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Physico-Chemical Assessment of Water Quality and its Effects on Marsh Crocodiles, *Crocodylus palustris* Population in Haleji Lake Wildlife Sanctuary, Thatta, Sindh, Pakistan

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Abstract: Present study was carried out in Haleji Lake Wildlife Sanctuary (240' 48" N, 600' 47" E) Thatta, Sindh, Pakistan from January to December 2009. Evaluation of physico-chemical quality of water such as: temperature (air and water), pH, electrical conductivity, total dissolved solids, turbidity, calcium, magnesium, bi-carbonate, chloride, sodium, potassium, sulphur, carbonate, biological oxygen demand and dissolved oxygen were compared with the recognized standards of world health organization and their impacts on Marsh Crocodiles. It was examined that the level of EC, Turb, Hard, K and HCO_3 was higher and Lake water suggest that the current population is threatened. While pH, TDS, Ca, Mg, Alkal, Cl, Na, SO_4, As, BOD and DO values were in tolerable range. We analyzed our data with mean ± SD (Standard Deviation). Marsh Crocodile is considered vulnerable and threatened in Pakistan due to hunting pressure, alteration of habitat and poor water quality in the last decades. The current studies witnessed that the quality of lake water was changing as a result of discharge of untreated wastes from industries. Due to poor water quality of Haleji Lake which may pose problems to Crocodile population.

Keywords: Marsh Crocodiles, Contamination, Vulnerable, Hazard, Threats

1. INTRODUCTION

The Marsh Crocodile is considered as one of the vulnerable and threatened reptilian species of Pakistan. The crocodilian species of Marsh Crocodile, *Crocodylus palustris* is categorized as nationally "Vulnerable" subsequent to an assessment under the IUCN criteria for the threatened species as cited by Singh *et al.,* (1980) and has received the highest legal protection in Pakistan as it is listed in the Schedule I of the Pakistan Wildlife Protection Act (1972). After the decades of 1970, while the *C. palustris* population in Pakistan was reported declining including Sindh province due to hunting pressure, habitat degradation and illegal fishing practices as cited by Chang *et al.,* (2013a, 2013b, 2013c). Haleji Lake is considered as an important refuge for wintering and an ideal home of thousands of birds and regarded as one of the most appropriate wintering area for migratory waterfowl in Eurasia as cited by Chang *et al.,* 2013d. HLWS (Haleji Lake Wildlife Sanctuary) is located at distance of 88 km away from Karachi. The Lake Haleji was constructed and store seasonal water, collecting water in a depression as cited by Chang *et al.,* (2013d). HLWS has an area of 12 miles complete circuit and water reservoir covers an area of about 6.58 Square miles and it has the maximum depth recorded more than 6 meters. The area and depth of HLWS was reported variable and depending upon the influx of rain water and canal water as cited by Chang *et al.,* (2013d).

In this wetland there are more than 223 avian species have been recorded in the environs of Lake as cited by Chang *et al.,* (2013d). The Government of Sindh first declared it as a wildlife Sanctuary than declared it as a Ramsar site and received legal protection to preserve and conserve the biodiversity. In HLWS, the most important species of aquatic ecosystem and vulnerable species of reptilian, the Marsh Crocodile is also living. Incessant practices of industrial and agricultural effluents are used as irrigation water, chemical pollutants such as heavy metals can accumulate in the soil and crops and due to these practices aquatic as well as humans are distress. When people using the contaminated irrigation water which cause an infection with the intestinal helminthes as cited by Khuhawar *et al.,* (1999).

The current studies focused on physico-chemical characteristics of Lake water and its effects on biodiversity of wetland including Marsh Crocodile population.

2. MATERIALS AND METHODS

For the examination of physico-chemical parameters, water samples were collected randomly from three sampling stations from the upstream, midstream and downstream to effluent discharge point at Haleji Lake. Water were collected from the S1 Haleji Lake upstream, S2 Haleji Lake Midstream and S3 Haleji Lake captive farm downstream in every month of January to December 2009 **(Table 2).** We collected the samples randomly from the layers of upper surface and bottom and kept in Van Don Plastic bottles (1.5). The samplings were collected for the estimation of the level of pollution before and after the mixing of effluents in lake water. We kept them in polythene plastic bottles which were soaked previously in 10% nitric acid for 24 hours and rinsed with ultrapure water from lab water system. In laboratory, we mixed them in acid washed bucket to make one composite sample than rinsed with

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ultrapure water at 4°C temperature till for further examination. Assessment were carried out through the standardization methods of water analysis (APHA, 2005). Sampling of water was usually carried out from 11:00 am to 5:00 pm at monthly intervals. Water temperature was analyzed with the help of mercury thermometer and dipped into water for 2-5 minutes at 15 cm depth. The value of pH examined with ORION Model 420 (pH meter) and EC, TDS, and Na were examined with WTW 320 (Conductivity meter). The values of alkalinity, hardness, Cl and phosphates were analyzed with the standard methods of APPHA, (2205). For the assessment of Ca, HCO_3, CO_3, the standardized titration method (2310) was applied. The Mg was analyzed with the help of Atomic Absorption Spectrophotometry (Dissolved 0.829 g of magnesium oxide, MgO; analytical reagent grade), in 10 ml of redistilled NHO3 and dilute to 1 liter with deionized distilled water 1ml = 0.50 mg (500 mg/l). The K was measured with the help of tetraphenylborate method. The insolubility of K compound used to determine the concentration of potassium ions by precipitation and gravimetric analysis. The compound adopts a polymeric structure with bonds between the phenyl rings and potassium. We examined Arsenic (As) with Atomic Absorption Spectrometry (AAS) and Graphite Furnace Atomic absorption (GFAA). BOD was examined with Winkler method and DO was examined with Oxygen meter (Jenway Model 9071).

3. RESULTS

The observed parameters of water and soil of the Haleji Lake are suitable for aquatic fauna and vital activities of *Crocodylus palustris* except EC, Turb, Hard, K and HCO_3.

The results of physico-chemical assessment of parameters were collected from the Haleji Lake (Table 2).

3.1. Temperature (Air & Water) °C: We observed the highest temperature of air was 38.33 ± 0.94 °C (Mean ± SD) during the month of July and lowest was observed 20 ± 0.81 °C during the month of December (Table 2). The temperature of water was observed the highest 34.33 ± 0.94 °C during the month of July and lowest was observed 17.67 ± 0.47 °C during the month of December (Table 2).

3.2. pH: The highest level of pH was recorded 7.56 ± 0.12 during the month of December and lowest level was recorded 7.03 ± 0.04 during the month of June, respectively (Table 2).

3.3. Electrical Conductivity: The highest level of EC was observed 746.33 ± 12.65 uS/cm during the month of March and lowest level was observed 604 ± 8.64 uS/cm during the month of November (Table 2). However, in Lake fluctuation was observed in water samples due to the flow of rain water.

3.4. Total Dissolved Solids: We examined the highest level of TDS was 481 ± 8.17 mg/l in March and lowest level was examined 386.67 ± 5.55 mg/l in November (Table 2).

3.5. Turbidity: Highest level of turbidity was observed 30 ± 3.26 NTU during the month of January and lowest level 15 ± 1.58 NTU was observed during the month of April (Table 2).

3.6. Calcium: The highest level of calcium was recorded 55.33 ± 2.49 mg/l during the month of March and lowest was 21.33 ± 1.63 mg/l observed in November (Table 2).

3.7. Magnesium: The highest level of magnesium was recorded 33.66 ± 0.47 mg/l during the month of March and lowest level 22.67 ± 0.94 mg/l was recorded during the month of January (Table 2).

3.8. Hardness: The highest level of hardness was observed 276.66 ± 4.71 mg/l during the month of March and lowest level 160 ± 8.16 mg/l was observed during the month of June (Table 2).

3.9. Bicarbonate: The highest level of bicarbonate was observed 488.33 ± 8.17 ppm during the month of January and lowest was observed 92.67 ± 7.36 ppm during the month of November (Table 2).

3.10. Alkalinity: We observed the highest range of alkalinity was 3.1 ± 0.24 mg/l in January and lowest was observed 1.96 ± 0.04 mg/l in October (Table 2).

3.11. Chloride: The highest level of chloride was observed 131.67 ± 3.29 mg/l during the month of March and lowest level observed 61.67 ± 5.24 mg/l was observed during the month of July (Table 2).

3.12. Sodium: The highest level of sodium was observed 74 ± 3.74 g/l during the month of May and lowest level 42 ± 3.26 g/l was observed during the month of February (Table 2).

3.13. Potassium: The highest level of potassium was recorded 12.67 ± 1.24 mg/l in August and lowest range was 5.67 ± 0.94 mg/l was recorded during the month of January (Table 2).

3.14. Sulphate: The highest level of Sulphate was observed 117.67 ± 2.49 mg/l during the month of September and lowest level 67 ± 5.35 mg/l was observed during the month of February (Table 2).

3.15. Arsenic: The concentration of arsenic was not observed in Lake water during the research study (Table 2).

3.16. Carbonate: We did not examine the carbonate concentration during our research study (Table 2).

3.17. Biological Oxygen Demand: The highest range of BOD was examines 4.37 ± 0.24 mg/l in January and lowest range was examined 3.1 ± 0.08 mg/l in December (Table 2).

3.18. Dissolved oxygen: The highest level of DO was observed 6.33 ± 0.12 mg/l during the month of November and lowest level 4.3 ± 0.21 mg/l was observed during the month of October **(Table 2).**

4. DISCUSSION

It was observed that the Crocodile population is threatened in low water quality (Joshi *et al.*, 2001). Elasticity of snout and hunch back conditions were occurring due to the higher amount of calcium (Singh *et al.*, 2001). In dry season when the low level of water without replacement of Lake water is another cause of bacterial infection in hatchling of Crocodiles (Misra *et al.,* 1993). The polluted water and extreme humidity in monsoon causes few mycotic infection and death of hatchlings Crocodiles (Lal, 1982; Maskey, 1989).

In present study we observed that the range of hardness in water samples was estimated higher from the above guidelines given by WHO (WHO, 2004). The level of salinity and magnesium concentration was reported in acceptable limit while the concentration of EC was higher **(Table 2),** which indicates that the contamination and waste particles added into the lake water. The concentration of TDS was reported in acceptable level from 386.67 to 481 mg/l. The concentration of chloride was observed 61.67 to 131.67 mg/l in acceptable level in the lake water.

However, we examined the some parameters such as EC, Turb, Hard, K (only August and September little higher) and HCO_3 were exceed the permissible range (Table 2). When the concentration of DO level decreased below 5 mg/l which causes the mortality of fish as cited by Sahato (2004). The most favorable level of DO for healthy growth of fish and aquatic life in water is considered 4-5 mg/l as cited by Jafri (1997). The seasonal flooding and heavy rain that can damage the nesting and destroy the eggs of Crocodiles in their habitats (Kannan *et al.,* 2005; Mara and Cairncross, 1998; Santiapillai and de Silva, 2001). It was witnessed that the industrialization and urbanization are increasingly growing in the last decades becoming the key factors of pollution and alteration of the water resources, affecting the both types of variables: physico-chemical parameters and biota but also due to seasonal fluctuations in flow and temperature (Barbu *et al.,* 2012; Caldararu *et al.,* 2013; Chapman, 1996; Jaji *et al.,* 2007; Qureshi and Bhatti, 2008.

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Table 2. Over all mean ± SD of the Parameters of the Water Analysis

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp: air	20.33 ± 1.24	21 ± 0.81	23 ± 0.81	27.66 ± 0.47	28.33 ± 0.94	37.33 ± 0.47	38.33 ± 0.94	27.66 ± 0.47	26 ± 0.81	25 ± 0.81	26 ± 0.81	20 ± 0.81
Tem: H_2O	18 ± 0.81	18 ± 0.81	20 ± 0.81	24.66 ± 0.47	25.33 ± 0.94	33.33 ± 0.47	34.33 ± 0.94	24.66 ± 0.47	23 ± 0.81	22.33 ± 0.81	22 ± 0.81	17.67 ± 0.47
pH	7.4 ± 0.08	7.16 ± 0.04	7.6 ± 0.08	7.40 ± 0.21	7.29 ± 0.09	7.03 ± 0.04	7.36 ± 0.12	7.11 ± 0.08	7.2 ± 0.18	7.41 ± 0.16	7.5 ± 0.08	7.56 ± 0.12
EC	695.33 ± 11.67	703 ± 9.89	746.33 ±12.65	721.66 ±4.92	715.33 ±3.68	616.33 ± 26.33	619.67 ± 25.36	675.67 ±29.39	709.67 ± 19.39	635 ± 7.25	604 ± 8.64	626.33 ±30.02
TDS	445 ± 7.48	450 ± 6.16	481 ± 8.17	461.6 ± 3.29	443 ± 2.44	394 ±16.87	396.67 ±16.53	432.67 ± 18.78	454.33 ± 12.55	406.33 ±4.78	386.67 ± 5.55	400.67 ±19.15
Turb	30 ± 3.26	15.33 ± 2.05	13.43 ± 0.65	15 ± 1.58	16.26 ± 2.66	23 ± 0.81	17.97 ± 2.46	17.66 ± 2.49	16.63 ± 1.66	17.53 ± 1.66	16.86 ± 0.49	20.2 ± 2.78
Ca	45.33 ± 1.88	52.66 ± 2.49	55.33 ± 2.49	32.66 ± 0.94	29.33 ± 0.94	24.67 ± 2.49	25.67 ± 1.88	24.67 ± 1.88	30 ± 2.82	21.33 ± 1.88	24 ± 1.63	26.67 ± 2.49
Mg	22.67 ± 0.94	29 ± 0.81	33.66 ± 0.47	26.67 ± 0.94	29.67 ± 0.47	23.67 ± 1.69	25.67 ± 1.88	28.67 ± 0.94	32.67 ± 1.88	29.67 ± 3.77	25.33 ± 0.94	26.67 ± 1.88
Hard	206.67 ± 4.71	253.33 ± 4.71	276.66 ± 4.71	193.33 ± 4.71	196.67 ± 4.71	160 ± 8.16	170 ± 8.16	180 ± 8.16	226.67 ± 30.91	170 ± 8.16	163.3 ± 4.71	176.6 ±12.47
HCO_3	488.3 ± 467.87	117.33 ± 2.86	100 ± 4.08	113.33 ± 4.71	116.67 ± 4.71	106.67 ±4.71	100 ± 4.08	111.66 ± 2.35	113.33 ± 4.71	98.33 ± 2.35	92.67 ± 7.36	116.67 ±13.12
Alkal	3.1 ± 0.24	2.5 ± 0.16	2 ± 0.08	2.27 ± 0.09	2.67 ± 0.09	2.13 ± 0.09	2 ± 0.08	2.23 ± 0.04	2.26 ± 0.09	1.96 ± 0.04	2.36 ± 0.41	2.4 ± 0.35
Cl	96 ± 9.93	125 ± 3.29	131.67 ±3.29	78.67 ± 0.94	80.67 ± 0.94	63.33 ± 4.92	61.67 ± 5.24	72 ± 1.41	79 ± 4.54	73 ± 1.41	65 ± 4.32	66.67 ± 3.68
Na	68.67 ± 2.05	42 ± 3.26	37.66 ± 1.69	73 ± 1.63	74 ± 3.74	61 ± 3.26	58 ± 0.81	64.67 ± 2.86	61 ± 2.44	60.33 ± 1.69	55.67 ± 2.05	60.33 ± 1.69
K	5.67 ± 0.94	10 ± 0.81	8.66 ± 0.94	11.33 ± 1.24	10.33 ± 0.47	8.33 ± 0.47	8.33 ± 0.47	12.67 ± 1.24	12.33 ± 2.05	10 ± 0.81	10.33 ± 0.47	11.33 ± 1.69
SO_4	72 ± 2.44	67 ± 5.35	81.66 ± 3.29	116.33 ± 2.05	114.67 ± 2.86	109.67 ±8.99	97.67 ± 8.05	114.67 ± 8.17	117.67 ± 2.49	96.33 ± 1.69	108 ± 4.08	113.33 ±14.42
As	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
HCO	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
BOD	4.37 ± 0.24	4.23 ± 0.20	3.5 ± 0.24	3.4 ± 0.16	3.2 ± 0.08	3.23 ± 0.12	3.26 ± 0.20	3.13 ± 0.12	3.33 ± 0.26	3.16 ± 0.16	3.36 ± 0.12	3.1 ± 0.08
DO	4.5 ± 0.24	5.23 ± 0.12	6.2 ± 0.08	5.26 ± 0.16	5.36 ± 0.24	6.13 ± 0.12	6.2 ± 0.08	4.5 ± 0.28	4.5 ± 0.16	4.3 ± 0.21	6.33 ± 0.16	6.3 ± 0.08

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