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Analysis of aquatic habitats of amphibians in agricultural ponds of Taluka Sehwan in District Jamshoro, Sindh-Pakistan

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Abstract. Present study was carried out in a subdivision of District Jamshoro "Sehwan" for thorough record of amphibian environmental status. Field survey and analytical study was conducted from March to October during three years (2011-2013) at six ponds wherein amphibian populations lived perpetually. Present investigation revealed the nature of agricultural ponds via analysis of some crucial physico-chemical parameters amongst which only pH value (8.2±0.6) and CO_2 value (17.4±3.4) was within normal limit. Values of other parameters including EC (2313.9±1157.9), TDS (1507.7±707.8), T-Hard (487.0±267.3), T-Alk (349.2±92.3), Cl (355.3±98.2), SO_4 (467.8±159.2), PO_4 (361.8±86.6), NO_2 (5.3±3.5), NO_3 (6.9±2.7) and K (75.5±10.3) were above the normal limit into amphibian ponds. This hazardous level of parameters is indication of unsuitable environmental condition that may be critical for the amphibian populations of study area.

Key words: amphibian ponds, physico-chemical parameters, Taluka Sehwan, District Jamshoro, Pakistan.

Introduction

There are about 7000 amphibian species worldwide (Cogger et al. 2004), as four of them (*Bufo stomaticus*, *Hoplobatracus tigerinus, Euphlyctis cyanophlyctis* and *Allopa hazarensis*) are reported from District Jamshoro (Shaikh et al. 2014). This deteriorated amphibian diversity dragged attention towards possible environmental degradation that might be the reason for their decline in the study area. In this perspective, the present study was designed to reveal and highlight the characteristics of the amphibian habitats via analysis of dreadful physico-chemical contaminants.

The rate of the amphibian decline has become greater than the past extinction rates (McCallum 2007). The extinction is related mainly with a number of factors including climate alteration, infectious maladies, habitat destruction, ultraviolet radiations and water contamination (Eisenbeis 2006). Amphibians have delicate skin performing respiratory function; hence they remain exposed to contamination of water bodies where their eggs and larvae remain confined into water bodies until completion of their development to adult (Blaustein & Wake 1990). A number of physical, chemical and biological properties determine the quality of water as a media for organisms which develop and respire in water. Pollution creates a major global problem for the organisms living in polluted water bodies which affect the whole biological community (Paulu et al. 2009). Most important reason that causes amphibians to decline is water contamination mainly due to agricultural, industrial and pharmaceutical chemicals. These chemical pollutants impact the amphibian populations depending to their concentration. The effects of contaminants include various types of physical and physiological abnormalities (Bridges 1997 & 1999, Burkhart et al. 2000). The affected amphibians encounter with variety of cancers, endocrine disruption and malfunctioning of their reproductive systems (Boone & Semlitsch 2002). Chemical pollutants can also cause sexual malformations such as hermaphroditism into amphibians (Kiesecker 1996). High concentration levels of some chemical elements weaken the immune system and makes amphibians prone to parasitic infections (Christin et al. 2003). In many cases the central nervous system of amphibians is altered and the animals become inactive or unable and to react to predators (Kiesecker 1996).

One of the most prominent chemical characteristics that affect amphibians is the hydrogen ion concentration, which has adverse effects on the growth and development of the animals (Freda et al. 1990). Unfavorable level of pH may lead to mortality of amphibians (Freda & Dunson 1985). Amphibians prefer to dwell in stagnant water of ponds and ditches which are among the most affected by acidification (Pough & Wilson 1977). Increased level of EC and TDS has indeed harmful effect on amphibians (Boyer et al. 1995, Stekoll et al. 2003), as their spawns and juveniles are very sensitive to extreme level of the parameters in question (Chapman et al. 2000). Hard waters may similarly cause many physiological problems including abnormal functioning of the physiological activities (Chapman et al. 2000). High rate of alkalinity in water bodies can worsen the status of the aquatic habitats (Wurts & Durborow 1992, EPA 1976). The chloride high value is also proved threatening amphibian's health by increasing the stress levels (Lori 2007, Meador & Carlisle 2007). A pond with a chloride concentration over 162 mg/L can damage the spawning severely (Karraker 2008).

Sulphates increase eutrophication that supports algae to grow rapidly creating respiratory problem for all the aquatic breading animals, because the algae consume massive amount of oxygen (O_2) from water and let aquatic animals encounter with O_2 deficiency (Murrel & Ringer 1877). Like sulphates, phosphates also contribute in exceeding eutrophication and therefore its high concentration depletes dissolved oxygen level (Ansar & Khad 2005). Thyroid hormone (TH)-dependent metamorphosis in amphibians is affected due to high value of nitrite (Ashley et al. 2012). Tadpoles exhibit poor swimming and low feeding activity, overdeveloped head, digestive deformities, edema and paralysis when get affected by the high concentration of nitrites (Bakker & Waights 1993). Likewise when another nitrogenous compound - the nitrates- reaches up to high concentration, they potentially cause the death of amphibian larvae (Romano & Zeng 2007). High level of nitrate can inhibit growth, impair the immune system and cause stress in aquatic species (Romano & Zeng 2007). Excesses of dissolved CO_2 in water may correspondingly affect the health of the aquatic organisms by creating hypercapnia (Crocker & Cech 1996). Unsuitable level of CO_2 may not induce mortality, but may affect the growth and the reproduction of amphibians (Crocker & Cech 1996). Potassium influences many physiological processes into amphibians, especially when other parameters viz: TDS, T-Hard, Cl etc. get dissolved in very high concentration (Shirley et al. 1956, APHA 1992).

Decline in amphibian populations has been reported for some parts of the world including western United States, Central America, South America, Eastern Australia and Fiji. In these localities the agricultural effluents are proved to be highly responsible for the contamination of amphibian habitats (Blaustein & Wake 1990). The Environmental Protection Agency reported, that the agriculture ranks first as the leading source of water quality problems, whereas contaminated lakes and rivers also affect amphibian populations and make them endangered (Krogh 2002). In the past, amphibian environmental ecology was poorly studied in Pakistan; but some analytical studies like the present investigation have disclosed actual condition of wild habitats. The present study may be informative to the wildlife organizations which may subsequently enforce management and conservation rules for saving the amphibian fauna in the wild.

Material and Methods

Field surveys were conducted in Taluka Sehwan, where interviews from local people helped in confirming permanent habitations of amphibians. Six agricultural ponds (Fig. 1) wherein amphibians existed were selected for the study of eight months (March to October) for three years i.e. 2011, 2012 and 2013.

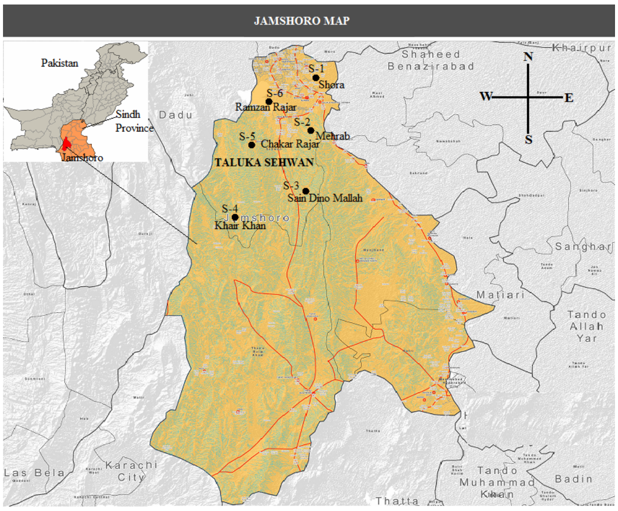

Figure 1. Map of District Jamshoro with location of study sites in Taluka Sehwan

Physico-chemical parameters were compared with scientific literature after being analyzed (see Adolfo & Blaustein 1999, APHA 1992, Bakker & weights 1993, Boyer et al. 1995, EPA 1976 & 1986, EPD 2000, Karrakar 2008, Kerry & Griffis 2007, Pierce 1985, Wurts & Durborow 1992, Rouse et al. 1999, Shirley et al. 1956). The process helped in the identification of water quality of the ponds.

Water sampling was carried out during day time (between 09am and 05pm) and large water samples were brought to the laboratory of The Institute of Advanced Research Studies in Chemical Sciences of University of Sindh, Pakistan. Apparatus and techniques used and applied during the laboratory work included pH meter (Model: Orion, 420), conductivity meter (Model: Orion. 115), ultraviolet (visible) spectrophotometer (Model: Hitachi 200), atomic absorption Spectrophotometer (Model: Perkin Elemer Analyst 800) and various modes of titration.

pH meter was used for the analysis of hydrogen ion concentration, whereas value of electric conductivity (EC) and total dissolved solids (TDS) was measured using conductivity meter. Parameters including total hardness (T-Hard), total alkalinity (T-Alk), chloride (Cl) and carbon dioxide (CO_2) were evaluated via titration procedures as suggested by Danial (1948) and Sunita (2002). The concentration of non-metallic parameters such as sulphates (SO_4), phosphates (PO_4), nitrites (NO_2) and nitrates (NO_3) were measured using ultraviolet visible spectrophotometer, whereas value of potassium was recorded by using atomic absorption spectrophotometer. Mean value and standard deviation were calculated using Excel 2010 for the thorough understanding of monthly and yearly tendencies in the water quality determined at all the six habitations.

Results

The present study explicates concentration of physico-chemical parameters persisting in six amphibian habitats (Table 1-3). Comparative study highlights fluctuation in concentration of parameters throughout the study period of three years (Fig. 2). Maximum concentration of all parameters was recorded in July, while their minimum value was noted in October; though value of CO_2 varied in the opposite mode. Combined studies of three years indicated range of pH extending from 7.0 to 9.2, whereas value of EC and TDS persisted respectively between 945.8 to 4725.8 uS/cm and 580.6-3180.1 mg/L. Concentration of T-Hard prevailed from 130.0 to 950.9 mg/L at entire study area, however level of T-Alk ranged within 145.5-537.0 mg/L and Cl value prevailed from 145.5 to 537.0 mg/L. Concentration of non-metallic parameters was evaluated as followed: SO_4 233.8-800.0 mg/L, PO_4 158.2-600.0 mg/L, NO_2 0.1-14.6 mg/L and NO_3 3.0-14.0 mg/L. Total range of CO_2 was recorded from 12.0 to 25.5 mg/L, while concentration of K persisted between 53.3 to 98.8 mg/L.

Our analysis showed unfavorable status of all amphibian ponds due to high value of influential parameters, whereas comparative study displayed higher rate of contamination in year-2012.

Discussion

Because of the permeable skin, amphibians are very sensitive to poor water quality mainly during the initially stage of their life when they remain confined into stagnant water bodies. Standing water especially in agricultural area accumulates variety of chemical contaminants, which deteriorate the health of aquatic living organisms. Amphibians are highly affected by water pollutions.

The present investigation recorded amphibian habitats containing massive amount of harmful characteristics due to

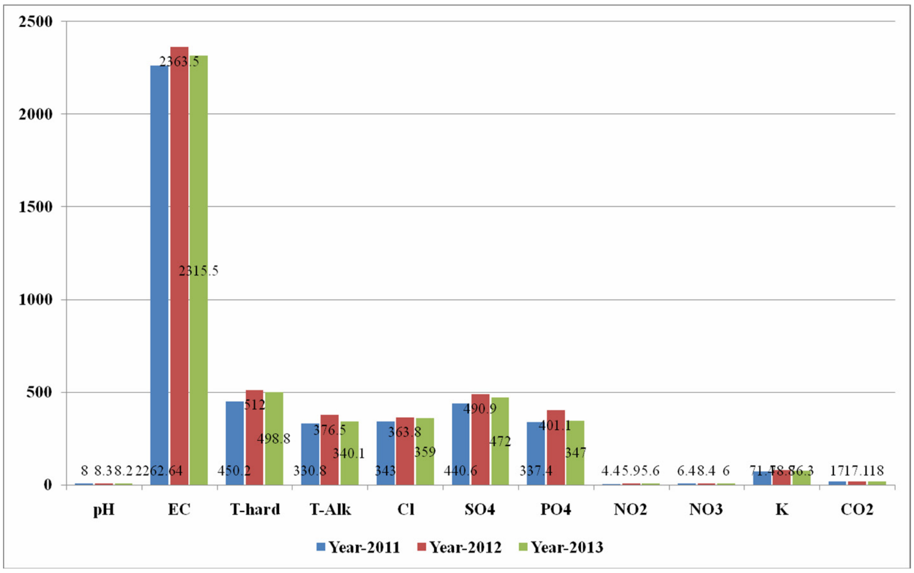

Figure 2. Yearly variation in the measured concentrations (mean value)

Table 1. Value of physico-chemical parameters in all amphibian ponds during year-2011 (Stdev. = Standard deviation).

Parameters	Value	March	April	May	June	July	August	September	October
pH	Range	7.0-8.5	7.0-8.5	7.5-8.8	7.5-8.9	7.5-9.0	7.5-9.0	7.0-8.8	7.0-8.0
	Mean	7.8	7.8	8.1	8.2	8.3	8.1	7.9	7.6
	Stdev	0.6	0.7	0.6	0.6	0.6	0.6	0.6	0.4
EC µS cm^{-1}	Range	950.5-3795.0	955.0-3850.0	960.9-3997.2	977.5-4052.0	985.0-4590.0	975.5-4461.0	970.0-4358.1	945.8-3585.0
	Mean	2130.8	2151.3	2317.8	2391.0	2456.2	2345.6	2248.1	2060.3
	Stdev	1178.9	1193.5	1343.9	1380.8	1428.1	1281.9	1220.3	1124.7
TDS mg L^{-1}	Range	600.0-2300.0	620.2-2347.0	635.5-2470.2	650.0-2885.4	660.0-3075.0	650.1-3050.0	645.2-2985.5	580.6-2179.0
	Mean	1364.0	1385.4	1534.2	1563.3	1595.6	1548.7	1442.6	1308.4
	Stdev	685.9	691.6	891.0	912.0	920.4	864.2	736.7	650.3
T-Hard mg L^{-1}	Range	130.2-800.0	135.0-842.2	144.2-850.8	150.8-887.5	166.5-920.0	150.5-900.0	140.6-878.5	130.0-758.0
	Mean	422.6	436.0	457.1	473.7	489.0	470.0	448.1	404.8
	Stdev	290.0	302.4	326.0	330.0	329.2	319.8	303.1	276.3
T-Alk mg L^{-1}	Range	150.0-400.0	150.1-450.8	160.0-480.2	168.5-500.0	180.0-537.0	177.2-500.0	170.2-491.3	145.5-388.6
	Mean	302.7	317.7	336.7	352.6	363.8	346.8	332.2	293.8
	Stdev	97.9	109.5	336.7	119.7	126.5	117.7	112.6	94.7
Cl mg L^{-1}	Range	180.1-450.0	188.0-500.0	191.4-568.2	200.8-585.5	213.8-605.3	200.3-550.3	185.5-535.5	178.2-400.2
	Mean	290.9	308.0	354.9	391.9	406.5	158.1	344.0	271.4
	Stdev	103.1	118.8	123.7	163.5	166.0	376.7	124.9	91.3
SO_4 mg L^{-1}	Range	250.0-600.0	250.0-678.4	700.0-270.2	285.0-715.2	288.4-750.0	280.3-738.1	272.1-730.0	233.8-550.0
	Mean	407.3	418.6	455.5	469.1	486.5	468.5	437.8	381.2
	Stdev	148.9	178.4	206.4	203.8	209.5	191.2	181.9	127.9
PO_4 mg L^{-1}	Range	250.2-445.0	158.2-485.5	170.0-500.2	177.5-583.8	180.0-600.0	168.5-558.6	160.0-545.1	250.0-400.0
	Mean	323.9	325.1	337.7	349.7	364.3	349.6	336.9	311.8
	Stdev	57.7	129.5	146.0	150.1	158.2	152.1	71.0	127.2
NO_2 mg L^{-1}	Range	0.1-8.0	0.1-8.5	0.2-8.8	0.2-10.0	0.2-14.6	0.2-14.5	0.1-14.0	0.1-7.8
	Mean	3.4	3.6	4.4	5.4	5.5	5.1	3.8	3.4
	Stdev	4.0	3.3	3.8	5.2	5.3	5.1	3.4	3.2
NO_3 mg L^{-1}	Range	4.0-9.9	4.0-10.0	4.5-10.5	5.0-12.5	5.5-12.8	5.0-12	4.8-10.5	3.8-9.5
	Mean	5.1	5.4	6.8	7.4	8.0	7.1	5.5	2.2
	Stdev	2.2	2.2	2.0	2.5	2.7	2.8	2.2	6.1
CO_2 mg L^{-1}	Range	12.5-20.0	13.0-20.0	13.5-22.0	12.0-20.5	12.0-21.5	13.7-22.6	12.8-22.5	12.0-20.6
	Mean	18.1	3.5	16.7	15.5	15.5	16.6	17.2	18.2
	Stdev	3.5	17.8	3.1	3.0	3.5	2.9	2.8	3.7
K mg L^{-1}	Range	55.0-85.0	55.5-85.2	58.7-88.2	60.0-90.2	65.5-98.8	65.0-90.1	58.5-88.5	53.3-82.2
	Mean	68.9	69.4	71.6	74.4	77.5	72.7	11.1	66.4
	Stdev	11.6	11.6	11.6	10.3	12.6	10.9	70.5	11.7

extremely high value of physico-chemical parameters (Table 1-3). The values of pH were mostly within normal range with slight increase during June to August each year.

Throughout the study, the value of EC, TDS and T-Hard

Table 2. Value of physico-chemical parameters in all amphibian ponds during year-2012.

Parameters	Value	March	April	May	June	July	August	September	October
pH	Range	7.2-8.8	7.5-8.8	8.0-8.5	8.0-9.0	8.2-9.0	8.0-8.8	7.5-8.8	7.0-8.5
	Mean	8.1	8.2	8.4	8.5	8.7	8.5	8.2	7.9
	Stdev	0.6	0.5	0.4	0.4	0.3	0.3	0.5	0.6
EC µS cm^{-1}	Range	1047.2-3950.0	1162.0-4128.5	1200.0-4250.0	1262.0-4582.0	1310.5-4725.8	1274.0-4524.0	1250.0-4180.4	1009.5-3832.5
	Mean	2214.1	2323.1	2378.5	2499.4	2567.6	2495.2	2344.0	2086.1
	Stdev	1204.5	1253.1	1273.4	1363.9	1412.6	1386.4	1251.5	1139.3
TDS mg L^{-1}	Range	725.5-2352.5	778.5-2388.0	800.2-2400.5	850.8-2575.0	885.5-3180.1	868.8-3070.0	850.2-2405.0	700.1-2275.5
	Mean	1425.6	1466.3	1494.0	1669.2	1704.0	1556.9	1485.7	1349.8
	Stdev	659.7	654.2	653.0	850.1	879.5	701.1	624.7	633.8
T-Hard mg L^{-1}	Range	200.0-850.1	250.5-865.5	250.0-870.1	269.2-889.5	300.0-950.9	300.0-900.0	285.5-885.5	200.0-835.5
	Mean	463.3	490.3	528.7	553.8	571.2	533.9	508.1	446.8
	Stdev	281.4	270.0	266.3	269.8	280.5	272.5	264.8	278.9
T-Alk mg L^{-1}	Range	210.0-444.8	250.5-460.8	272.5-475.5	300.0-481.2	328.5-500.0	300.5-488.5	278.9-478.4	200.0-415.5
	Mean	336.1	360.5	389.3	406.2	421.2	398.9	381.4	318.7
	Stdev	92.4	84.0	71.5	74.1	69.9	78.9	83.7	91.4
Cl mg L^{-1}	Range	210.5-465.0	250.0-475.8	265.5-480.0	280.0-485.5	300.0-500.7	288.0-480.5	270.0-480.0	200.5-450.0
	Mean	337.1	358.9	368.6	383.1	395.7	378.6	364.8	323.4
	Stdev	92.8	85.3	84.0	76.3	81.3	83.8	77.2	90.3
SO_4 mg L^{-1}	Range	300.8-750.1	321.8-755.5	350.0-762.8	388.4-780.5	400.0-800.0	370.5-789.2	325.0-760.8	284.0-700.0
	Mean	462.7	478.1	496.1	519.6	538.2	518.5	479.2	434.7
	Stdev	175.1	174.8	168.8	166.1	166.6	172.0	180.7	168.4
PO_4 mg L^{-1}	Range	341.5-450.6	350.0-481.3	362.4-485.0	380.5-495.5	385.8-500.1	380.2-458.3	341.5-458.0	300.0-400.0
	Mean	382.6	388.4	410.3	426.5	440.1	413.5	401.9	345.3
	Stdev	39.5	44.4	30.3	47.7	43.9	46.8	51.3	41.9
NO_2 mg L^{-1}	Range	1.8-10.0	2.0-10.5	2.5-10.9	3.0-11.0	3.4-11.9	3.0-8.9	2.5-10.5	1.0-9.2
	Mean	5.1	5.6	6.0	6.5	7.0	6.5	6.0	4.5
	Stdev	3.6	3.5	3.3	3.3	3.3	3.2	3.5	3.6
NO_3 mg L^{-1}	Range	5.0-12.7	5.8-13.0	6.0-13.6	6.5-13.7	7.0-14.0	7.3-12.6	5.8-12.2	4.5-12.0
	Mean	7.7	8.0	8.7	9.0	9.5	9.0	8.2	7.1
	Stdev	3.1	2.6	3.0	2.9	2.7	2.2	2.9	3.1
CO_2 mg L^{-1}	Range	13.7-22.4	12.9-21.5	13.8-20.5	12.5-20.8	12.2-20.0	13.9-20.5	13.9-22.1	14.2-25.5
	Mean	17.9	17.6	16.9	16.2	15.5	16.6	17.2	19.0
	Stdev	3.2	3.2	2.7	3.4	3.1	3.2	2.5	4.0
K mg L^{-1}	Range	60.8-85.5	65.5-88.8	70.5-90.0	72.0-90.5	75.0-95.5	70.2-92.2	67.5-85.0	58.2-80.0
	Mean	74.2	76.6	81.8	82.6	85.7	82.3	78.2	68.8
	Stdev	9.2	6.2	7.1	6.7	7.3	8.0	8.6	8.5

was prominently out of recommended level (see EPA 1976). It is noteworthy that the value of EC is affected by the level of TDS and in fact EC represents how much quantity of different salts were dissolved into the water bodies. Recommended value of EC for healthy amphibian's environment lies between 150.0 – 500.0 µS/cm (Boyer et al. 1995, EPA, 1976), whereas suggested level of TDS extends from 50.0 mg L^{-1} to 250.0 mg L^{-1}. In this context EC and TDS value were completely unfavorable for the amphibians, along with Hardness concentration which was up to 950.9 mg L^{-1}.

The level of T-Alk persisted high along with some other parameters: Cl, SO_4, PO_4, NO_2 and NO_3. Total alkalinity was ranging from low to very high levels, whereas chloride values remained permanently high (178.2 to 605.3 mg L^{-1}). We discovered concentration of SO_4 out of optimum levels as it stayed highly surpassed (233.8 to 800.0 mg L^{-1}), whereas PO_4 was suspended in concentration of 158.2-600.0 mg L^{-1} in six amphibian habitats. NO_2 concentration prevailed between 0.1 to 14.6 mg L^{-1}, value of this parameter fluctuated between normal and nonstandard level, however the range of NO_3 concentration was entirely out of preferable level. Like pH, CO_2 values were normal; however concentration of K was higher than auspicious level (25.0 - 50.0). High values of these parameters especially from June to August in year 2011, 2012 and 2013 may cause worse effects on the spawning and hatching of amphibians.

It was noted that concentration of all parameters fluctuated in synchronized manner, increasing and decreasing at the same time (except for CO_2 value that varied in the opposite tendency). The concentration of the parameters (except CO_2) varied in cyclic manner every year - starting gradually increasing from march, peeked in July and then decreasing gradually until October (Table 1-3).

Previous studies in other Talukas of District Jamshoro (Taluka Kotri and Thano Bula Khan) have indicated similar results divulging unsuitable environmental conditions for amphibians (Shaikh et al. 2016a,b). In the comparison of those studies, the present investigation shows that Taluka Sehwan retains intermediary position concerning the water quality. The contamination of the waters in Taluka Kotri is less severe, but the waters of the Taluka Thano Bula Khan's are in a more dire condition. The present analysis corre-

Table 3. Value of physico-chemical parameters in all amphibian ponds during year-2013.

Parameters	Value	March	April	May	June	July	August	September	October
pH	Range	7.0-8.8	7.2-8.8	7.5-8.8	7.5-8.9	8.0-9.2	7.8-8.9	7.5-8.5	7.2-8.2
	Mean	8.0	8.1	8.3	8.5	8.7	8.4	8.2	7.8
	Stdev	0.7	0.7	0.6	0.5	0.4	0.6	0.4	0.4
EC $\mu S\ cm^{-1}$	Range	1000.0-3840.0	1082.0-3872.0	1125.8-3885.0	1167.0-3970.0	1248.5-4085.0	1200.0-4007.0	1189.0-3850.0	1150.0-3592.0
	Mean	2180.3	2246.4	2321.7	2410.6	2496.5	2379.7	2282.8	2206.0
	Stdev	1179.6	1190.8	1182.4	1238.6	1281.6	1235.5	1186.4	1120.5
TDS $mg\ L^{-1}$	Range	635.5-2415.0	650.8-2450.0	700.8-2479.0	745.2-2800.0	800.5-2982.0	750.8-2920.0	700.2-2675.0	700.0-2471.5
	Mean	1427.6	1464.9	1558.7	1658.5	1728.0	1573.4	1479.2	1401.5
	Stdev	714.2	708.7	772.2	846.2	888.2	799.0	715.6	713.9
T-Hard $mg\ L^{-1}$	Range	150.0-809.5	187.5-840.2	200.5-850.0	215.8-888.5	250.0-900.5	229.7-900.0	200.5-850.3	200.0-800.0
	Mean	465.7	482.8	501.6	534.0	551.2	520.8	490.2	444.3
	Stdev	282.2	261.3	272.7	286.4	283.7	287.4	278.0	281.6
T-Alk $mg\ L^{-1}$	Range	162.8-420.0	185.5-420.6	200.8-442.5	220.6-450.0	245.0-465.5	240.5-450.9	225.8-400.0	200.0-380.5
	Mean	318.6	327.3	342.4	356.3	370.3	353.8	335.8	316.5
	Stdev	99.8	90.4	89.4	81.8	89.9	87.5	73.9	73.5
Cl $mg\ L^{-1}$	Range	200.0-450.0	250.0-452.8	275.5-458.0	285.0-460.5	300.5-475.0	300.0-462.5	300.0-450.8	250.0-400.0
	Mean	326.6	350.1	368.4	380.0	391.2	373.0	356.7	326.4
	Stdev	65.3	83.1	72.2	65.4	66.0	74.3	65.8	96.8
SO_4 $mg\ L^{-1}$	Range	268.8-650.0	280.0-650.9	285.5-671.5	300.0-680.0	340.7-685.5	335.5-670.0	300.0-650.0	280.5-600.0
	Mean	441.4	449.2	479.6	495.0	515.9	493.6	467.8	433.2
	Stdev	138.0	156.4	158.1	155.0	147.7	147.2	143.1	157.1
PO_4 $mg\ L^{-1}$	Range	272.5-450.5	280.0-455.8	292.5-460.0	300.0-475.5	310.5-480.0	300.0-477.5	288.5-450.0	265.5-405.0
	Mean	328.7	348.8	347.4	358.4	374.8	352.9	337.1	327.9
	Stdev	65.9	65.5	60.6	64.3	61.6	67.8	61.7	56.4
NO_2 $mg\ L^{-1}$	Range	1.0-9.5	1.7-10.0	2.0-10.2	2.5-10.5	3-11.1.0	3.0-10.9	2.5-9.8	2.0-9.0
	Mean	5.1	5.4	5.8	6.4	6.7	6.0	5.5	4.2
	Stdev	3.5	3.3	3.2	3.3	3.5	3.4	3.5	3.4
NO_3 $mg\ L^{-1}$	Range	4.2-10.0	4.5-10.2	4.5-10.5	4.8-11.5	5.0-12.4	4.4-12.0	4.0-11.0	3.0-9.5
	Mean	5.6	5.8	6.0	6.4	6.8	6.3	5.9	5.1
	Stdev	2.2	2.2	2.2	2.8	2.8	2.6	2.6	2.3
CO_2 $mg\ L^{-1}$	Range	12.0-19.5	13.5-22.5	12.5-22.5	13.7-23.5	12.0-24.0	13.5-22.5	12.5-24.0	14.5-24.8
	Mean	18.9	18.7	17.9	17.3	15.6	17.4	18.4	20.1
	Stdev	4.3	3.6	3.6	4.4	3.1	3.7	3.8	3.9
K $mg\ L^{-1}$	Range	58.5-85.9	60.2-88.2	65.0-88.5	68.5-90.5	72.0-95.0	65.0-89.8	62.0-85.5	58.0-80.0
	Mean	72.4	73.8	77.0	77.7	84.0	80.8	75.7	69.1
	Stdev	10.9	8.5	9.3	9.3	8.4	8.6	10.6	8.1

sponds with previous studies (Shaikh et al. 2016a,b) apropos prevalence of dangerous condition without major variations in monthly and yearly values. Water quality plays major role in either developing or damaging amphibian populations, hence regular check and balance of their habitats is very important. Environmental contamination may result from massive negligence of local people who pollute water reservoirs wherein wild animals dwell. Therefore, native people should be educated to keep environment free from pollutions by avoiding usage of harmful chemicals and throw of garbage into ponds. Environment friendly anthropogenic activities must be enhanced in order to save amphibian fauna.

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