaipur revealed that the water quality is not fit for drinking without treatment. Changes in water quality were due to use of land for agriculture after water recedes in the dried up area of the wetland, waste disposal and other polluting practices around the lake (Moundiotiya et al*.,* 2004). Review of the literature reveals that very few studies have been made to scientifically assess the pollution status of Kalakho lake. The present study deals with the necessity of restoring the water quality of the lake and is aimed at calculating a Water Quality Index (WQI) in order to assess the suitability of its water for human uses.

MATERIALS AND METHODS

Area of study

Kalakho Lake is situated in the Dausa district of Rajasthan (India) and was constructed in 1952. It receives water from the Khardi river, natural streams and canals. It is deep, apparently oligotrophic (lat. $26^{o}54'$ and long. $76^{o}27'$). It has a vast catchment area of 52.25 sq. miles, with a gross storage capacity of 469.00 Mcft. During the winter months many migratory birds arrive, and this lake is a wonderful site for tourism, especially bird watching. The anthropogenic activities in its catchment area and associated pollutants are a major threat to the future of Kalakho Lake.

Collection and storage of water samples

Samples of water were collected from four sites on the lake once every month (January 2002 to December 2003). One-litre P.E.T. bottles were used for collection of water samples from a depth of 30 cm during morning hours between 8:00 -10:00 AM. The bottles were sealed by screw cap. For dissolved oxygen measurement, a 300 ml capacity BOD bottle was used for collection of water samples and the oxygen was fixed at the sampling site before being carried to the laboratory. The analysis of the lake water was done as per the standard methods of APHA (1989) and Trivedy and Goel (1986).

Water Quality Index (WQI)

The concept of indices to represent gradation in water quality was first proposed by Horton (1965). It indicates the quality by an index number, which represents the overall quality of water for any intended use. It is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water (Deininger and Maciunas, 1971; Harkins, 1974; and Tiwari and Manzoor, 1988). The WQI has been calculated from the point of view of the suitability of lake water for human consumption.

WQI Calculation

For calculation of WQI, selection of parameters has great importance. Since selection of too many parameters might widen the water quality index, and the importance of various parameters depends on the intended use of water, eight physicochemical parameters, namely pH, TDS, E.C., total alkalinity, acidity, total hardness, chloride, DO and BOD were used to calculate the WQI. The calculation of WQI was made using a weighted arithmetic index method given below (Brown et al., 1972) in the following steps.

Calculation of sub index of quality rating (q_n)

Let there be n water quality parameters where the quality rating or sub index (q_n) corresponding to the nth parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard permissible value. The value of q_n is calculated using the following expression.

$$q_n = 100[(V_n - V_{io}) / (S_n - V_{io})] \tag{1}$$

where

q_n = quality rating for the nth water quality parameter.

V_n = estimated value of the nth parameter at a given sampling station.

S_n = standard permissible value of nth parameter

V_{io} = ideal value of n^{th} parameter in pure water.

All the ideal values (V_{io}) are taken as zero for drinking water except for pH=7.0 and dissolved oxygen=14.6mg/L.

Calculation of quality rating for pH

For pH the ideal value is 7.0 (for natural water) and a permissible value is 8.5 (for polluted water). Therefore, the quality rating for pH is calculated from the following relation:

$$q_{pH} = 100\ [(V_{pH} - 7.0)/(8.5 - 7.0)] \tag{2}$$

where

V_{pH} = observed value of pH during the study period.

Calculation of quality rating for dissolved oxygen

The ideal value (V_{DO}) for dissolved oxygen is 14.6 mg/L and standard permitted value for drinking water is 5 mg/L. Therefore, quality rating is calculated from following relation:

$$q_{DO} = 100\ [(V_{DO} - 14.6)/(5 - 14.6)] \tag{3}$$

where

V_{DO} = measured value of dissolved oxygen

Calculation of unit weight (W_n)

Calculation of unit weight (W_n) for various water quality parameters are inversely proportional to the recommended standards for the corresponding parameters.

$$W_n = \mathrm{K}/S_n \tag{4}$$

where

W_n = unit weight for nth parameters

S_n = standard value for nth parameters

K = constant for proportionality

Calculation of WQI

WQI is calculated from the following equation

$$\mathrm{WQI} = \sum_{n=1}^{n} q_n W_n \Big/ \sum_{n-1}^{n} W_n \tag{5}$$

RESULTS AND DISCUSSION

The mean values of various physicochemical parameters during seasons for the calculation of WQI are presented in Table 1; the quality rating in Table 2(a, b); the sub index values in Table 3(a, b); drinking water standards and unit weights in Table 4; the status of water quality based on WQI in Table 5, and WQI values in Table 6.

pH

pH is one of the most important factors that serve as an index for the pollution. The average pH values of the lake water ranged within 7.9 to 8.37 during summer, 7.05 to 7.27 during the monsoon and 7.83 to 7.93 during winter. The pH of water was relatively high in the summer months and low in monsoon and winters. This is in accordance with earlier work by Wetzel (1975) who reported that the value of pH ranges from 8 to 9 units in Indian waters.

The alkaline nature of water was a characteristic throughout the study period with slight seasonal variations at the lake (pH 6.5 to 8.9). This coincides with the study of Kaur et al. (1996) who also failed to observe any major seasonal fluctuation in pH. The high pH recorded during winter and summer can be attributed to higher productivity of water as evidenced by high growth rate of algal population, which utilized CO_2 through photosynthetic activity. A pH between 6.7 and 8.4 is suitable, while pH below 5.0 and above 8.3 is detrimental. In the present investigation pH values were within the ICMR standards (7.0-8.5).

A trend of lower pH during the monsoon was due to the dilution of alkaline substances and high turbidity, whereas in other seasons high pH can be attributed to high temperatures, which enhance microbial activity, causing excessive production of CO_2. Ghose and Sharma (1988) also recorded relatively high pH of water in winter months in their study of the Ganga River attributing high pH to increased primary productivity. The pH of Kalakho Lake is in accordance with the findings of Singh and Ray (1995) and Perking (1976).

Total dissolved solids (TDS)

The total dissolved solids in water of Kalakho Lake ranged between 302 to 421 mg/L. The average total dissolved solids in water ranged within 353.5 to 368.1 mg/L during summer, 406.1 to 409.0 mg/L during monsoon and 354.3 to 356.7 mg/L during winter. The concentration is high during monsoon period, which may be due to addition of solids from runoff water, sewage and industrial effluents to the lake. Gupta and Singh (2000) also reported high concentration of TDS in the Damoder River due to mixing of sewage and industrial wastes. A similar observation was made by Marker (1977). The amounts of total solids are influenced by the activity of the plankton and organic materials. Very high values of TDS were recorded at all the sampling stations much beyond permissible WHO limit. Water containing more than 500 mg/L of TDS is not considered desirable for drinking water supply.

Total Alkalinity

Total alkalinity values in our observations fluctuated between 98 to 276 mg/L, indicating that the water is hard. The observed average values of total alkalinity ranged within 155.8 to 197.3 mg/L during summer, 112.0 to 189.31 mg/L during monsoon and 114.8 to 115.8 mg/L during winter. Higher values of alkalinity registered during summer might be due to the presence of excess of free CO_2 product as a result of decomposition process coupled with mixing of sewage and domestic waste. Alkalinity was high during summer season followed by steep fall in the monsoon periods. The low alkalinity during monsoon period may be due to dilution. Jain et al. (1996) also reported similar finding in the study of the Halali River.

Excessive alkalinity may cause eye irritation in humans and chlorosis in plants. Surface water with alkalinity less than 200 mg/L is potentially sensitive to heavy acid deposition. Alkalinity itself is not harmful to human beings, still water supplies with less than 100 mg/L of alkalinity are desirable for domestic use. According to USPHA the maximum permissible limit is 120 mg/L.

Total Hardness

The average total hardness values ranged from 117.25 to 122.97 mg/L during summer, 71.73 to 94.25 mg/L during monsoon and 80.66 to 81.12 mg/L during winter. Higher values of hardness during summer can be attributed to low water level and high rate of evaporation of water and addition of calcium and magnesium salts. Mohanta amd Patra (2000) stated that addition of sewage, detergents and large scale human use might be the cause of elevation of hardness. Hardness values declined during monsoon due to dilution of lake water. Palharya et al. (1993) also recorded similar observation during summer and monsoon in the Narmada River. No significant change in hardness values were noticed during winter.

Kannan (1991) has classified water on the basis of hardness values in the following manner; 0-60 mg/L, soft, 61-120 mg/L, moderately hard, 121-160 mg/L, hard and greater than as 180 mg/L very hard. Kalakho Lake water (68 to 136.3 mg/L) was moderately hard but the hardness values were in permissible limits. Hardness below 300 mg/L is considered potable but beyond this limit produces gastrointestinal irritation (ICMR, 1975). Normally water hardness does not pose any direct health problem but may cause economic problems.

Chloride

The average chloride values ranged from 46.52 to 55.05 mg/L during summer, 25.79 to 54.02 mg/L during monsoon and 35.0 to 35.31 mg/L during winter. The higher concentration of Cl^- is

Table 1. Seasonal mean values of some water quality parameters of Kalakho Lake at four sampling sites.

		Jan.2002 to Dec.2002				Jan.2003 to Dec.2003			
S.N.	Sampling Site	S 1	S 2	S 3	S 4	S 1	S 2	S 3	S 4
1	pH								
	Summer	7.933	7.933	8.4	8.35	7.9	7.866	8.3	8.4
	Monsoon	7.15	7.275	6.95	7.3	7.125	7.275	7.15	7.2
	Winter	7.9	7.9	7.8	7.78	7.86	7.96	7.78	7.88
2	TDS								
	Summer	369	366.333	355	352	367.333	367.333	355	355
	Monsoon	411	405.75	410	408	407	406.5	408	406
	Winter	355.4	356.6	355.2	354.8	355.2	356.8	354.6	353.8
3	EC (micro s./cm)								
	Summer	615.67	627	600	603.5	617.666	626	601	601
	Monsoon	591.75	602.5	511	510	596.5	603.25	511	510
	Winter	552.6	555.6	552.2	554	546.8	551.2	550	549.6
4	Total Alkalinity								
	Summer	197.33	194.333	153.25	153	197.333	196	158.5	159.4
	Monsoon	186.65	189.5	119	112	187.5	189.125	117.5	112
	Winter	116.066	114.6	115.4	114.8	114.666	115	116.8	116.8
5	Acidity								
	Summer	15.383	15.433	11.65	11.73	13.7	13.666	11.05	11.05
	Monsoon	14.5825	14.4025	8.14	7.6	13.205	13.3225	8.15	7.8
	Winter	8.054	7.93	8.052	8.048	7.864	7.924	7.998	8.012
6	Hardness								
	Summer	118.8	122.173	117.25	117.25	122.766	123.766	117.5	117.5
	Monsoon	92.2675	93.4925	80.335	70.67	93.825	95.025	82.8	72.8
	Winter	81.96	81.772	81.32	81.44	80.28	79.78	80.14	79.88
7	Chloride								
	Summer	52.833	54.166	46.25	46.25	54.8333	55.933	46.8	45.65
	Monsoon	54.29	54.215	26.785	29.77	53.7	53.825	24.8	22
	Winter	34.98	35.42	34.76	35.26	35.2	35.2	35.24	35.16
8	DO								
	Summer	10.4	9.7666	10.4	10	10.566	10.033	10.3	10.5
	Monsoon	5.6775	5.2	5.3	5.4	5.88	5.22	6.05	7.4
	Winter	12.062	11.2	11.2	11.3	12.102	11.8	11.6	11.64
9	BOD								
	Summer	39.867	41.4	40.1	42.1	39.1333	40.966	40.2	41.5
	Monsoon	53.4	53.675	50.7	47.2	52.7	53.925	50.7	47.2
	Winter	35.56	35.4	34.88	34.74	35.02	34.4	34.68	34.88
10	COD								
	Summer	115.27	115.6	114.5	114.8	115.8	113	108.6	118.5
	Monsoon	145.75	143.325	134.65	124	153.75	151.325	139	124
	Winter	103.74	105.914	109.36	110.42	112.916	117.44	116.76	121.16
11	Temperature								
	Summer	25.333	25.333	24.5	24.5	25.7333	25.466	24.75	24.7
	Monsoon	28.75	28.625	28.15	28.5	28.725	28.675	28.5	28.5
	Winter	20.3	20.02	19.56	20.32	20.64	20.32	20.24	20.48

(All values are in mg/L except pH and EC)

considered to be an indicator of higher pollution due to higher organic waste of animal origin. Govindan and Sundaresan (1979) observed that a concentration of higher Cl^- in the summer period could be also due to sewage mixing and increased temperature and evapotranspiration by water. The chloride in Kalakho Lake water was found within the acceptable limit of 200 mg/L. Presence of chlorides above the required acceptable limits can also be used as an indicator of pollution by domestic sewage. In natural surface water the concentration of chloride is normally low.

Dissolved oxygen (DO)

The average dissolved oxygen values ranged from 9.9 to 10.48 mg/L during summer, 5.2 to 6.4 mg/L during monsoon and 11.4 to 12.08 mg/L during winter. The maximum dissolved oxygen in

Table 2(a). Water quality rating (q_n) of lake different stations (Jan.02 to Dec.02).

	pH	TDS	Alkalinity	Hardness	Chloride	DO	BOD	COD
Summer								
S1	62.25	73.8	164.442	39.6	21.1332	43.75	797.34	1152.7
S2	62.25	73.2666	161.944	40.7244	21.6667	50.3472	828	1156
S3	93.333	71	127.708	39.0833	18.5	43.75	802	1145
S4	90	70.4	127.5	39.0833	18.5	47.9167	842	1148
Monsoon								
S1	10	82.2	155.542	30.7558	21.716	92.9427	1068	1457.5
S2	18.3333	81.15	157.917	31.1642	21.686	97.9167	1073.5	1433.25
S3	3.3333	82	99.1667	26.7783	10.714	96.875	1014	1346.5
S4	20	81.6	93.3333	23.5567	11.908	95.8333	944	1240
Winter								
S1	60	71.08	96.7217	27.32	13.992	26.4375	711.2	1037.4
S2	60	71.32	95.5	27.2573	14.168	35.4167	708	1059.14
S3	53.3333	71.04	96.1667	27.1067	13.904	35.4167	697.6	1093.6
S4	52	70.96	95.6666	27.1467	14.104	34.375	694.8	1104.2

Table 2(b). Water quality rating (q_n) of lake different stations (Jan.03 to Dec.03).

	pH	TDS	Alkalinity	Hardness	Chloride	DO	BOD	COD
Summer								
S1	60	73.4666	164.444	40.889	21.9333	42.0139	782.666	1158
S2	57.778	73.4666	163.333	41.2556	22.3733	47.5695	819.333	1130
S3	86.6666	71	132.083	39.1667	18.72	44.7917	804	1086
S4	93.3333	71	132.833	39.1667	18.26	42.7083	830	1185
Monsoon								
S1	8.3333	81.4	156.25	31.275	21.48	90.8333	1054	1537.5
S2	18.3333	81.3	157.604	31.675	21.53	97.7083	1078.5	1513.25
S3	10	81.6	97.9167	27.6	9.92	89.0625	1014	1390
S4	13.3333	81.2	93.3333	24.2667	8.8	75	944	1240
Winter								
S1	57.3333	71.04	95.555	26.76	14.08	26.0208	700.4	1129.16
S2	64	71.36	95.8333	26.5933	14.08	29.1667	688	1174.4
S3	52	70.92	97.3333	26.7133	14.096	31.25	693.6	1167.6
S4	58.6666	70.76	97.3333	26.6267	14.064	30.8333	697.6	1211.6

the water of Kalakho Lake was recorded during winters thereafter it started declining gradually and in summers reached the lowest concentration. This can be attributed to addition of effluents containing oxidizable organic matter and consequent biodegradation and decay of vegetation at higher temperature leading to consumption of oxygen from water (Jameel, 1998).

The presence of DO in water may be due to direct diffusion from air and photosynthetic activity of autotrophs. The addition of a variety of biodegradable pollutants from domestic and industrial sources stimulates the growth of microorganisms, which consume the DO of water. The values further deplete during summers because at high temperature, the oxygen holding capacity of water decreases. The water quality of Kalakho Lake markedly deteriorates in summer as the banks become crowded by algal blooms, which may also be responsible for depletion of DO. DO is a good indicator of water quality and its relation to the distribution and abundance of various algal species along with the degree of pollution by organic matter, destruction of organic matter and level of self purification of the water.

Concentrations below 5 mg/L may adversely affect the functioning and survival of biological communities and below 2 mg/L may lead to fish mortality. Water without adequate DO may be considered wastewater. The DO in stream is an inverse function of the microbial population that in turn is controlled by their food supply, the organic pollutants. Excessive organic pollution causes fish kill by oxygen depletion. Fish kill and odor problems are associated with zero oxygen

Table 3 (a). Sub index ($q_n W_n$) values of different parameters at different stations (Jan.02 to Dec.02).

	pH	TDS	Alkalinity	Hardness	Chloride	DO	BOD	COD
Summer								
S1	13.581456	0.27365	2.54062	0.24479	0.15676	16.2264	295.725	213.762
S2	13.581456	0.27167	2.50204	0.25174	0.16072	18.6733	307.097	214.374
S3	20.3630206	0.26327	1.97309	0.2416	0.13723	16.2264	297.454	212.335
S4	19.63584	0.26104	1.96988	0.2416	0.13723	17.7718	312.289	212.891
Monsoon								
S1	2.18176	0.3048	2.40312	0.19012	0.16109	34.4715	396.111	270.286
S2	3.99988606	0.3009	2.43981	0.19264	0.16086	36.3163	398.15	265.789
S3	0.72724606	0.30406	1.53212	0.16553	0.07948	35.93	376.082	249.702
S4	4.36352	0.30257	1.442	0.14562	0.08833	35.5436	350.12	229.952
Winter								
S1	13.09056	0.26356	1.49435	0.16888	0.10379	9.80544	263.777	192.381
S2	13.09056	0.26445	1.47548	0.16849	0.1051	13.1357	262.59	196.412
S3	11.63604606	0.26342	1.48577	0.16849	0.10314	13.1357	258.733	202.803
S4	11.345152	0.26312	1.47805	0.16781	0.10462	12.7493	257.694	204.768

Table 3 (b). Sub index ($q_n W_n$) values of different parameters at different stations (Jan.03 to Dec.03).

	pH	TDS	Alkalinity	Hardness	Chloride	DO	BOD	COD
Summer								
S1	13.09056	0.27241	2.54067	0.25276	0.1627	15.5825	290.283	214.745
S2	12.60577292	0.27241	2.5235	0.25503	0.16596	17.643	303.883	209.553
S3	18.90857212	0.26327	2.04069	0.24211	0.13886	16.6128	298.196	201.393
S4	20.36308606	0.26327	2.05227	0.24211	0.13545	15.8401	307.839	219.752
Monsoon								
S1	1.81812606	0.30183	2.41406	0.19333	0.15933	33.6892	390.918	285.122
S2	3.99988606	0.30146	2.43498	0.1958	0.15971	36.239	400.005	280.625
S3	2.18176	0.30257	1.51281	0.17061	0.07359	33.0324	376.082	257.769
S4	2.90900606	0.30109	1.442	0.15001	0.06528	27.8168	350.12	229.952
Winter								
S1	12.50875006	0.26342	1.47632	0.16542	0.10444	9.65087	259.771	209.397
S2	13.963264	0.2646	1.48062	0.16439	0.10444	10.8176	255.172	217.787
S3	11.345152	0.26297	1.5038	0.16513	0.10456	11.5903	257.249	216.526
S4	12.79964412	0.26238	1.5038	0.1646	0.10433	11.4358	258.733	224.685

level. Present observations are in agreement with similar ones made by Yogesh Shastri and Pendse (2001) and Shanthi et al. (2002) at Dahikhura reservoir and Singanallur Lake respectively.

Biochemical Oxygen Demand

BOD is the measurement of the amount of biologically oxidizable organic matter present in waste. The increased levels of BOD and COD indicated the nature of chemical pollution. The entry of sewage water, industrial effluents and the agricultural runoff might be responsible for the increased levels of BOD and COD. The level of BOD ranged from 31.5 to 58.2 mg/L in the lake. Permissible limits are 5 mg/L. High content of BOD and COD cause oxygen depletion, which leads to the suffocation of the aquatic life (Verma et al., 1984).

The average BOD values of Kalakho Lake ranged from 39.50 to 41.80 mg/L during summer, 47.20 to 53.80 mg/L during monsoon and 34.78 to 35.05 mg/L during winter. At the S-2 sampling site throughout the study period the BOD was above the permissible limit. High BOD was registered during monsoon and summer. The peak values of BOD in monsoon were due to high concentration of dissolved and suspended solids in water (Jameel 1998). In summer BOD values increased due to increased biological activities at elevated temperature (Palharya et al., 1993), high input of organic pollutants and reduced rate of flow (Singh and Srivastva, 1988). The values of BOD were always recorded much above permissible limits indicating presence of decomposable organic matter in the Kalakho Lake.

Table 4. Drinking water standards by recommending agencies and unit weights.

S.N.	Parameters	Standards (Sn)	Recommending Agency	Unit weights (Wn)
1	pH	7.0 to 8.5	ICMR	0.21818
2	T.D.S.	500	WHO	0.00371
3	Total Alkalinity	120	ICMR/US	0.01545
4	Total Hardness	300	ICMR	0.00618
5	Chlorides	250	ICMR	0.00742
6	D. O.	5	WHO	0.37089
7	B.O.D.	5	ICMR	0.37089
8	C.O.D.	10	WHO	0.18545
	K = 1.85445		Sum Valu	**1.17816**

Table 5. Status of water quality based on WQI (quoted by Mishra and Patel, 2001).

Water Quality Index	Status
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
100 and above	Unsuitable for drinking and propagation of wildlife & fish culture

Chemical Oxygen Demand (COD)

COD is a very important water pollution parameter. The organic waste is utilized as food by many of the microbes present in the aquatic environment. The COD in the water ranged from 90 to 167 mg/L. The average COD values ranged from 111.5 to 116.6 mg/L during summer, 124.0 to 149.7 mg/L during monsoon and 108.3 to 115.7 mg/L during winter. Throughout the study period the COD was above the permissible limit at the S-2 sampling site.

Assessment of Kalakho Lake Water Quality Based on WQI

In the present study the application of WQI gives us a comparative evolution of water quality at different sampling stations during different seasons. The values at all the stations are much above 100 indicating unsuitability of lake water for drinking purposes. Seasonal as well as station wise variation of index values are due to variation in physicochemical characteristic of lake water.

WQI values were 460, 599, 408 at Station I, 472, 600, 413 at Station II, 465, 564, 414 at Station III and 479, 527, 414 at Station IV in summer, monsoon and winters respectively at Kalakho Lake in 2002. In 2003 WQI values at Station I were 455, 606, 418, at Station II 464, 614, 424, at Station III 456, 569, 423 and Station IV 480, 520, 432 in summer, monsoon and winter respectively (Table 6). Perusal of WQI data from Table 6 indicates that the index values were maximum at Station S-2 (614 in monsoon, 2003). The reason for high index values were continuous discharge of agricultural runoff, malpractices, industrial effluents and municipal sewage effluents flowing into

Table 6. Water quality index (WQI) of Kalakho Lake.

	(Jan.02 to Dec.02)			(Jan.03 to Dec.03)		
Sampling Station	**Summer**	**Monsoon**	**Winter**	**Summer**	**Monsoon**	**Winter**
Station I	460.474	599.333	408.336	455.737	606.553	418.736
Station II	472.697	600.386	413.562	464.2	614.485	424.182
Station III	465.975	564.035	414.484	456.471	569.639	423.327
Station IV	479.73	527.907	414.69	480.824	520.096	432.615

the lake. WQI values of Kalakho Lake at S4 were lower than that at S3 and the values at S1 is less than that at S2. WQI values in 2003 were higher than 2002 at all the sampling stations.

WQI values were always above 100 at all the sampling stations. According to Mishra and Patel (2001) index value more than 100 or above is unsuitable for drinking and propagation of wildlife and fish culture. In 2002 water quality was much better than 2003 in the wetland.

From the present observations, it can be calculated that water quality of the wetland is under stress of severe pollution due to the discharge of wastewater from various sources into the lake. The water is not suitable for drinking, bathing, swimming, pisciculture etc. In order to save these wetlands from further deterioration, effective pollution control measures must be taken in the near future.

A government commitment is needed along with cohesive academic research centered on wetlands as a problem and a vital biome, so that its importance may be understood, and so that conservation as a principle may be accepted by administrators. Careful management of natural resources should be a result – not destruction of habitat and erosion of resources. The Water Quality Indices are among the most effective ways to communicate the information on water quality trends to the general public or to the policy makers and water quality management.

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ADDRESS FOR CORRESPONDENCE
Rashmi Sisodia
Department of Zoology
University of Rajasthan
Jaipur 302004 India

Email: rashsisodia@yahoo.co.in