International Indexed & Refereed Research Journal, January, 2013 ISSN 0975-3486, RNI- RAJBIL- 2009-30097, VOL- IV * ISSUE- 40

Research Paper—Geomorphology

Water Quality Assessment of Four Different Wetlands And Its Implication to Climate Change

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January,2013

A B S T R A C T

Water quality index is considered as an effective indicator of the health of water. With the climate change scenarios the quality determination of wetlands becomes a burning issue. In India different wetlands have different set of regional and local teething troubles regarding their health. In the present paper a framework is set for water quality assessment and comparison between four wetlands having differing environmental constraints.

Key Words: Water Quality, Cultural Eutrophication, Ecoclimatic Regime, Bio-diversity.

Introduction:

Wetlands are transition areas between land and water, characterized by shallow water overlying waterlogged soil as well as interspersed submerged or emergent vegetation (Prsad et al., 2002). It has its own characteristics ecosystem and diverse habitat. Preservation of wetlands, thus, is the sole requirement to save our inland diverse endangered habitat, especially in the light of climate changes (Khan et al., 2008; Erwin, 2009). Study of water quality is an indicator of health of any water body and for this research paper 4 wetlands of India, according to their specific locations and different influencing factors of Water Quality (WQ), are chosen. These wetlands are Renuka Lake of Himachal Pradesh (L1), Udhagamadalem Lake (Ooty) of Tamil Nadu (L2), Ramgarh Tal of Uttar Pradesh (L3), and Chandola Lake of Gujarat (L4). However, along with their Water Quality Index (WQI) calculation, a study of individual water quality parameters has also been done in order to fulfill the following two major objectives: Firstly, to assess the water quality of four different lakes in India using Water Quality Index, and Secondly, to determine the level of contamination of water by individual parametric analysis.

The water quality data has been collected from Central Pollution Control Board (CPCB) of India for three consecutive years viz. 2003, 2004 and 2005. Different water quality parameters are used (having standard units) for the present study depending on the availability of secondary data. Hence, use of WQ parameters is liable to their availability and use.

Methodology:

For the measurement of water quality and contamination Water Quality Index (WQI) is calculated. The modified Weighing WQI (after Alam and Pathak, 2010) is used in which a specific weight is assigned to the parameter according to the influence of it in modifying water quality. The parameters are listed in Table 1. Their ratings are given according to the permissible limits given by CPCB , WHO , OWQI method , EPA , ICMR and Alam and Pathak (2010).

The two fundamental steps for calculating WQI are (a) a quality rating is calculated for each water quality parameter used in the indices (table 1) and (b) aggregating these sub indices into overall index.

Table 1: Water quality parameters used in calculating WQI

Parameters	Standard Values	Weight Assign(Wa)	Unit Weight (Wi)	SOURCE	STANDARD GIVEN BY/TAKEN FROM:
Temperature	11 o 32	4	0.100	+	Oregon Water Quality Index
pH	6.5 to 8.5	4	0.100	*	CPCB
Dossolved Oxygen (DO)	>6	4	0.100	#	Alam and Pathak (2010)
Biological Oxygen Demand (B.O.D.)	2 to 6	4	0.100	*	CPCB
Total Alkalinity	<120	3	0.075	#	Alam and Pathak (2010)
Total Amonia	0.05 to 5	2	0.050	* $	CPCB and WHO (1997)
Total Solids	500 to 1500	4	0.100	#	Alam and Pathak (2010)
Chloride	200 to 500	2	0.050	#	Alam and Pathak (2010)
Total Hardness	100 to 500	2	0.050	#	Alam and Pathak (2010)
Phosphate	0.1 to 3	4	0.100	+	Oregon Water Quality Index
Total Coliform	50 to 5000	3	0.075	*	CPCB
Turbuduty	5	4	0.100	^	ICMR
∑Wi	40		1.000		

Table:2, Quality rating scale for water quality parameters (qi)

Parameters	Permissible 100	Slight 80	Moderate 50	Severe 0
Temperature	<11	11-20.0	21-32	>32
PH	6.5-8.50	8.6-8.8	8.9-9.2	>9.2
		6.0-6.4	5.5-5.9	<5.5
Dissolved Oxygen	>6.0	4.5-5.9	3.0-4.4	<3.0
B.O.D	<2	2.0-3.0	3.0-6.0	>6.0
Total Alkanity	<50	50-85	85-120	>120
Total Amonia	<0.05	0.051-1.2	1.21-5	>5
Total Solids	<500	501-1000	1001-1500	>1500
Chloride	<200	200-400	401-600	>600
Total Hardness	<100	101-300	301-500	>500
Phosphate	<0.1	0.1-0.4	0.41-3	>3
Total Coliform	<50	50-500	501-5000	>5000

Table :3 Degree of pollution

Class	WQI	Degree of Pollution	Water Quality
I	90-100	Permissible Range	Excellent
II	70-89	Slight to Permissible Range	Good
III	50-69	Moderate to Slight Range	Satisfactory
IV	26-49	Severe to Moderate Range	Poor
V	0-25	Severe to Moderate Range	Unacceptable

After allocation of weight, the unit weight is calculated as follows:

Unit weight (Wi) = Wai / ?Wani=1 and ? Wi = 1

Where, Wai = Weight assigned to parameter.

?Wani=1 = Sum of weights of all parameters

For calculating WQI each parameter is given a rating value ranging between 0 and 100 (Table 2). Then the unit weight (Wi) value of each parameter is multiplied with the given rating qi (Si=Wi*qi) to calculate Subindex (Si) and sum of Si (?Si) gives the WQI of that water body.

Sub Index (SI)i = qi x Wi

Where, (SI)i = Subindex of ith parameter.

Wi = Unit weight of ith parameter.

qi = quality rating of ith parameter.

WQI = ? (qi x Wi)n.

Study Region:

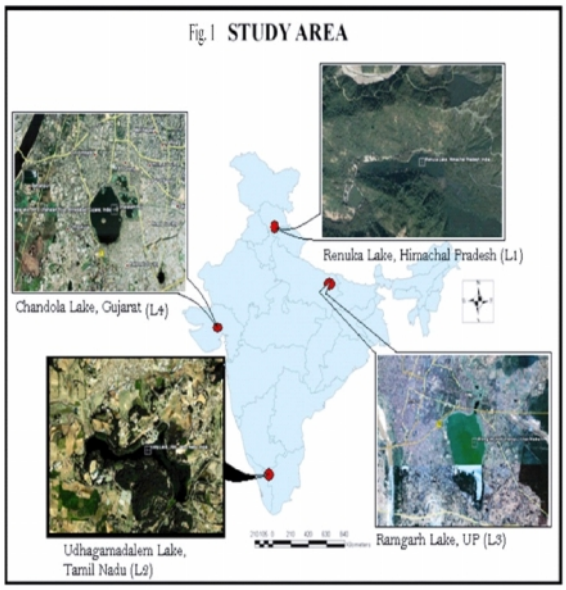
Four wetlands of India according to their specific location and different influencing factors of Water Quality (WQ) are chosen. The four wetlands are Renuka Lake of Himachal Pradesh (L1) (30° 36' N & 77° 27' E, 660 m.asl), Udhagamadalem Lake (Ooty) of Tamil Nadu (L2) (11° 24' N & 76° 41' E, 2218m.asl), Ramgarh Tal of Uttar Pradesh (L3) (° 44' N & 72° 35' E, 68 m.asl), and Chandola Lake of Gujarat (L4) (22° 59' N & 72° 35' E, 40m.asl) (Fig. 1).

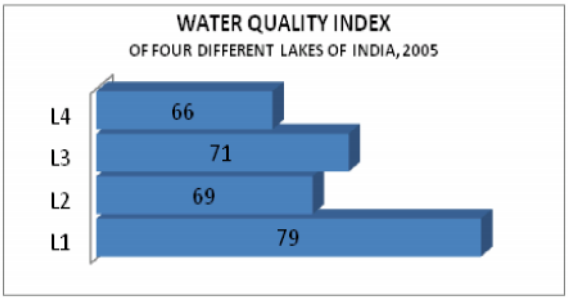
Findings: a .Water Quality of Four Different Wetlands in India: The calculated WQI (applying 12 parameters; *on the assumption that more the parameters more the actual index*) for the four different wetlands based on 2005 CPCB Ponds and Lakes data (using mean value), shows that the L1 has 79, L2 - 69, L3 - 71 and L4 - 66 values (fig.2). It means by category the L1 has good condition, L2 has satisfactory condition (turbidity plays major role), L3 has good condition, and L4 has satisfactory conditions but their value range from high to low within the broad categories which is likely to note. Like, L3 is slightly above the category (i.e. 70-89 = Good) but still categorized in good WQ and that of L2 is slightly lower than good but is categories as satisfactory. The variation in WQI values can be seen from the graph (Fig 3).

It is thus clear if the wetlands are not in the first category (excellent), they are not in the fourth and fifth category i.e. poor and unacceptable too indicating that there is enough that one can improve from this, and special attention should be given to L4 and L2 to improve their WQ relative to others.

b. Analysis of Water Quality Parameters:

The analysis of individual parameter can give the conditional changes along with their present conditions of level of contamination.





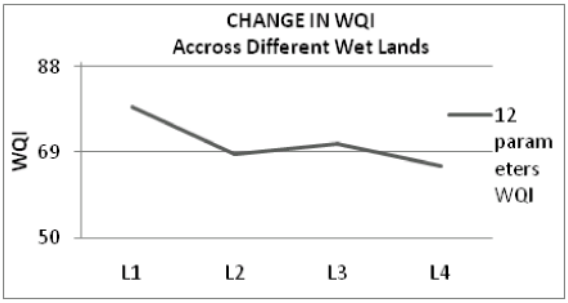
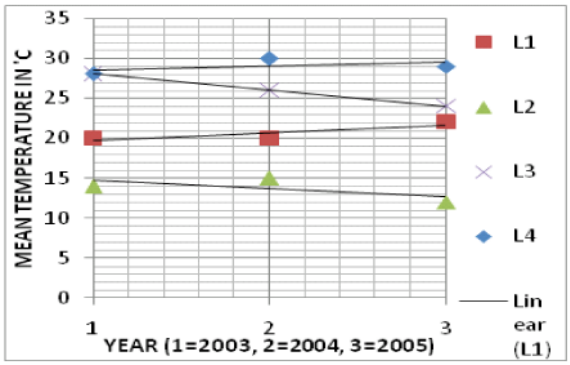
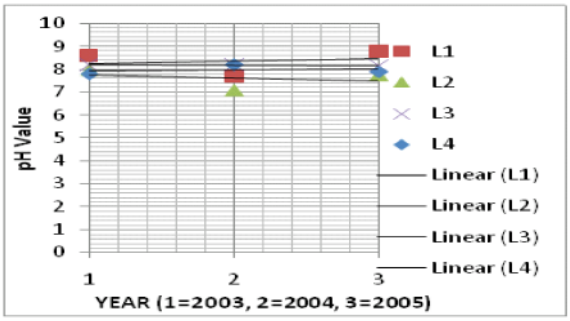
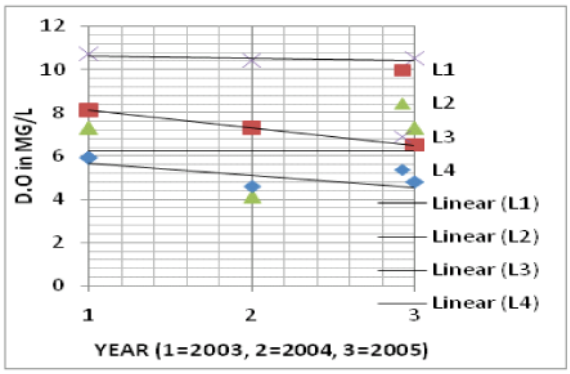
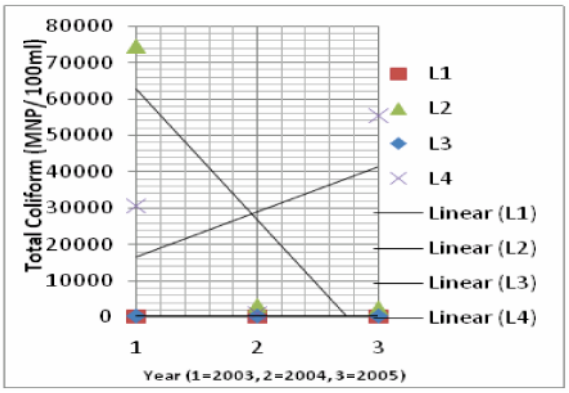


Table: 5 Parameters	Temperature			pH			Dossolved Oxygen			
Units/Locations	C	Rating	Si		Rating	Si	(mg/l)	Rating	Si	
RENUKA LAKE (L1)	22	50	5	8.79	80	8	6.5	100	10	
UDHAGAMADALEM LAKE (L2)	12	80	8	7.76	100	10	7.3	100	10	
RAMGARH LAKE (L3)	24	50	5	8.14	100	10	10.5	100	10	
CHANDOLA LAKE (L4)	29	50	5	7.91	100	10	4.8	80	8	
	B.O.D.			Total Alkalinity			Total Amonia			
	(mg/l)	Rating	Si	(mg/l)	Rating	Si	(mg/l)	Rating	Si	
RENUKA LAKE (L1)	4.1	50	5	70	80	6	0.53	80	4	
UDHAGAMADALEM LAKE (L2)	9.8	0	0	120	50	3.75	5.6	0	0	
RAMGARH LAKE (L3)	4.9	50	5	118	50	3.75	0.59	80	4	
CHANDOLA LAKE (L4)	13.3	0	0	200	0	0	0.69	80	4	
	Total Solids			Chloride			Total Hardness			
	(mg/l)	Rating	Si	(mg/l)	Rating	Si	(mg/l)	Rating	Si	
RENUKA LAKE (L1)	695.2	80	8	19.9	100	5	306	50	2.5	
UDHAGAMADALEM LAKE (L2)	604	80	8	50	100	5	96	100	5	
RAMGARH LAKE (L3)	455.6	100	10	25.6	100	5	147.2	80	4	
CHANDOLA LAKE (L4)	354	100	10	30	100	5	190	80	4	
	Phosphate			Total Coliform			Turbidity			12 parameters
	(mg/l)	Rating	Si	MPN/100ml	Rating	Si	NTU	Rating	Si	WQI
RENUKA LAKE (L1)	0.3	80	8	34	100	7.5	1.3	100	10	79
UDHAGAMADALEM LAKE (L2)	0	100	10	2550	50	3.75	21	50	5	68.5
RAMGARH LAKE (L3)	0.4	80	8	222	80	6	127	0	0	70.75
CHANDOLA LAKE (L4)	0	100	10	55490	0	0	1.3	100	10	66









For L1 & L3 temperature is at moderate level and in L2 it is low (altitude) and healthy (DO) but in L4 the temperature is very high (due to industrial release and arid, semi-arid climate). In L4 temperature is directly affecting the DO and BOD (fig.1a). In L1 pH is relatively higher than others; it may be because of geology and soil erosion factors as well as reduction in photosynthesis hydrophytes in and around the wetland and at L2 it is lower. Except in L1 in 2003 and 2005 (8.6 and 8.71 respectively) other have standard permissible limit (fig.1b). In L4 DO is negative to temperature and positive to BOD. At others DO concentration is ranging from >10 to >4 i.e. within the permissible limits stated by CPCB. But the decreasing DO for L4 and L1 (very high hardness - 306mg/l, and total solids-TDS-362 mg/l, TSS-63.2 mg/l and TFS-270 mg/l) is a matter of concern. High DO level in L3 (10.5mg/l) is due to high nitrate (4.46mg/l) and Phosphate (0.4mg/l) in water (causing eutrophication and further deterioration of DO and WQ) (fig.1c).

At L4 (increasing temperature) and L2 (increasing aerobic activities or increase in respiration and organic decaying or pH level fluctuation or increase in Nutrition) high BOD can be discernible (fig.1d). In L1 decreasing DO and BOD and increasing pH may be because of reduction in aquatic plants, fish and microbial communities. COD is relatively high in L1 (100mg/l) (high soil erosion and TS) and low for others. In L1 the TDS concentration is relatively maximum (362mg/l) but less than that of permissible limit followed by L2, L3 and L4. EC is relatively high in L1 but it shows decreasing trend (high TDS) followed by L4, L3 and L2. All are way under permissible limit (fig.1e). In L3 slight increase can be notices from 2003-05. L1 has relatively high hardness followed by L3, L4, and L2; - none of them are above permissible limits. NH3 is very high in L2 (5.6mg/l) and higher than the CPCB permissible limit (1.2mg/l). The high and increasing BOD level along with high NH3 concentration is indicating the eutrophication in the L2. Others register concentration below permissible limits. TC concentration is found to be highly fluctuating over the 3 years in L4 and L2 while in others TC is steady i.e. it is steadily declining in L1 and rising in L3. In the L4 the TC is higher (55490MNP/100ml) than the permissible level and so as in L2 (2550 MNP/100ml) which is matter of concern. Phosphate is relatively high in L1 and L3 and absent in other two resulting in eutrophication in L3. Total Alkanity is relatively high in L4 followed by L2, L3 and L1. In L4 it is above Permissible limit whereas for L2 and L3 the contamination level is moderate to moderate high. Other parameters and their relative condition in determining WQ of these wetlands can be discussed through the following table (Table 5).

Table:5 Parameter	Relative position	Permissible limit	Remark
Chloride	L2 has relatively high Concentration	All is under permissible limits	GOOD
Fluride	L4 has relatively high Chloride	All is under permissible limits ; L4 below permissible limits	GOOD
Turbidity	L3 has very high turbidity followed by L2	Below permissible limits	Influence the WQI value and may be the result of domestic wastes (also may be same for L2)

Conclusion And Suggestion:

From the aforesaid study following conclusion can be drawn about the water quality of the four different wetlands of India. Renuka lake (L1) has been experiencing decreasing DO & BOD but increasing pH level, COD, high TS, high Total hardness and electric conductivity. Soil erosion is high as well. That means the high concentration of solids positively affects DO concentration which adversely affect the BOD and the aquatic life forms in the wetlands; the relatively high pH along with decreasing DO and BOD and uniform temperature also support the adversely affected ecology in the wetland. High Total hardness and electric conductivity are also indicators of deteriorating water quality in the wetland. Hence although by WQI study the lake has good condition (79) but it is likely to become more contaminated (or aging) in near future. Udhagamadalem (Ooty) lake (L2) also has high Total Amonia indicating eutrophication in the wetland. The relatively high BOD also supports the above view. It is likely it may lose its charm and water quality even after having satisfactory condition according to WQI (69) in future. Ramgarh Tal (L3) has experienced high nitrate and phosphate levels in recent years but DO is within permissible limits (with relatively high BOD) and thus vulnerable to eutrophication. Chandola Lake (L4) has experienced satisfactory water quality as per as WQI is concerned (66) but the very high water temperature (mean 29°C) and rapidly decreasing Dissolved Oxygen is a major concern for the wetland.

Hence, all the four wetlands have their own special problems related to their location and natural and anthropogenic factors. Although by overall water quality all the four are satisfactory to good levels but individual parametric analysis gives more accurate problems of the wetlands. Understanding of the wetlands and their quality assessment become increasingly more and more important in the future climatic change scenario, hence more accurate and extensive study of water quality of wetlands is worth requirement.

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