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Water quality assessment and flora study of desert Thar and Nagarparkar District Tharparkar, Sindh, Pakistan

S. M. Leghari, M. A. Mahar, M.Y. Khuhawar* and T. M. Jahangir*

Department of Fresh Water Biology & Fisheries, University of Sindh, Jamshoro 76080, Sindh, Pakistan

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Abstract:

A number of water samples (24) were collected from wells, water pumps, natural and artificial depressions from Naukot, Vajuto, Mithi, Islamkot, Virawah and Nagarparkar area and analyzed on the site and at the laboratories for 18 different parameters. There was a wide variation in water quality; conductivity157 to 41400 µS/cm and total dissolved solids 100 to 26500 mg/L. The highest values were observed at Virawah area and lowest at an artificial depression of rainwater within Nagarparkar town. The higher vegetation of Thar region consists mainly of thorny or prickly shrubs and perennial herbs capable of drought resistance as *Calligonum polygonoides, Aerva javanica, Salvadora oleoides, Acacia senegal, Capparis decidua, Tamarix aphylla, Prosopis spicigera, Leptadenia pyrotechnica* and *Zizyphus nummularia.* During rainy season when dunes are covered with grasses and other herbs *Salvadora oleoides, Capparis decidua,* and *Tamarix aphylla* were found scattered in Thar area.

Acacia leucophloea, Acacia senegal, Salvadora oleoides, Commiphora mukul, Barleria prionitis, Blepharis sindica, Euphorbia caudicifolia were found on dry and rocky area. Rainwater pools contain total 83 algal sp; 37 sp belonging to Cyanophyta; 23 sp Volocothyta; 10 sp Chlorophyta; 3 sp Charophyta; 10 sp Bacillarophyta; some algal species found epiphytic on aquatic plants such as *Chaetophora pisiformis, Stigeoclonium subsecundum, Oedogonium* sp. *Spirogyra rhizobrachialis, S. fluviatilis* and *Gloeotrichia natans* attached to *Najas minor, Nymphaea stellata, and Typha domingensis.*

Keywords: Water quality assessment, flora study of Thar and Nagarparkar

1. Introduction

Thar Desert of Tharparkar district occupies southeast corner of Pakistan. Towards the south is the sandy salt marsh of Kach. The area is divided into sandy hills, flat alluvial plains and rocky hill tract. The area is dry and arid with low rainfall. The people depend upon rain for agriculture and livestock. Rainfall is low and is highly variable. The area is thinly populated with low vegetation. Eastern Nara supplies some water for irrigation upto Naukot. The main source of water in the region are underground water (wells) and rainwater. The water is collected within depressions between sand dunes. The underground water in Mithi, Islamkot upto Variwah is brackish while fresh in Nagarparkar area (Panhawar, 1986). Recently high deposits of coals have been detected within the region, which increases the economical importance of the area (Fassett & Durrani, 1994). The hard granite stones and China Clay found in the Nagarparkar area are also of considerable importance (Panhwar, 1986 Fassett & Durrani, 1994).

As systematic water quality of the region has not been reported, the present work is a preliminary study to evaluate the water quality and flora of Thar and Nagarparkar area.

* Dr. M. A. Kazi Institute of Chemistry, University of Sindh, Jamshoro 76080, Sindh, Pakistan

The water samples were collected from Mithi, Islamkot and Nangarparkar area. The water sources within the area are wells and natural depressions (Tarai) where the rainwater is collected and remains as a source of water for both, the humans and animals for 2 to 8 months. The wells also vary significantly in depth and water quality. Twenty four (24) water samples were collected from Mithi, Islamkot and different villages in between Islamkot and Nagarparkar. 12 samples were of wells from (1) Village Lakhi Tobo, (2) Lonri yoon Saman (3) Adi jo Tar, (4) Kisaraki Paro Islamkot, (5) Tarho jo Goth about 10 Km from Mithi to Islamkot, (6) Nanukot to Vajuto, in between Mithi and Islamkot and (7) ground water boring from China Clay factory near Verawah (8) collected from whell Wajoto.

5 wells were sampled from Mithi area 9 Wahar wells, 10 Lal shah wells from village Sobharo shah, 11 well of village Kharo Bajer, 12 well from Mithi used for animals and 13 well from Mithi used for human consumptions.

A sample of rainwater was collected in depression about 1km from Adi jo Tar and a sample of water stream near Soothan Jo Wandhion before Nagarparkar area were also collected.

Ten samples were collected from Nagarparkar area. Six samples were collected from water ponds (1) Grhitari pond of about 1 acre area, half km outside Nagarparkar town, (2) Lorai Tarai pond with covered area of 4 acres, (3) Naryasoo Dam, (4) Ram Sar pool about 35 Km out side Nagarparkar town toward Rann of Kach, (5) Pond near village Phulpoyo and (6) Bhodasir reservoir behind historic Mosque of Munja, (7) from water supply of town Nagarparkar, (8) Piyao well about 1 km north of town Nagarparkar, (9) Inchile sar spring within Karonjhar mountains and (10) Punwah about 20km from Nagarparkar.

The samples were collected from the surface at the depth of 3 to 9 inches from the depressions, water pools and Dam about 2 to 6 feet from the side. The wells were sampled by lowering the buckets up to the bottom and filled buckets were pulled out. The samples from the water supply of Nagarparkar was collected after allowing water to flow for 5 min. The water sample from Inchile Sir Spring was collected from a small pool of water filled with continuous seepage of the mountain from creeks. The water samples were collected in 1.5L plastic bottle, rinsed several times with water before collection of samples taken in July 2005.

3. Material and Method

Water temperature, conductivity, salinity and total dissolved solids (TDS) were measured with WTW conductivity meter at the sampling site. The pH was measured with Orion 420 pH meter. Chloride, alkalinity and hardness were determined by titration with standard silver nitrate, hydrochloric acid and EDTA respectively. Nitrate, nitrite and phosphate were determined by spectrophotometry using Hitachi 220 spectrophotometer. Nitrate was determined using brucine sulphate as derivatizing reagent. Total phosphate was determined by persulphate digestion method fallowed determination as orthophosphate by reducing phosphomolybdic acid formed with ascorbic acid to molybdenum blue. Sulphate was determined by turbidiometry using barium chloride (APHA, 1992).

Sodium, potassium, calcium and magnesium were determined by Varian Spectra AA-20 atomic absorption spectrometer with air acetylene flame using standard burner at conditions recommended by the manufacturer. Sodium, potassium, calcium and magnesium were determined at 589.0nm, 766.5 nm, 422.7 nm and 285.2 nm respectively with integration time 3 sec and delay time 3sec.Higher plants and Algal flora were identified with the help of taxonomic keys Jafri (1966), Islam and Sheikh (1966), Bhandri (1978), Desikachary (1959) and Prescott (1961).

4. Results and Discussion

Tharparkar district is covered with sand dunes, up to 80 meter thick. The Nagarparkar part of Thar district is only a rocky texture, which dominantly consists of granite with minor

amount of Rhyolite and other metamorphic rocks (Fassett and Durrani, 1994).

The water quality of the study area may be divided into two parts (1) Mithi and Islamkot area and (2) Nagarparkar area.

Six wells were examined within Islamkot area upto Mithi which indicated conductivity of 1653-14730 µS/cm and TDS 9427 mg/L (Table-1 samples III to VIII). The sample with highest conductivity and TDS is used as a source of water for cattle, but wells III, IV,V,VI, and VIII are used as a source of water for both human and animals. The pH of all the wells was observed within acceptable limits i.e. 7.55 to 8.3. The chloride contents were observed within 283-1525 mg/L except sample 7 which indicated 3722-mg/L. Nitrate, nitrite and total phosphate were present only in traces and were within the safe limits. Among the metal ions the sodium was dominant followed by calcium, magnesium and potassium.

Table 1. Samples collected from Thar, District Tharparkar
Date of Collection 22-07-2005

Parameters	I*	II*	III*	IV*	V*	VI*	VII*	VIII*
Time	8.08	8.30	16.25	19.12	9.45	11.55	12.50	13.40
Temperature of Water in °C	25	27.6	30.5	30.2	27.1	31.3	36.6	36.9
pH	7.41	7.90	7.55	7.77	7.85	8.0	8.23	8.0
Conductivity µS /cm	2340	36100	4340	1653	6387	5383	14730	3140
Salinity g/L	1.2	25.8	2.60	4.3	3.6	3.6	7.5	1.3
TDS mg /L	1497	23104	2777	1057	4087	3445	9427	2009
M. alkalinity as Ca CO_3 mg /L	200	480	150	200	425	350	400	200
Chloride mg /L	354	6286	818	283	1691	1525	3722	670
Hardness as Ca CO_3 mg /L	450	3700	800	500	440	800	650	310
Acid Hydrolysable Phosphate µg /L	980	80	40	90	80	50	60	50
Nitrite µg / L	10	15	B.D	B.D	B.D	B.D	B.D	B.D
Nitrate µg /L	150	350	30	500	B.D	10	30	300
Sulphate mg /L	150	600	280	40	450	680	612	210
Na mg /L	209	2750	322	189	826	1053	2546	241
K mg /L	25	240	44	10	56	56	34	10
Ca mg /L	101	850	190	69	214	179	137	172
Mg mg /L	54	417	87	41	147	119	70	94

*Sampling stations:
(I) Natural depression, 1 km ahead Adi Jo Tar rain water (II) Stream near Soothan Jo Wandhio standing water in bed of the stream (III) well of village Lakhi Jo Wandhio (IV) Well Haroon Samo (In between Nagarparkar and Islam Kot) (V) Well Adi Jo Tar (About 75 ft in depth (VI) Well of Kasarai Paro Islam Kot (About 150ft in depth). (VII) Well of Tarho Jo Goth (About 10km from Mithi to Islam Kot) (VIII) Well of Wajutoo (In between Naokot and Mithi and Islamkot).

Five more samples around Mithi indicated highly variable salt contents. Wahar well of village Kharo Bajer and well from Mithi town, used for both human and animals indicated conductivity within 2.04- 4.83 mS/cm and TDS of 1305-3091 mg/L. However the pH of Mithi well was on the higher side 8.99. Lal Shah well and well from Mithi used for animal indicated high conductivity and TDS within the range 11.01- 11.58 mS/cm and of 7046–7411 mg/L respectively; Nitrite was below the detection limits in all the samples **(Table 2).**

Table 2. Samples collected from Mithi, district Tharparkar.
Date of Collection 16-07-2005

Parameters	I*	II*	III*	IV*	V*
Temperature of Water in °C	36.9	36.7	36	36.4	36.4
pH	7.92	7.31	7.94	8.90	8.99
Conductivity µS/cm	2.04	11.58	4.83	11.01	3.80
TDS mg /L	1305	7411	3091	7046	2432
P. alkalinity as Ca CO_3 mg/L	B.D	B.D	B.D	50	80
M. alkalinity as Ca CO_3 mg /L	100	200	180	210	140
Chloride mg / L	300	2470	580	1646	428
Hardness as Ca CO_3 mg /L	280	650	380	640	310
Acid Hydrolysable Phosphate µg /L	0.06	0.09	0.08	0.3	0.3
Ortho phosphate µg /L	20	48	40	150	210
Sulphate mg /L	85	330	120	250	170
Nitrate µg /L	.35	B.D	0.20	0.10	0.10
Na mg /L	170	1310	148	730	182
K mg /L	24	57	42	46	28
Ca mg /L	73	303	106	334	98
Mg mg /L	46	71	80	88	54

*Sampling stations:

I. Wahar well from village Sobharo Shah.
II. Lal Shah well from village Sobharo Shah
III. Well of village Kharo bajeer
IV. Well from Mithi (used for animals)
V. Well from Mithi town.

The rainwater collected in depression (Table-1 sample-I) used as a source of water for human and cattle indicated conductivity of 2340 µS/cm and TDS 1497 mg/L with acceptable pH 7.41. In Isalamkot, Mithi and Wajuto area, well water is hard water and is not suitable for human beings, but is suitable for animals and washing. The well water of moist surrounding soil area covered *Phormidium favosum* ,*Phormidium ceylanicum, Oscillatoria chalybea, Oscillatoria brevis, Oscillatoria lemmermannii, Gloeocapsa magma* belonging to Cyanophyta. Other two sources of water, ground water of China Clay factory Virawah and stream near Soothan Jo Wandhion, indicated extreme values of conductivity due to high amount of salt contents. China Clay ponds are full of *Oscillatoria amoena, Scenedesmus armatus, Spirogyra subsalsa* and *Glenodinium pulvisculus* are the dominant flora **(Table-3).**

Table - 3. Samples collected from central Thar district Tharparkar
Date of Collection 22-07-2005

Parameters	I*	II*
Temperature of Water in °C	29.7	30.5
pH	7.39	6.77
Conductivity µS / cm	1097	41400
TDS mg /L	702	26496
M. alkalinity as Ca CO_3 mg /L	210	250
Chloride mg /L	190	1168
Hardness as Ca CO_3 g/L	300	1200
Acid Hydrolysable Phosphate mg /L	0.04	0.08
Sulphate mg / L	90	500
Nitrate µg /L	B.D	0.12
Na mg /L	106	450
K mg /L	25	65
Ca mg /L	60	281
Mg mg /L	35	142

* Sampling stations.

I. Punwah well (45 ft in depth)
II. Ground water (By bording from about 100ft in depth) China Clay factory Virawah.

The well and rain water are used for human consumption, but the sources cross the safe limits of TDS 1000 mg/L. Samples III, IV,

V, VI & VIII collected from wells even cross the maximum permissible limits of 1500 mg/L.

The second water resource observed within the Nagarparkar area indicated conductivity within 157 to 1487 µS/cm and TDS 100 to 951 mg/L except water collected from a depression near village Phulpoyo which indicated conductivity 3390 µS /cm and TDS of 2169 mg/l may be because of extensive evaporation from the surface or due to dissolution of the salts at the bottom (**Table – 4**).

The collected sample at Bhodasir reservoir behind historic Mosque of Munja indicated the lowest electrical conductivity and TDS because the water was collected at the foot of the hard granite mountains having low dissolved solids.

Chloride, alkalinity, hardness, Sulphate, nitrite and phosphate were within the limits set for drinking water. Here also sodium was higher in concentration followed by calcium, magnesium and potassium.

Table 4. Samples collected from Nagarparkar, district Tharparkar.
Date of Collection 22-07-2005

Parameters	I*	II*	III*	IV*	V*	VI*	VII*	VIII*	IX*
Time	10.30	10.40	10.54	12.50	14	15.55	18.30	19.25	8.20
Temperature of Water in °C	27.7	30.5	30.6	32.5	32.1	33.4	30.7	30.4	30
pH	7.71	7.70	7.80	8.51	7.48	7.54	7.99	7.07	7.18
Conductivity µS / cm	887	236	237	255	1030	3390	157	1487	1298
Salinity g/ L	0.5	0.3	0.3	0.3	0.4	2.0	0.1	0.9	0.5
TDS mg / L	567	151	152	163	659	2169	100	951	830
M.Alkalinity as Ca CO_3 mg/ L	250	100	75	75	50	100	50	250	400
Chloride mg/ L	292	118	142	148	269	1095	44	276	202
Hardness as Ca CO_3 mg / L	240	250	230	210	290	620	150	290	300
Acid Hydrolysable Phosphate µg/L	80	50	50	50	50	90	100	500	50
Nitrate µg /L	150	250	500	B.D	200	350	360	320	320
Sulphate mg/L	60	40	60	61	170	400	25	130	100
Na mg /L	138	46	86	65	128	534	20	119	163
K mg /L	36	14	12	17	15	31	8	29	37
Ca mg /L	76	32	44	57	89	235	34	81	120
Mg mg /L	45	23	21	24	51	71	14	46	40

*Sampling stations:
(!) Water supply of town Nagarparkar
(II) Grhitari pond of about 1 acre and half km outside Nagarparkar
(III) Lorai Taraie pond (covered area of 4 acre)
(IV) Naryashoo Dam
(V) Ram Sir pool about 35 km out side Nagar parkar town toward Rann of Katch
(VI) Pond near village phulpoyo (160 sq ft)
(VII) Bhodasir reservoir behind historic Mosque of Munja (4000sq ft and 20-25 in depth)
(VIII) Inchile Sir Spring within Karonjar mountains
(IX) Piyao well (36ft in depth) about 1 km north of town Nagarparkar.

Panhwer (1986) has reported potable water between Naukot and Nangarparker to contain high salt contents, because of being part of the sea. However for Nangarparkar area it has been suggested that fresh water floats over brackish heavier water.

The results of chemical analysis indicat sodium chloride concentration higher tha calcium carbonate. Thus it does support that th area might have remained under the influence c

seawater. However at Nagarparkar area hard granite mountain and strong bed with low water soluble salts have proved a shield to retain fresh water for longer time within the area. Thinly populated area has maintained natural balance with precipitation and the extraction of underground water. In Thar area relative humidity is quite high ranging between 40-48% where the higher plants are *Salvadora persica, Acacia Senegal, Zizyphus nummularia, Tecomella undulata, Calotropis procera,* and *Acacia jacquemontii*, also covered with the grasses which is used for the cattle farming. Nagarparkar where the rainfall is 7-21 % is comparatively higher then the other area and predominant plants were *Commiphora mukul, Leptadenia spartium, Capparis decidua, Cassia angustifolia, Crotalaria burhia* and *Tamarindus indica.* The grasses and other vegetation are comparatively higher in the area and are used for cultivation and cattle forming. The pools of rain water were full with the *Najas graminea and Najas minor* alongwith Algalflora..

CYANOPHYTA

Aphanocapsa elachista
A.halophytica
A.littoralis
A. pulchra
Aphanothece saxicola
A.halophytica
Chroococcus tenax
C. minimus
C. minor
C. turgidus
Lyngbya aestuarii
L.limnetica.
Microcoleus chthonoplastes
Microcystis aeruginosa.
M. flos-aquae
M.marginata
M.pulverea
Oscillatoria amoena
O. angusta
O. chalybea
O. chlorina.
O. curviceps,.
O. formosa
O. salina
O. sancta
O. brevis
O. kuetzingiana
Phormidium ambiguum
P. ceylanicum
P. fragile
P. tenue
P. faveosum
Spirulina major
S. subsalsa
S. Laxa
Merismopedia glauca
Anabaena sp.

VOLVOCOPHYTA

Chlorococcum humicola
Golenkinia radiata
Pediastrum simplex
P. duplex
P. tetras
Tetraedron muticum
T. pentaedricum
Lagerheimia longiseta
Chlorella vulgaris
Gloeotaenium loitels bergerianum
Oocystis crassa
O. elliptica
Botryococcus braunii
Ankistrode mus falcatus
A. spiralis
Coelastrum microporum
Crucigenia tetrapedia
Scenedesmus dimorphus
S. arcuatus
S. abundans
Cosmarium leave
C. granatum

CHLOROPHYTA

Stigeoclonium lubricum
Cladophora fracta
C. glomerata
Pithophora oedogonia
Rhizoclonium hieroglyphicum
Oedogonium oviforme
Spirogyra rhizobrachialis
S. subsalsa
S. rhizopus
Zygnemopsis indica

CHAROPHYTA
Chara setosa
C. zeylanica
Nitella hyalina

BACILLAROPHYTA
Amphora ovalis
Gyrosigma sp
Navicula pygmaea
N.viridulla
Navicula sp
Cymbella sp
Nitz schia vermiculuis
Cyclotella operculata
C. kutzingiana
Cocconeis pedeculus

The Thar and Karonjhar hilly areas during rainy season were covered with grasses; *Scirpus littoralis, Chenopodium album, Digera arvensis, Aerva javanica, Amaranthus viridis* used as food, fodder for the domestic and wild animals. *Arva javanica* is used for filling the pillows and chairs seats.

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