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RESEARCH ARTICLE

WATER QUALITY INDEX OF RANJIT SAGAR WETLAND SITUATED ON THE RAVI RIVER OF INDUS RIVER SYSTEM

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Abstract

Water quality index (WQI) is commonly used for the detection and evaluation of water pollution. Study of physico-chemical parameters of Ranjit Sagar Wetland was carried out from June, 2012 to May, 2014. The various physico-chemical parameters like air temperature, water temperature, electrical conductivity, total dissolved solids, dissolved oxygen, free CO_2, turbidity, pH, alkalinity, salinity, chlorides, total hardness, calcium and magnesium hardness, phosphates, sulphates, nitrates, nitrites and silicates were analyzed on monthly basis. The mean, standard deviation, range, correlation and water quality index of measured parameters were calculated. The mean values were compared with WHO and ISI standards for drinking water quality. The Water Quality Index of Ranjit Sagar Wetland is 66.06. WQI indicated poor quality of water so water of this wetland is not suitable for drinking purposes without prior treatment.

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INTRODUCTION

Wetlands are very important from ecological point of view and constitute a treasury of biodiversity. They are having complex water and land interactive systems and are supposed to be the most fertile and productive sites in the world. Wetlands support a wide array of flora and fauna and deliver many ecological, climatic and societal functions. Due to human civilization, unplanned rapid urbanization and industrialization, aquatic resources are used as dumping grounds for sewage, industrial and technological wastes (Hynes 1960). The decline in water quality affects man, animals and plant life. In India, due to enormous urbanization and industrialization, the problem of water pollution has assumed an alarming situation, and about 70% rivers in India are polluted (Singh and Nautiyal 1990; Trivedy et al. 1990; Kishor et al. 1998). Pollution firstly affects the physicochemical characteristics of the river then systematically destroys the community structure, disturbing the delicate food web and is also hazardous to the public health (Jindal and Sharma, 2011).
Water quality index (WQI) is commonly used for the detection and evaluation of water pollution and may be defined as “A rating reflecting the composite influence of different quality parameters on the overall quality of water” (Mishra and Patel, 2005). Water quality index provide 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. Ranjit Sagar Wetland is situated amidst the Shivalik range of hills which occupies large area and support variety of aquatic organisms. It was observed that this wetland has not been exploited earlier for water quality assessments. The present study is an endeavour in this direction. The water quality index will further strengthen its conservation and management efforts.

MATERIALS AND METHODS

Study area

The Ranjit Sagar wetland is a fresh water ecosystem situated on the river Ravi at 32º26’30”N latitude and 75º43’30”E longitude, at the elevation of 1697 ft. near Pathankot city, Punjab. This wetland falls into three states i.e.

Punjab, Himachal Pradesh and Jammu & Kashmir and spread over an area of 87.60 sq.km and catchment area spread in 6086 sq.km (Fig. 1).

Water samples were collected on monthly basis from June, 2012 to May, 2014. Parameters like air and water temperature, conductivity, total dissolved solid, total alkalinity, salinity, pH, free carbon dioxide and dissolved oxygen were analyzed on the spot with the help of water analysis kit. For the rest of the parameters, water sample was brought to the laboratory for further analysis of turbidity, total hardness, calcium and magnesium hardness, chlorides, nitrites, nitrates, phosphates, sulphates and silicates. Standard methods were adopted to analyze the physico-chemical parameters (Trivedi and Goel, 1984; APHA, 2012).

Calculation of water quality parameters

Weighed 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 various scientists and the calculation of WQI was made by using the following equation (Brown *et al.*, 1972):

$$\mathbf{WQI = \Sigma QiWi / \Sigma Wi}$$

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

$$\mathbf{Qi = 100[(Vi\text{-}Vo/Si\text{-}Vo)]}$$

Where, Vi is estimated concentration of ith parameter in the analyzed water Vo is the ideal value of this parameter in pure water Vo = 0 (except pH = 7.0 and DO=14.6mg/l), Si is the recommended standard value of ith parameter. The unit weight (Wi) for each water quality parameter is calculated by using the following formula:

$$\mathbf{Wi = K/Si}$$

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

$$\mathbf{K = 1 / \Sigma(1/Si)}$$

The water quality index with ranges of 0-24 is excellent, 25-49 is good, 50-74 is poor, 75-100 is very poor and more than 100 is unfit for human consumption.

Statistical analysis

Pearson's correlation coefficient was applied for calculating relationship between various physiochemical parameters of this wetland (Table-4).

RESULTS AND DISCUSSION

Water Quality Index

The results of the physico-chemical parameters for water samples were compared with World Health Organisation (WHO), Indian Standard Institute (ISI) standards for drinking water quality (Table-1). The mean value, range, standard deviation and correlation are given in Table-1 and 4. The value of Water Quality Index of these parameters is 66.06 (Table-2) which shows that water quality of Ranjit Sagar Wetland falls under poor category (Table-3). Matrix of correlation among different parameters is shown in Table-4.

Water Temperature

The water temperature of a wetland is very important, as many of the physical, biological and chemical characteristics of a wetland are directly affected by temperature. Water temperature of this wetland was in the range of 11.9 to 30.93 with mean value of 23.3±6.48 (Table-1). Minimum value of water temperature has been recorded as 11.9^0C in winter and maximum 30.93^0C during summer. Similar observations were also made by Kannan, 1991; Mishra *et al.*, 2008. The temperature variations are associated with wind force, inland water flow, influx of the rainwater and atmospheric temperature (Ramanandhan *et al.*, 1964). Water temperature shows positive relationship with TDS (0.25597), Turbidity (0.41005), Silicates (0.39204) and significant negative relationship with Ca++ (-0.095134), Mg++ (-0.31688), TH (-0.24735) and Phosphates (-0.32156) Table-4. This observation is in close conformity with the findings of Khatoon *et al.* (2013) and Abir (2014).

pH

pH is the concentrations of hydrogen ions (H^+) present in water and is a measure of acidity or alkalinity. Most of the aquatic organisms are very sensitive to pH change and pH can alter various metabolic activities of aquatic organisms. During present investigations the average pH value of this wetland ranged within 7.1-9 with mean value of 8±0.57 (Table-1). The mean value of pH comes within the value prescribed by WHO (6.5-8.5). The high value of pH were recorded in the winter season specially in the month of January, 2013 (9) and low value in the month of April and May, 2014 (7.1) Fig.-5. During the month of January, the water becomes unfit for drinking purposes as value of pH reaches to 9. Similar findings were observed by Wetzel, 1975; Adebisi, 1981; Singh and Ray, 1995 and Kulkarni et al., 2009. pH during the study period shows significant positive relationship with DO (0.63822), Total Alkalinity (0.23047) and significant negative relationship with Free carbon dioxide (-0.34566), TDS (-0.21194), Cl^- (-0.39237) Table-4. Same results were observed by Sen *et al.*, 2011; Khatoon *et al.*, 2013 and Qureshimatva *et al.*, 2015.

Dissolved Oxygen (DO)

The DO test measures the amount of life sustaining oxygen present in the water. Natural waters contain dissolved oxygen concentrations ranging from about 5 to 14.5 mg per litre depending on the water temperature, salinity, and altitude. The DO concentration present in water reflects atmospheric dissolution, as well as autotrophic and heterotrophic processes that respectively, produce and consume oxygen. Thus, dissolved oxygen measurement is vital for maintaining aerobic treatment processes intended to purify domestic and industrial wastewaters (Parmar and Parmar, 2010). During the present study the average DO values ranged from 6.9 to 8.7 mg/l showing mean value of 7.77±0.56 (Table-1). The maximum DO in the water of Ranjit Sagar Wetland was recorded during winters thereafter it started declining gradually and in summers reached the lowest concentration (Fig.-5). The dissolved oxygen is the most important indicator of water quality i.e. polluted water has low level of DO (Gupta *et al.*, 2011; Patil and Gorade, 2013). The maximum DO in winter may be due to low atmospheric temperature and minimum DO in summer may be due to high metabolic rate of organisms (Hazelwood and Parker, 1961; Edmondson, 1965; Tara *et al.*, 2011; Patil and Gorade, 2013). In the present study, DO of Ranjit Sagar wetland shows significant negative correlation with Conductivity (-0.25191), Free Carbon dioxide (-0.29352), TDS (-0.47981), and significant positive relation with pH (0.63822), total alkalinity (0.29502) Table-4. DO show negative correlation with TDS, low value of DO depicts high value of TDS (Ismail, 2007). Joshi *et al.*, 2009; Khatoon *et al.*, 2013 and Abir, 2014 shows similar observations during their study period.

Total Dissolved Solids

TDS is a measure of the solid materials dissolved in the water. This includes salts, some organic materials, and a wide range of other things from nutrients to toxic materials. The amount and nature of dissolved and undissolved matter occurring in liquid materials vary greatly. The presence of synthetic organic chemicals (fuels, detergents, paints, solvents, etc.) imparts objectionable and offensive tastes, odors and colors to fish and aquatic plants even when they are present in low concentrations (Nollet, 2000). In present study, TDS value range from 70 to 200 mg/l showing mean value of 136.75±45.29 (Table-1) which were within the limits of drinking water standards. The limits set by WHO [30] for total dissolved solid is 500 mg/L. The concentration of TDS is high during rainy season, which may be due to addition of solids from runoff water, sewage and industrial effluents to the wetland (Fig.-6). A similar observation was made by Tiwari and Manzoor, (1988); Gupta and Singh, (2000). Total Dissolved Solids during the study period showed significant positive relationship with Ca^{++} (0.30497), salinity (0.27443), TH (0.24958) and significant negative relationship with pH (-0.21194), Alkalinity (-0.5584), DO (-0.47981) Table-4. Similar findings were observed by Bhandari and Nayal, 2008 and Sen *et al.*, 2011.

Total Hardness

Total hardness depends on the amounts of cations like calcium and magnesium present in the waterbody. As per APHA (2012), total hardness was ideally range from 0-30 soft, 30-60 moderate soft, 60 -120 moderate hard, 120-180 hard and greater than 180 very hard. In the present study total hardness ranged between 64-228 with mean value of 113.47±47.73 (Table-1). The limit of drinking water is setup to 500mg/L by WHO, therefore total hardness of the water body is suitable for use as potable water. Similar observations were made by Khadade and Mule (2003). Elevation of calcium and magnesium hardness is due to the addition sewage, detergents and large scale human use (Mohanta and Patra, 2000). During present investigations, it was observed that, total hardness of the wetland is maximum in the winter, medium in summer and minimum in monsoon season (Fig.-6). Barot and Patel (2014) have made similar observation on Physicochemical Properties of Selected Wetlands of Mehsana Districts, North Gujarat. Total Hardness during the study period shows significant positive relationship with Mg^{++} (0.89205), Cl^- (0.4894), Ca^{++} (0.92906) and significant negative relationship with DO (-0.04842), pH (-0.28478), Turbidity (-0.37741) Table-4. Similar results were observed by Bhandari and Nayal, 2008; Joshi *et al.*, 2009; Khatoon *et al.*, 2013 and Abir, 2014.

Chloride

Chloride is one of the most important inorganic anion in water. Due to its high solubility it is present naturally in all types of waterbody. The main source of chloride in water is the domestic sewage discharge. The concentration of chloride in freshwater is an indicator of sewage pollution (Wetzel, 1966; Trivedy and Goel, 1984). In present study values of chloride range from 2.98-24.85 (Table-1). So, chloride content of the sample was found within the permissible limit of 250mg/l set by WHO. High chlorides were recorded during summer season as compared to monsoon and winter (Fig.-6). Similar observations were made by Mishra *et al.,* 2008 and Arya *et al.,* 2011. Chloride shows significant positive relationship with Ca^{++} (0.46357), Mg^{++} (0.5091), salinity (0.32101), TH (0.4894) and significant negative relationship with DO (-0.14613), pH (-0.39237), alkalinity (-0.16684) Table-4. Similar results were observed by Bhandari and Nayal, 2008 and Khatoon *et al.,* 2013.

Electrical Conductivity (EC)

Electrical conductivity is the capacity of water to conduct the electric current. This is due to the presence of cation and anion in the water. During the present course of work, the value of EC range from 124-340 µs/cm with average value of 210.25±62.60 (Table-1). EC is high during the summer season and low in the monsoon and winter season (Fig.-6). Similar findings were observed by Kedar *et al.*, 2007 and Rao *et al.*, 1990. In the present study EC showed significant positive correlation with turbidity (0.38901), TDS (0.54455), Total Hardness (0.12925) whereas EC showed negative correlation with Sulphates (-0.20782), DO (-0.25191), Total Aalkalinity (-0.23893) and Phosphates (-0.28562) Table-4. Khatoon *et al.*, 2013; Prasad *et al.*, 2014 and Abir, 2014 were observed similar results.

Total Alkalinity

Alkalinity is the acid neutralizing capacity of water. Natural alkalinity of water depends mainly on salts of weak acids such as bicarbonates, carbonates, borates, silicates, phosphates and the salts of humic and fulvic acids (Budhlani *et al.*, 2014). Total alkalinity help to maintain the pH of the waterbody. Total alkalinity of this wetland ranges from 12-284 and average value is 114.43±72.18 (Table-1). The highest value of alkalinity shows in the winter season and lowest in the summer season. Total Alkalinity during the study period shows significant positive relationship with pH (0.23047), DO (0.29502) and significant negative relationship with TDS (-0.5584), Ca++ (-0.046349), silicates (-0.32743) Table-4. Similar observations were reported by Dhembare, 2011; Abir, 2014 and Khatoon *et al.*, 2013.

Calcium Hardness

Calcium is an essential nutrient for aquatic organisms and regulates physiological functions. It is very common in all water bodies (Chourasia and Adoni, 1985). The limit of calcium hardness was range from 0-20 soft, 20-40 moderate soft, 40-80 moderate hard, 80-120 hard and greater than 120 very hard (APHA, 2012). During present investigation calcium hardness of this wetland range from 12.61-60.55 with average value 26.65±11.16 (Table-1). The values shows water of this wetland fluctuate soft to moderate hard this is due to the seasonal variations. The calcium hardness is minimum in summer and maximum in winter (Fig.-3). Calcium hardness during the study period shows significant positive relationship with Mg++ (0.70923), Total Hardness (0.92906) Cl- (0.46357) and significant negative relationship with turbidity (-0.40472), pH (-0.24618) Table-4. Many organism use calcium as a structural or skeletal material. Similar findings were observed by Ismail, 2007 and Joshi *et al.*, 2009.

Magnesium Hardness

The magnesium is very important element for enzyme activation, growth of chlorophyll and phytoplankton. The main source of Mg^{++} is sewage inflows and minerals generate from soil erosion (Das and Shrivastva, 2003; Ramesh and Seetha, 2013). When the rainfall is high it depletes the magnesium quantity in water (Shastri, 2000). The value of magnesium range from 1.3-25.4 and average value is 10.84±6.40 (Table-1). The highest value of magnesium shows during the winter season and lowest in the summer season (Fig.-3). Similar observation has been reported by Brraich and Kaur, 2015. Mg^{++} hardness during the study period shows significant positive relationship with Ca^{++} (0.70923), Cl^- (0.5091) and significant negative relationship with turbidity (-0.42642), Water Temperature (-0.31688), TDS (-0.38885), silicates (-0.39883), pH (-0.31354) Table-4. Magnesium serves mainly as a transition metal in the chlorophyll molecule and play important role in algal photosynthesis Bhandari and Nayal, 2008: Joshi *et al.*, 2009).

Phosphate

Phosphate acts as an important regulating factor for productivity of water body. Only few sources of phosphate that occur naturally, major sources of their presence in water body are domestic waste, detergent and agricultural run-off containing fertilizer (Gopalkrusna, 2011). During the study period phosphate range from 0.09-2.163 with average value of 0.33±0.48 (Table-1). The mean value suggest that it rarely occur in high concentration in water as it is actively taken up by plants. High concentration indicates the presence of pollution and highly responsible for eutrophic condition (WHO, 1998). Similar observations were also made by Barot and Patel, 2014. In the present investigation phosphate showed significant positive correlation with free carbon dioxide (0.63499), salinity (0.46495), Cl^- (0.34529) and significant negtive correlation with water temperature (-0.32156), DO (-0.50917), pH (-0.37384) Table-4. Similar observations were given by Joshi *et al.*, 2009 and Abir, 2014.

Nitrate and Nitrites

The most stable form of nitrogen is nitrate. Nitrates and nitrites are naturally ions that are the part of nitrogen cycle. Nitrate ions are undesirable in water because they can cause methaemoglobinaemia in infants less than 6 month old (Egereonu and Nwachukwu, 2005). High nitrate concentration can result in excess algal blooms in water body.

Principle sources of nitrates is fertilizers, decayed vegetables and animal matter. During the present course of work value of nitrate and nitrites range from 0.045-1.78 and 0.01-0.24 with average value of 0.37±0.50 and 0.07±0.05 respectively (Table-1).

Sulphates

Sulphates naturally present in surface waterbody in the form of SO_4^{2-}. The main source is industrial discharge but atmospheric precipitation also add significant amount of sulphate in the surface water (Ikomi and Emuh, 2000). During study period value of sulphates range from 0.5 to 3.9 with average value of 1.75±0.82 Table-1. The values of sulphates shows significant positive relationship with DO (0.29744), pH (0.28199) and significant negative relationship with conductivity (-0.20782), salinity (-0.21373), Total Hardness (-0.26813) Table-4. Similar results were reported by Sen *et al.*, 2011.

Table-:1. Showing Range, Mean and Standard Deviation of different parameters from June, 2012 to May, 2014 at Ranjit Sagar Wetland.

Parameters	Mean	S.D	Range	WHO	ISI
Air Temperature(^{0} C)	27.32	7.56	12-40	-	-
Water Temperature(^{0} C)	23.3	6.48	11.9-30.93	-	-
Conductivity(µs/cm)	210.25	62.60	124-340	600	-
TDS(mg/l)	136.75	45.29	70-200	500	500
Turbidity(NTU)	7.69	7.50	1.5-21.5	-	10
Dissolved Oxygen(mg/l)	7.77	0.56	6.9-8.7	5.0	-
Free CO_2 (mg/l)	5.15	2.10	2-10	-	-
pH	8.00	0.57	7.1-9	6.5-8.5	6.5-8.5
Alkalinity(mg/l)	114.43	72.18	12-284	120	200
Salinity(mg/l)	129.16	46.43	100-200	500	-
Chlorides(mg/l)	13.54	6.35	2.98-24.85	250	250
Total Hardness(mg/l)	113.47	47.73	64-228	500	300
Ca++ Hardness(mg/l)	26.65	11.16	12.61-60.55	75	75
Mg++ Hardness(mg/l)	10.84	6.40	1.3-25.4	30	30
Phosphates(mg/l)	0.33	0.48	0.09-2.163	1.00	-
Sulphates(mg/l)	1.75	0.82	0.5-3.9	500	-
Nitrates(mg/l)	0.37	0.50	0.045-1.78	10	-
Nitrites(mg/l)	0.07	0.05	0.01-0.24	-	-
Silicates(mg/l)	6.4	1.96	2.15-9.5	-	-

Table-:2. Calculation for Water Quality Index during June, 2012 to May, 2014 of Ranjit Sagar Wetland.

Parameter	Observed value	Standard value	Unit Weight (Wi)	Quality Rating (Qi)	WiQi
TDS(mg/l)	136.75	500	0.002	27.35	0.054
Dissolved Oxygen(mg/l)	7.77	5	0.244	71.14	17.35
pH	8.00	6.5-8.5	0.163	200	32.6
Alkalinity(mg/l)	114.43	120	0.010	95.35	0.953
Salinity(mg/l)	129.16	500	0.002	25.83	0.057
Chlorides(mg/l)	13.54	250	0.004	5.41	0.021
Total Hardness(mg/l)	113.47	500	0.002	22.69	0.045
Ca++ Hardness(mg/l)	26.65	75	0.016	35.53	0.568
Mg++Hardness(mg/l)	10.84	30	0.040	36.13	1.445
Sulphates(mg/l)	1.75	500	0.002	0.35	0.0007
Nitrates(mg/l)	0.37	10	0.122	3.7	0.451
			∑Wi=0.829		**∑WiQi=54.87**

$$\mathbf{WQI = \sum WiQi / \sum Wi = 66.18}$$

Table-:3. Water Quality Index and status of water quality (Chatterji and Raziuddin, 2002).

WQI	**Water Quality Rating**
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
>100	Unfit for drinking purpose

Table-:4. Correlation matrix among the different physico-chemical parameter of Ranjit Sagar Wetland.

ameters	Air Temperature(^{0} C)	Water Temperature(^{0} C)	Conductivity(µs/cm)	TDS (mg/l)	Turbidity (NTU)	Dissolved Oxygen (mg/l)	Free CO_2 (mg/l)	pH	Alkalinity (mg/l)	Salinity (mg/l)	Chlorides (mg/l)	Total Hardness (mg/l)	Ca++ Hardness (mg/l)	Mg++ Hardness (mg/l)	Phosphates (mg/l)	Sulphates (mg/l)	Nitrates (mg/l)	Nitrite (mg/l
Air nperat (^{0} C)	1																	
ater nperat (^{0} C)	0.90615	1																
nducti y(µs/c m)	-0.09915	0.014301	1															
S(mg/l)	0.14908	0.25597	0.54455	1														
bidity TU)	0.28089	0.41005	0.38901	0.19721	1													
solved ygen ng/l)	0.13759	0.11194	-0.25191	-0.47981	0.050356	1												
e CO_2 ng/l)	-0.15774	-0.20762	-0.28416	-0.004635	-0.28602	-0.29352	1											
pH	-0.29196	-0.15383	0.083552	-0.21194	0.32642	0.63822	-0.34566	1										
alinity ng/l)	-0.32426	-0.35618	-0.23893	-0.5584	-0.19256	0.29502	-0.15137	0.23047	1									
inity ng/l)	-0.11106	-0.089693	0.042252	0.27443	-0.14319	-0.30862	0.37867	-0.30587	-0.2712	1								
orides ng/l)	0.038298	-0.0099931	-0.036539	0.24167	-0.16231	-0.14613	0.37645	-0.39237	-0.16684	0.26086	1							
otal dness ng/l)	-0.095446	-0.24735	0.12925	0.24958	-0.37741	-0.048422	0.29434	-0.28478	-0.010993	0.32101	0.4894	1						
a++ dness ng/l)	-0.095134	-0.18681	0.12193	0.30497	-0.40472	-0.023892	0.25823	-0.24618	-0.046349	0.36026	0.46357	0.92906	1					
g++ dness ng/l)	-0.094874	-0.31688	-0.073087	0.04263	-0.42642	-0.0069675	0.33256	-0.31354	0.069293	0.15241	0.5091	0.89205	0.70923	1				
sphat es ng/l)	-0.33523	-0.32156	-0.28562	-0.14671	-0.27119	-0.50917	0.63499	-0.37384	0.011172	0.46495	0.34529	0.099651	0.10741	0.11665	1			
phates ng/l)	-0.16861	-0.090135	-0.20782	-0.055445	0.0702	0.29744	-0.039501	0.28199	-0.019105	-0.21373	-0.072572	-0.26813	-0.33592	-0.057554	-0.24265	1		
rates ng/l)	0.3467	0.026375	-0.15981	-0.23151	-0.069103	0.061192	-0.16113	-0.2319	0.0076265	-0.044513	-0.035386	-0.13671	-0.16024	-0.017307	-0.14832	-0.13309	1	
rites(g/l)	0.06768	-0.27537	-0.24376	-0.15813	-0.35409	0.028395	0.11326	-0.36104	0.053328	0.073597	0.28267	0.41008	0.26137	0.55997	0.080898	-0.090464	0.53583	1
cates g/l)	0.10975	0.39204	0.17942	0.30968	0.18033	-0.0030143	-0.17005	0.19975	-0.32743	-0.19249	-0.015074	-0.22284	-0.11589	-0.39883	-0.13089	-0.045079	-0.51688	-0.4240

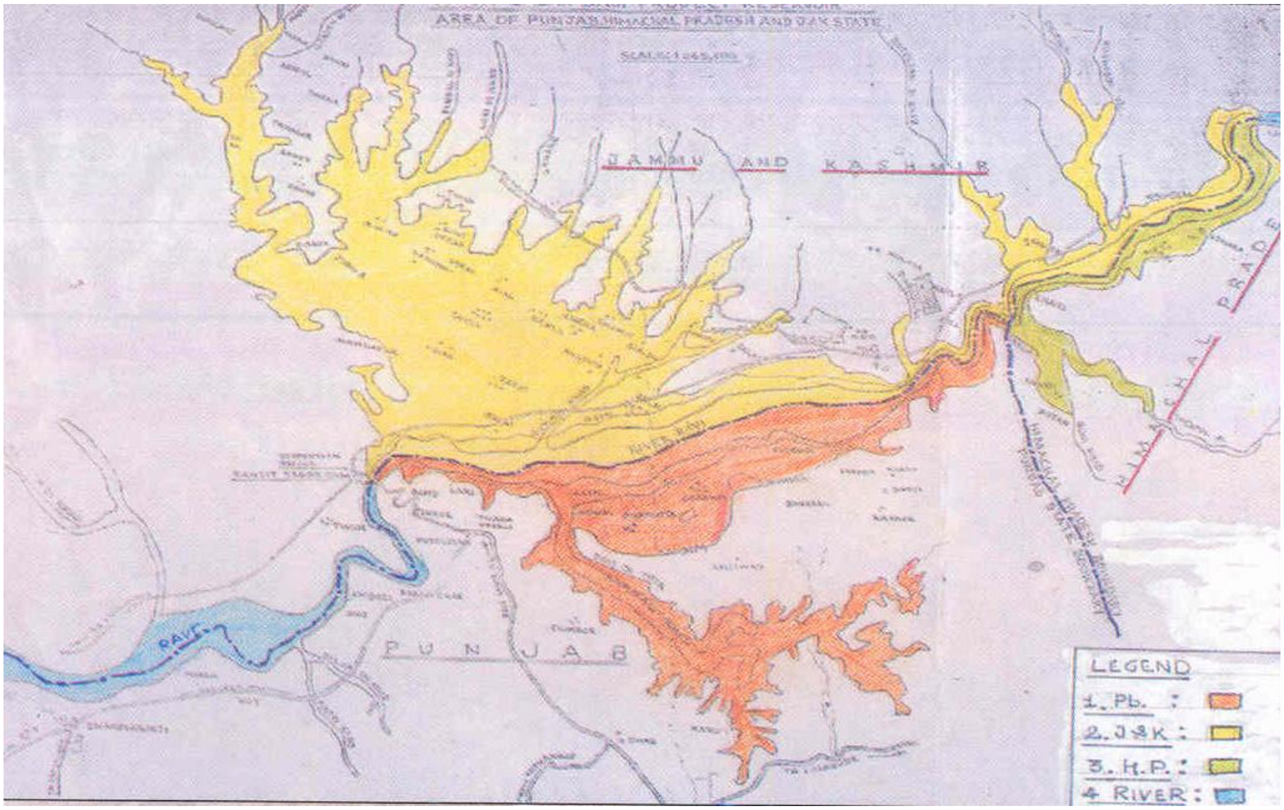

Fig.: 1. View of Ranjit Sagar Wetland

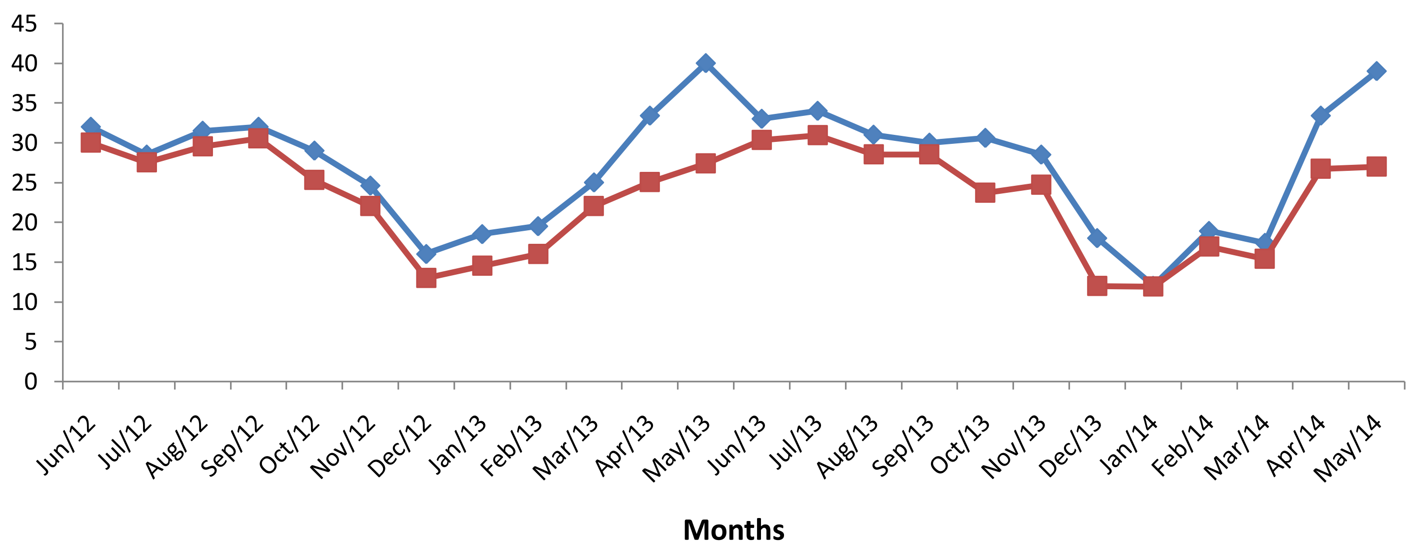

Fig. 2: Graphical representation of Air Temperature (°C) and Water Temperature of different sites at Ranjit Sagar Wetland.

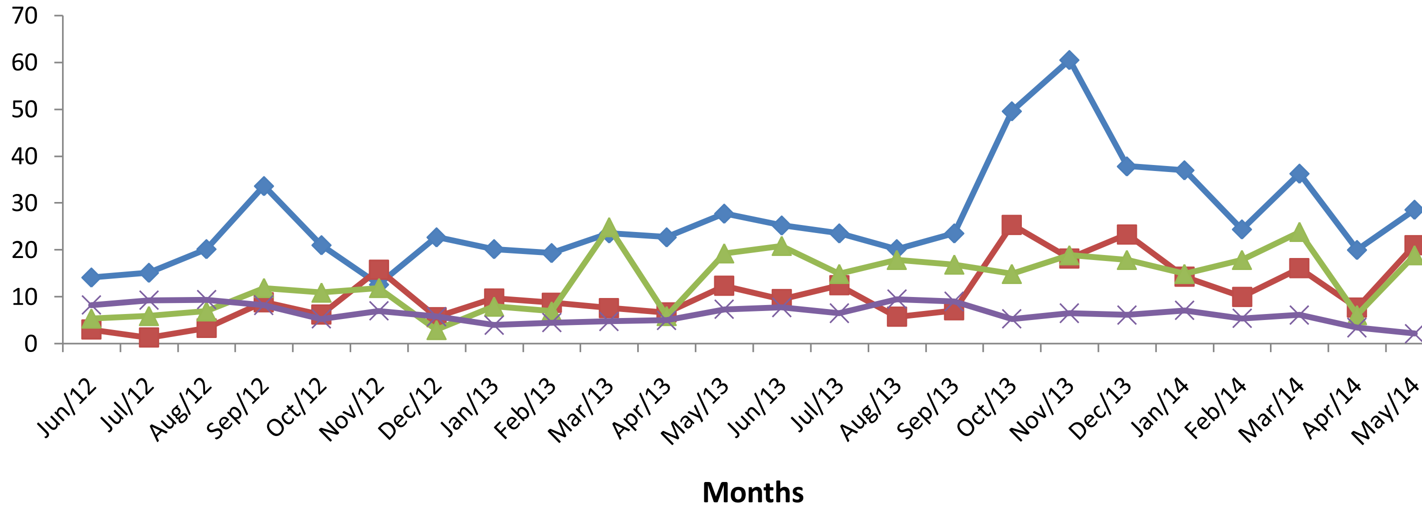

Fig. 3: Graphical representation of Ca^{++}, Mg^{++}, Chlorides and Silicates at Ranjit Sagar Wetland.

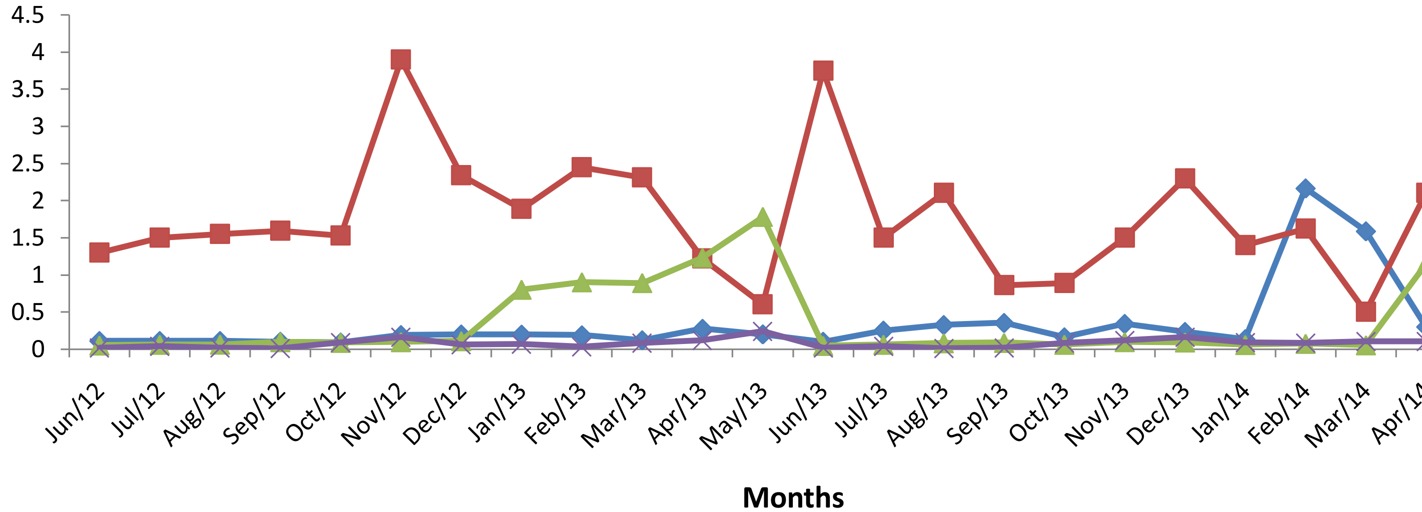

Fig. 4: Graphical representation of Phosphates, Sulphates, Nitrates and Nitrites at Ranjit Sagar Wetland

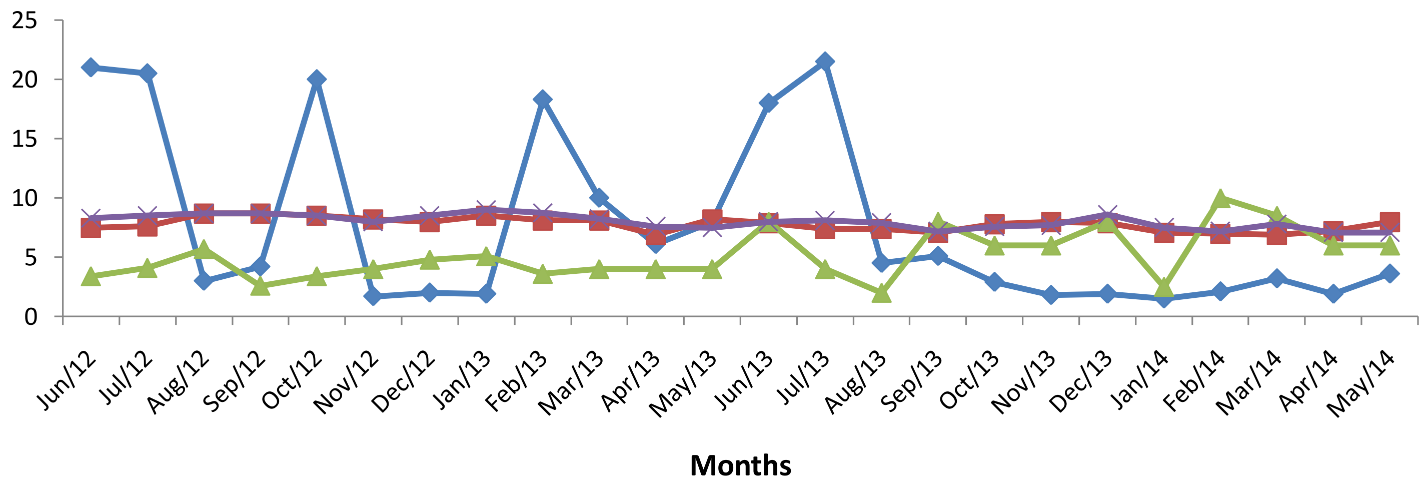

Fig. 5: Graphical representation of Turbidity, DO, Free CO_2 and pH at Ranjit Sagar Wetland.

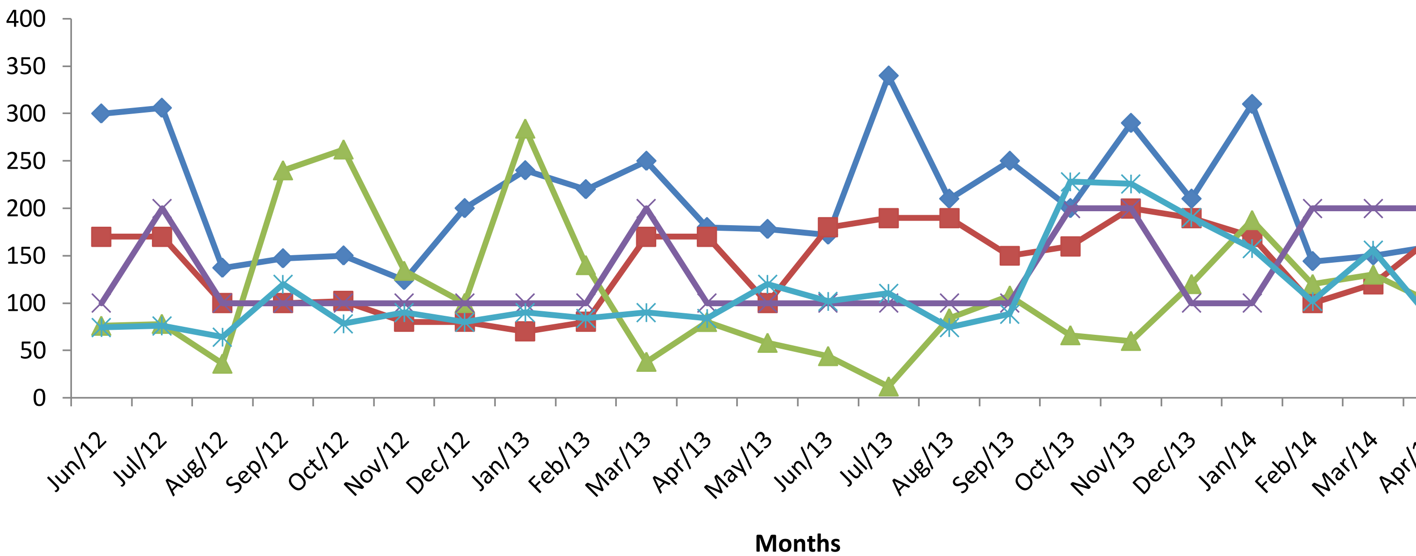

Fig. 6: Graphical representation of Conductivity, TDS, Alkalinity, Salinity and Total Hardness at Ranjit Sagar Wetland

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