

Physico-chemical assessment and ecological impacts on Marsh Crocodiles in protected areas of Nara Thar Desert Khairpur

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Abstract. Limnological studies of Nara Thar Desert Khairpur were carried out bimonthly January to November 2008. In water samples the determination of microbial contamination, detection of pollutant indicator organisms and hazard chemicals were performed. The present study deals with the physico-chemical parameters such as temperature of water and air, electrical conductivity, total dissolved solids, calcium, magnesium, bi carbonate, chloride, sodium, potassium, sulphur, carbonate, biological oxygen demand and dissolved oxygen were performed with the recognized standard method of world health organization. During present study various contaminants were observed below the detection range while other chemicals were found within the normal range. It was witnessed during the water analysis the range of contamination, proximity of pollution sources and water quality of lakes suggest that the crocodilian population is at high risk and in under threatened in the lakes of Nara Thar Desert except in Nara canal.

Key words: limnological, contamination, hazard, pollution, chemicals, threatened.

Introduction

Nara Thar Desert (NTD) Khairpur was declared in 1980 as Wildlife Sanctuary by the Government of Sindh and it was established for the protection and enhancement of wildlife in this protected areas of Sindh. NTD which provides a home to large numbers of migratory birds, mammals, reptiles including Marsh Crocodiles. In NTD there are more than 200 small, permanent, seasonal, freshwater, brackish, marshy and saline lakes. The Nara Canal twitches from the Sukkur barrage which run more than 200 km, the major source of cultivation and drinking in the large areas of Sukkur, Khairpur, Sanghar, Umarmkot and Mirpurkhas districts. In the last decades, the large numbers of Marsh Crocodile (*Crocodylus palustris*) and Gavials (*Gavialis gangeticus*) live co-existed in the Nara Thar Desert but unfortunately due to the increasing human population, hunting pressure and other anthropogenic activities the unique crocodilian species of Pakistan were extinct now.

In aquatic habitat various environmental factors include different physical properties of water such as solubility of gases and solids, light penetration, temperature and salinity of water. Physico-chemical factors such as hardness, phosphate and nitrates which are very important for the growth of primary productivity in aquatic habitat. Examination of water quality is among frequently conducted for bi monthly interval in NTD. Hence, the present study was based on the assessment of the physico-chemical parameters of NTD. The most important key species of ecosystem and endangered species of reptilian, the Marsh Crocodile is inhabitant in NTD Khairpur (WWF-Pakistan 2007). In aquatic habitat for the biodiversity the availability of pure and safe water is essential for the prevention of water borne diseases and their survival in aquatic habitat. The major sources of contamination may be due to rain water or pollution from the adjacent areas of lakes, shallow water tables and due to anthropogenic activities. The present study on water quality of NTD

related with its impacts on crocodilian health was conducted first time in Sindh province. Ecological changes in aquatic habitat depends upon the physico-chemical factors of water bodies. The present study of physico-chemical parameters in NTD provides the information and its influence on health and growth of Marsh Crocodiles.

Material and methods

Assessment of physico-chemical parameters of lake water in NTD Khairpur was conducted bi-monthly January to November 2008. During the collection of water samples we take from surface water and bottom layers by using Van Dorn plastic bottles (1.5 lit) from the crocodile's lake bi monthly interval. After collecting the water samples we were kept them in polythene plastic bottles, previously soaked in 10% nitric acid for 24 h and rinsed with ultrapure water obtained from lab water system. When we were reached at the laboratory; the collected water samples from different lakes were mixed in acid washed bucket to make one composite sample, rinsed with ultrapure water and kept under °C till for further analysis of water samples. During the examination of water samples the analytical data of water quality was ensured through the careful standardization and duplicate water samples. Assessment of physico-chemical parameters were carried out by the standard methods of water analysis (APHA 1998). For water sampling we were collected samples from 11:00 am to 5:00 pm at bi monthly intervals from the lakes of NTD Khairpur. For the analysis of physico-chemical properties of lake water such as temperature of water, depth and transparency, the procedure of secchi disk measurement was done during the water sampling. Assessment of temperature level the mercury thermometer was dipped into the water samples to a depth of 15 cm for 2-5 minutes, range of pH was examined with Orion Model 420 A pH meter, EC, TDS and Na was measured with WTW 320 conductivity meter. The alkalinity, hardness, Cl and phosphate were measured with the standard methods of APHA, 1998. For the assessment of Ca, HCO₃ and HCO the titration method (2310) was applied. Water analysis of Mg and K we were examined with the Spectrometer. The BOD was examined with the Winkler method and DO was determined with the Oxygen meter (Jenway Model 9071).

Table 1. Physicochemical parameters of NTD and their analytical procedure during 2008.

Variables	Abbreviations	Units	Analytical Method
Temperature	Temp	°C	Mercury Thermometer
pH	pH	pH Unit	pH Meter
Electrical Conductivity	EC	mu/Scm	Conductivity Meter
Total Dissolved Solids	TDS	Mg L ⁻¹	WTW 320
Turbidity	Tur	NTU	Nephelometric Turbidity Unit
Calcium	Ca	Mg L ⁻¹	Titration (EDTA)
Magnesium	Mg	Mg L ⁻¹	Titration (EDTA)
Hardness	Hard	Mg L ⁻¹	Titration (Silver Nitrate)
Bi Carbonate	HCO ₃	ppm	Titration (2310)
Alkalinity	Alkaline	Mg L ⁻¹	Titration (Silver Nitrate)
Chlorides	Cl	Mg L ⁻¹	Titration (Silver Nitrate)
Sodium	Na	Meq	WTW 320
Potassium	K	Mg L ⁻¹	Titration (EDTA)
Sulphate	SO ₄	Mg L ⁻¹	Titration (2310)
Carbonate	HCO	ppm	Titration (2310)
Biological Oxygen Demand	BOD	Mg L ⁻¹	Winkler Method
Dissolved Oxygen	DO	Mg L ⁻¹	Winkler Method

Results

Values for the analysis of physico-chemical parameters in water samples were collected randomly from ten sampling stations from the entire protected areas of Nara Thar Desert Khairpur. Water samples were collected from the S1. Gunjo Bhanbharo, S2. Bachal Bhanbharo, S3. Skebi Lake, S4. Tooti Dhandh, S5. Dangewari Dhandh, S6. Kharari Dhandh, S7. Raja Pathan Fish Farm, S8. Old Nara Dhandh, S9. Saiedo Patan and S10. Nara Canal Chundiko every bimonthly interval January to November 2008 (Tables 2-11). Presence of nutrient content in physico-chemical parameters in aquatic habitat play a vital role in the distributional patterns and species composition of primary organisms (Sahato et al. 2004). In aquatic habitat, the environmental factors includes various physical properties of water, such as solubility of gases and solids, light penetration, temperature, salinity and

density. Different factors of physico-chemical parameters like as pH, hardness, phosphate and nitrate are very essential for the growth and dispersal of phytoplankton on which zooplankton and other consumers depend for their survival in aquatic habitat. Hydrographic condition of crocodile lakes of NTD, seasonal and physico-chemical change in water level which can directly affect the abundance and distribution of other related aquatic biodiversity. Water samples were collected the randomly selected from the lakes of NTD Khairpur for the analysis of physico-chemical parameters (Tables 2-11).

Temperature of air/water °C: Temperature which is the most essential parameter can directly related to chemical reaction in aquatic habitat. It is the essential physico-chemical parameter which directly influences on the aquatic biodiversity and it can reduce the dissolved oxygen in water bodies. During our observation, it was recorded that the highest

Table 2. Physico-chemical analysis of water of Gunjo Bhanbharo Lake (S1).

	January	March	May	July	September	November
Date	16	14	12	10	13	11
Time	1:20	1:00	2:00	3:00	4:00	2:00
Temp: Air °C	20	26	32	36	32	23
Temp: H ₂ O °C	17	23	29	33	29	20
pH	8.2	8.3	8.0	7.9	7.8	8.0
EC mu/Scm	985	954	875	850	820	970
TDS mg/l	630	613	590	600	580	640
Turbidity ntu	30	32	40	45	28	35
Ca mg/l	40	52	58	65	35	45
Mg meq/l	27	37	35	40	23	24
Hardness mg/l	210	270	245	256	205	225
HCO ₃ ppm	175	162	150	130	140	165
Alkalinity mg/l	3.5	3.8	3.4	4.0	3.2	3.6
Cl mg/l	131	122	115	145	120	140
Na meq/l	128	145	120	150	110	130
K mg/l	18	21	19	25	16	20
SO ₄ mg/l	128	140	132	116	105	120
Co ₃ ppm	0	0	0	0	0	0
BOD mg/l	3.0	3.2	2.9	2.8	3.5	3.8
DO mg/l	4.8	4.0	3.7	3.9	4.2	4.1

Table 3. Physico-chemical analysis of water of Bachal Bhanbharo Lake (S2).

	January	March	May	July	September	November
Date	16	14	12	10	13	11
Time	2:50	2:00	3:00	4:00	5:00	3:00
Temp: Air °C	19	26	32	35	32	23
Temp: H ₂ O °C	16	23	29	32	29	20
pH	8.2	8.1	8.0	7.8	7.6	7.9
EC mu/Scm	2860	2730	2595	2370	2173	2436
TDS mg/l	1830	1650	1540	1285	1240	1464
Turbidity ntu	33	30	25	21	18	28
Ca mg/l	140	150	130	120	114	132
Mg meq/l	60	75	52	45	42	53
Hardness mg/l	600	680	580	590	563	620
HCO ₃ ppm	350	285	260	250	235	376
Alkalinity mg/l	7	12	8	10	6	9
Cl mg/l	192	210	170	165	154	184
Na meq/l	382	350	315	286	250	375
K mg/l	32	38	28	24	20	27
SO ₄ mg/l	778	725	635	605	582	683
Co ₃ ppm	0	0	0	0	0	0
BOD mg/l	3.5	3.2	3.6	3.8	3.7	3.8
DO mg/l	5.0	4.8	4.9	4.8	4.6	4.2

Table 4. Physico-chemical analysis of water of Skebi Lake (S3).

	January	March	May	July	September	November
Date	16	14	12	10	13	11
Time	2:50	2:00	3:00	4:00	5:00	3:00
Temp: Air °C	21	26	32	35	32	23
Temp: H ₂ O °C	18	23	29	32	29	20
pH	8.0	7.6	7.8	7.5	7.3	7.9
EC mu/Scm	925	856	814	725	705	883
TDS mg/l	586	547	510	462	443	532
Turbidity ntu	9.2	11.9	10.4	12.3	11.2	11.6
Ca mg/l	82	68	54	45	40	75
Mg meq/l	74	62	52	48	42	68
Hardness mg/l	538	426	410	430	410	520
HCO ₃ ppm	142	130	123	120	105	134
Alkalinity mg/l	3.5	2.6	2.5	2.2	2.1	3.2
Cl mg/l	168	139	130	118	106	156
Na meq/l	42	38	34	32	27	38
K mg/l	40	32	30	34	28	36
SO ₄ mg/l	208	195	173	164	153	192
Co ₃ ppm	0	0	0	0	0	0
BOD mg/l	3.9	3.8	3.6	3.7	3.5	3.9
DO mg/l	5.2	5.1	4.8	4.8	4.6	5.1

36 °C temperature of air found during the month of July and lowest was observed 20 °C in the month of January (Table 2). Temperature of water was recorded the highest 33 °C in the month of July and lowest was observed 17 °C in the month of January (Table 2).

pH: The highest level was observed 9.3 during the month of November and lowest was observed 6.9 in the month of November respectively (Table 9 & 10).

Electrical Conductivity: The range of EC was observed the highest 9120 mu/Scm in the month of November and lowest was observed 364 mu/Scm in the month of May (Table 9 & 11). However, in water bodies the fluctuation was observed in water samples due to the flow of rain water. The standard level of EC is 400 mu/Scm recognized by world

health organization. The water quality is depends upon the quantity of total dissolved solids (TDS).

Total Dissolved Solids: The range of TDS was observed the highest 10420 mg/l in the month of March and lowest level 214 mg/l during the month of May (Table 5 & 11).

Turbidity: The highest range of turbidity was recorded highest 186 NTU during the month of January and lowest level 0.20 NTU was recorded during the month of September (Table 7 & 5).

Calcium: The highest level of calcium was observed 1214 mg/l during the month of January and lowest level 13 mg/l was observed during the month of September (Table 6 & 8).

Magnesium: The highest level of magnesium was observed 876 meq/l during the month of March and lowest

Table 5. Physico-chemical analysis of water of Tooti dhandh (S4).

	January	March	May	July	September	November
Date	16	14	12	10	13	11
Time	2:50	2:00	3:00	4:00	5:00	3:00
Temp: Air °C	21	26	32	35	32	23
Temp: H ₂ O °C	19	23	29	32	29	20
pH	8.5	9	8.7	8.5	8.2	8.4
EC mu/Scm	1327	1270	1194	1054	983	1127
TDS mg/l	9827	10420	8974	7590	6580	8936
Turbidity ntu	0.27	0.29	0.25	0.23	0.20	0.29
Ca mg/l	728	772	685	608	582	782
Mg meq/l	838	876	782	678	645	812
Hardness mg/l	5428	5536	4528	3974	3792	5265
HCO ₃ ppm	182	170	162	156	140	172
Alkalinity mg/l	3.8	3.4	3.2	3.1	3.0	3.6
Cl mg/l	3329	3418	3236	3075	2868	3185
Na meq/l	52	46	58	48	42	49
K mg/l	84	72	88	74	56	78
SO ₄ mg/l	2980	2937	2830	2589	2438	2845
Co ₃ ppm	0	0	0	0	0	0
BOD mg/l	4.2	4.0	4.0	3.9	3.8	4.1
DO mg/l	5.5	5.4	5.3	5.1	5.0	5.2

Table 6. Physico-chemical analysis of water of Dangewari Dhandh (S5).

	January	March	May	July	September	November
Date	16	14	12	10	13	11
Time	2:50	2:00	3:00	4:00	5:00	3:00
Temp: Air °C	21	26	32	35	32	23
Temp: H ₂ O °C	19	23	29	32	29	20
pH	9.2	9.1	8.8	8.5	8.3	8.9
EC mu/Scm	7984	7920	7180	6568	5872	6217
TDS mg/l	5123	5068	4837	4287	4027	4839
Turbidity ntu	38	33	30	28	24	35
Ca mg/l	1214	1174	1034	983	845	1128
Mg meq/l	394	374	345	285	262	312
Hardness mg/l	3985	3923	3812	3529	3428	3782
HCO ₃ ppm	0.9	0.8	0.7	0.5	0.6	0.8
Alkalinity mg/l	2.9	2.64	2.5	2.1	2.0	2.8
Cl mg/l	147	132	127	120	108	142
Na meq/l	75	69	62	56	48	72
K mg/l	23	18	16	14	15	21
SO ₄ mg/l	1915	1819	1725	1528	1372	1882
Co ₃ ppm	0	0	0	0	0	0
BOD mg/l	4.5	4.2	4.1	4.0	3.9	4.2
DO mg/l	5.4	5.3	5.2	5.1	5.0	5.2

level 14 meq/l was observed during the month of May (Table 5 & 11).

Hardness: The highest level of hardness was observed 5536 mg/l during the month of March and lowest level 140 mg/l was observed during the month of May (Table 5 & 11).

Bi-Carbonate: The highest level of bi-carbonate was observed 3580 mg/l during the month of November and lowest level 0.5 mg/l was observed during the month of July (Table 9 & 6).

Alkalinity: The highest level of alkalinity was observed 71.6 mg/l during the month of November and lowest level 2.0 mg/l was observed during the September (Table 9 & 6).

Chloride: The highest level of chloride was observed 3418 mg/l during the month of March and lowest level 22

mg/l was observed during the month of May (Table 5 & 11).

Sodium: The highest level of chloride was observed 1231 mg/l during the month of November and lowest level 21 mg/l was observed during the month of May (Table 9 & 11). The concentration of sodium increases mostly during the winter season while sodium concentration decreases during the summer season.

Potassium: The highest level of potassium was observed 88 mg/l during the month of May and lowest level 3 mg/l was observed during the month of July (Table 5 & 11).

Sulphate: The highest level of Sulphate was observed 2980 mg/l during the month of January and lowest level 38 mg/l was observed during the month of May (Table 5 & 11).

Carbonate: The concentration of carbonate was observed

Table 7. Physico-chemical analysis of water of Kharari Dhandh (S6).

	January	March	May	July	September	November
Date	16	14	12	10	13	11
Time	2:50	2:00	3:00	4:00	5:00	3:00
Temp: Air °C	21	26	32	35	32	23
Temp: H ₂ O °C	19	23	29	32	29	20
pH	9	8.9	8.5	8.3	8.1	8.6
EC µm/Scm	8912	8720	7837	6865	5392	6836
TDS mg/l	5610	5580	4872	4583	3983	4892
Turbidity ntu	186	180	162	152	106	170
Ca mg/l	492	482	385	328	295	412
Mg meq/l	782	757	628	573	412	684
Hardness mg/l	4427	4321	4082	3862	3429	4128
HCO ₃ ppm	1.2	1.06	1.03	1.1	1.0	1.4
Alkalinity mg/l	2.8	2.6	2.4	2.2	2.1	2.5
Cl mg/l	142	130	126	114	108	125
Na meq/l	54	46	42	37	32	41
K mg/l	8	4	5	6	7	9
SO ₄ mg/l	2286	2213	2145	2096	1827	1273
CO ₃ ppm	0	0	0	0	0	0
BOD mg/l	4.6	4.3	4.2	4.1	3.9	4.3
DO mg/l	5.1	5.0	5.0	4.9	4.7	5.0

Table 8. Physico-chemical analysis of water of Raja Pathan Fish Farm (S7).

	January	March	May	July	September	November
Date	17	15	13	11	14	11
Time	2:50	2:00	3:00	4:00	5:00	3:00
Temp: Air °C	20	26	32	35	32	23
Temp: H ₂ O °C	18	23	29	32	29	20
pH	8	7.9	7.7	7.5	7.6	7.76
EC µm/Scm	5489	5282	4827	4628	5273	6190
TDS mg/l	3186	2973	2863	2682	2854	3340
Turbidity ntu	12.6	12	10	8	9	11.9
Ca mg/l	22	20	18	15	13	16
Mg meq/l	294	240	235	192	205	273
Hardness mg/l	1082	926	884	836	928	1180
HCO ₃ ppm	980	826	793	782	863	1070
Alkalinity mg/l	20.5	19.8	19.2	16.2	18.5	21.4
Cl mg/l	603	583	535	483	528	666
Na meq/l	787	782	739	626	712	821
K mg/l	38	31	29	26	28	32
SO ₄ mg/l	937	826	793	638	875	1040
CO ₃ ppm	0	0	0	0	0	0
BOD mg/l	3.7	3.1	2.9	2.7	2.9	3.0
DO mg/l	5.6	5.4	5.3	5.2	5.7	6.1

zero during the whole study period (Table 2-11).

Biological Oxygen Demand: The highest level of BOD was observed 4.6 mg/l during the month of January and lowest level 2.7 mg/l was observed during the month of July (Table 7 & 8).

Dissolved Oxygen: The highest level of DO was observed 6.1 mg/l during the month of November and lowest level 3.7 mg/l was observed during the month of July (Table 8 & 2).

Discussion

Seasonal fluctuation in the physico-chemical parameters

caused the similar rise in dissolved oxygen level has been recorded during the winter season (Singh et al. 1980). Microbial decomposition of dead organic matter reduction caused due to low organismal respiration demand, increased submerged growth of macrophytes and solubility of atmospheric oxygen by reduction in the level of temperature (Rao 1986). The assessment of pH and alkalinity range shows that the lakes of water in NTD remained slightly alkaline throughout the study period due to sufficient amount of water comes from the rain water. The permissible range of hardness is recognized 200 mg/l by world health organization (WHO). During our examination of water samples the level of hardness was estimated in higher range from the guidelines given by the WHO (1984). When the level of

Table 9. Physico-chemical analysis of water of Old Nara Dhandh (S8).

	January	March	May	July	September	November
Date	17	15	13	11	14	11
Time	2:50	2:00	3:00	4:00	5:00	3:00
Temp: Air °C	21	26	32	35	32	23
Temp: H ₂ O °C	19	23	29	32	29	20
pH	8.8	8.4	8.2	8.5	9	9.3
EC mu/Scm	8379	7838	4570	5820	7739	9120
TDS mg/l	1529	1482	1273	1382	1528	1690
Turbidity ntu	0.27	0.26	0.22	0.21	0.25	0.29
Ca mg/l	49	38	30	36	40	54
Mg meq/l	329	230	186	210	236	397
Hardness mg/l	1626	1327	1182	1268	1529	1770
HCO ₃ ppm	3428	3028	2793	2983	3218	3580
Alkalinity mg/l	67.4	48	43	50	60.2	71.6
Cl mg/l	320	257	216	237	285	397
Na meq/l	1125	937	792	845	1026	1231
K mg/l	67	53	47	52	62	72
SO ₄ mg/l	386	274	218	274	326	403
CO ₃ ppm	0	0	0	0	0	0
BOD mg/l	3.9	3.2	3.4	3.5	3.6	3.8
DO mg/l	5.6	4.8	5.0	5.2	5.4	5.8

Table 10. Physico-chemical analysis of water of Saiedo Patan (S9).

	January	March	May	July	September	November
Date	17	15	13	11	14	11
Time	2:50	2:00	3:00	4:00	5:00	3:00
Temp: Air °C	21	26	32	35	32	23
Temp: H ₂ O °C	19	23	29	32	29	20
pH	7.9	7.8	7.3	7.1	7	6.9
EC mu/Scm	1263	1172	938	1027	1263	1495
TDS mg/l	729	628	510	543	692	808
Turbidity ntu	31	28	25	27	30	33
Ca mg/l	58	50	40	46	53	64
Mg meq/l	49	46	36	42	47	56
Hardness mg/l	328	275	204	232	245	390
HCO ₃ ppm	210	189	145	162	186	240
Alkalinity mg/l	4.3	4.0	3.9	4.1	4.2	4.8
Cl mg/l	152	138	110	126	135	166
Na meq/l	141	136	106	124	130	150
K mg/l	17	16	12	14	15	18
SO ₄ mg/l	239	143	137	153	172	260
CO ₃ ppm	0	0	0	0	0	0
BOD mg/l	3.8	3.5	3.3	3.0	3.1	3.6
DO mg/l	5.0	4.9	4.8	4.7	4.9	5.0

hardness increased in the water bodies that means the flow of rain water added into the lakes water. The amount of salinity and magnesium concentration was observed high and the concentration of electrical conductivity and total dissolved solids were also substantially high; this increased probability indicates that there could be some contamination and waste particles accidentally added into the water bodies. The chloride which is a pollution indicating physico-chemical parameter i.e. related with the sewage contamination with the degradation products into the lakes water. In the lakes of NTD the level of chloride was examined in higher range. The level of chloride is recognized 250 mg/l acceptable for the healthy life and for drinking purpose. However, the range of Ca, K, SO₄, HCO₃, CO₃, COD and

BOD was estimated in elevated concentration compared to the maximum permissible limits (Tables 2-11).

The salinity which is the most important physico-chemical parameter which can directly effect on the biodiversity (Khuhawar & Mastoi 1995) and it was observed during our observation that the level salinity was high in the lakes of NTD. The variables of physico-chemical factors in NTD when we have compared with other water bodies of Sindh; such as Keenjhar lake Thatta (Chloride 38.9 mg/l, salinity 0.05 mg/l, alkalinity 200 mg/l; Khuhawar et al. 1999); Haleji Lake Thatta (Alkalinity 525 mg/l, chloride 75 mg/l, TDS 338 mg/l; Khuhawar et al. 1999); Hamal Lake Larkana (Hardness 670 mg/l chloride 1750 mg/l, alkalinity 275 mg/l; Khuhawar et al. 1999); Bakar Lake Sanghar (TDS 580 mg/l,

Table 11. Physico-chemical analysis of water in Nara Canal Chundiko (S10).

	January	March	May	July	September	November
Date	17	15	13	11	14	11
Time	2:50	2:00	3:00	4:00	5:00	3:00
Temp: Air °C	21	26	32	35	32	23
Temp: H ₂ O °C	19	23	29	32	29	20
pH	7.6	7.2	7	6.9	7	7.03
EC mu/Scm	528	489	364	387	472	596
TDS mg/l	312	307	214	230	278	321
Turbidity ntu	162	147	117	126	145	180
Ca mg/l	47	53	38	42	48	60
Mg meq/l	18	17	14	15	16	19
Hardness mg/l	210	203	140	154	182	230
HCO ₃ ppm	171	154	104	120	125	180
Alkalinity mg/l	3.5	3.4	3.1	3.0	3.1	3.6
Cl mg/l	30	29	22	25	28	32
Na meq/l	31	30	21	27	29	33
K mg/l	7	6	5	3	5	4
SO ₄ mg/l	61	47	38	40	46	69
Co ₃ ppm	0	0	0	0	0	0
BOD mg/l	3.9	3.5	3.3	3.1	3.2	3.8
DO mg/l	5.0	4.9	4.7	4.6	4.8	5.0

alkalinity 550 mg/l, hardness 210 mg/l; Jafri et al. 1997) and Hub Dam Karachi (Transparency 2.1-3.3 m, pH 6.8-7.5, dissolved oxygen 3.1-5.3 mg/l, salinity 0.15-25 ppt, total dissolved solids 502 ppm; Iqbal & Kazmi 1998); these studies indicate that all these water resources possessed the typical fresh water characteristics despite the progressive eutrophication. In the lake water of NTD it was observed that the process of eutrophication was higher level due to the shallowness of basin and range of most of the physico-chemical parameters was gone up high, beyond the permissible limits recommended by the world health organization (1984). The crocodile population which mostly focuses their attention on important issue is related with water pollution that is directly concerned with the health and survival of aquatic life (Chang et al. 2012, 2013). The water quality is the major factor to determine the aquatic life related with their survival and health (Gachal et al. 2001, 2004, 2006). The crocodile population is faced by many shortcomings within its impacts and prediction on crocodile in NTD (Chang et al. 2012, 2013). The crocodile population is threatened by water quality in the NTD. The seasonal flooding and heavy rains can also damage and destroy the nesting and the eggs of crocodile in their native habitats (Santiapillai et al. 2001). It was estimated that the variation and access limits of physico-chemical parameters in water quality the hazard chemicals were examined during the analysis of water samples in the laboratory analysis which causing the harmful effects on the health of crocodile population. It was observed that the current scenario indicates that the crocodile population in NTD extremely threatened with the interaction of large number of people and disturb them; low water and its quality in NTD; insufficient amount of food availability and usually reduces the suitability of the habitat for the growth and development of crocodile population. The flourishing breeding of Marsh crocodile have made disturb by the wild animals and local community for the expanding population of crocodile which is naturally rough and tough for its longevity and future

survival. During our study it was observed that the water quality and water level is not suitable for their healthy growth in NTD Khairpur.

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