

## A COMPREHENSIVE ANALYTICAL STUDY OF AMPHIBIAN HABITATS IN DISTRICT LARKANA, SINDH, PAKISTAN

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### **Abstract**

An analytical study of physico-chemical parameters in amphibian habitats was carried out for three years (2011-2013) in four talukas (subdivisions): Bakrani, Dokri, Larkana and Rato Dero of District Larkana which were explored distinctively for the search of amphibian habitats in agricultural fields. From 26 agricultural ponds (permanently inhabited by amphibians) water samples were collected and analyzed for the determination of physico-chemical parameters including pH, EC, TDS, T-Hard, T-Alk, Cl, SO<sub>4</sub>, PO<sub>4</sub>, NO<sub>2</sub>, NO<sub>3</sub>, CO<sub>2</sub> and K using scientific instrumentation and chemicals. Present study recorded value of most of parameters too high to support amphibian survival in all subdivisions. Variation in value of parameters was recorded every month with maximum upsurge in July, while minimum value of all parameters was noted in October, but it was duly recorded that even minimum value was still too high to meet favorable criteria. Yearly variation in water quality was also obvious as pollution rate was higher during year 2012, while comparatively lower level of the contamination was recorded during year 2011. Present investigation confirmed the existence of massive pollution into aquatic habitats in District Larkana which may affect amphibian fauna badly.

**Keywords:** Amphibian habitat; physico-chemical parameters; District Larkana;

### **Introduction**

Amphibian population has been declining drastically since 1950 but the mortality rate has become extremely higher for the last two decades [1]. About 43% population of amphibians is on the verge of decline, while about 168 amphibian species have already declined [1]. This deplorable status of amphibian population urges on the regular check and balance of amphibian diversity, population and habitats as environmental pollution is one of the major reasons behind their decline. Many studies in Sindh province have recorded deplorable status of amphibian habitations [2-9].

Larkana is a main district located in the North-West of Sindh province at 27°33" North (Latitude) 68°13" East (Longitude). This study zone consists of plain soil with extremely muddy and swamp fields with large number of water reservoirs which not only support agricultural products to grow, but also provide shelter to variety of aquatic animals including amphibians which are sensitive to water quality of their habitats. Therefore, present study was based on evaluation of physico-chemical characteristics of amphibian habitats in agricultural

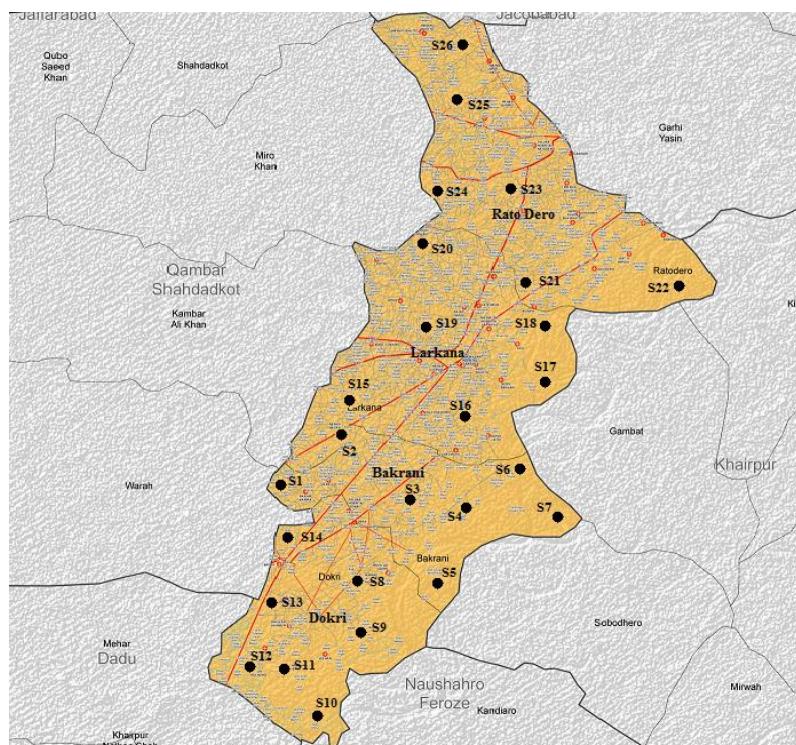
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areas of District Larkana where no check and balance has ever been conducted for the conservation of amphibian fauna. This comprehensive study was also focused on distinguishing the water quality of habitats situated all subdivisions separately as well as to represent status of whole District along with monthly and yearly variations in concentration of physico-chemical parameters into amphibian habitats.

Physico-chemical parameters have lethal or sub lethal effects on amphibians according to their concentration. Sub lethal effects of contaminants include retarded growth and hindered development in amphibians along with different physical and physiological abnormalities [10]. Chemical pollutants can also induce different types of diseases and may also weaken the immune system [10].

## Material and Methods

Present study consisted of field surveys and laboratory analysis, both conducted from March to October during three consecutive years (2011-2013). Altogether 26 amphibian habitats in agricultural ponds were selected (Fig. 1).



**Fig. 1.** Map of study area with location of study sites (S): S1 Mehrab pur, S2 Bahadur Khan, S3 Wakro, S4 Mud bahu, S5 Goth Wazir, S6 Purano abad, S7 Wahan, S8 Garelo, S9 Faridabad, S10 Arija, S11 Kot chandka, S12 Fateh pur, S13 Badrah, S14 Sihar, S15 Zakaria Mahesar, S16 Dhamrah, S17 F. Muhammad, S18 Habib bughio, S19 Bero chandio, S20 Rashid wagan, S21 Wassayo Bhutto, S22 Kodrani, S23 Zangeja, S24 Khanwah, S25 Noudero, S26 Kahirodero

Field surveys and water sampling was conducted by following systematic and scientific methods, while specific analytical instruments were used for the determination of concentration of parameters [10]. Value of electric conductivity (EC) and total dissolved solids (TDS) was

measured with help of conductivity meter (Model: Orion. 115), whereas concentration of sulphate ( $\text{SO}_4^{2-}$ ), phosphate ( $\text{PO}_4^{3-}$ ), nitrite ( $\text{NO}_2^-$ ) and nitrate ( $\text{NO}_3^-$ ) was analyzed using ultra violet (UV) Spectrophotometer (Model: Hitachi 200).

Other parameters such as T-Hard, T-Alk,  $\text{Cl}^-$  and  $\text{CO}_2$  were analyzed via specific titration procedures [11-12], whereas concentration of potassium ( $\text{K}^+$ ) was recorded using Atomic absorption Spectrophotometer (Model: Perkin Elmer Analyst 800).

## Results and Discussion

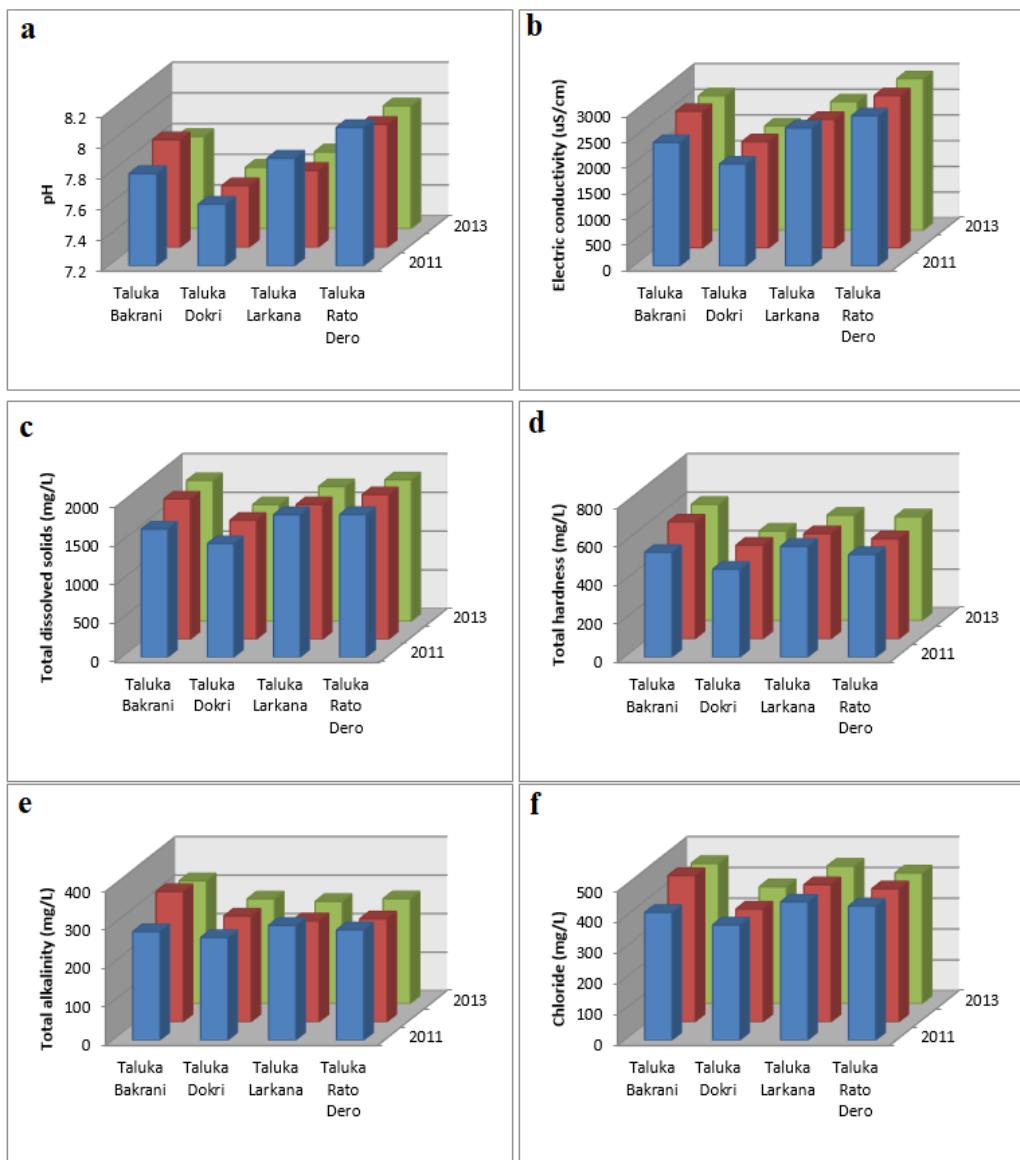
Values of physico-chemical parameters in entire District Larkana were recorded unsuitable for amphibian fauna. Concentration of each parameter was recorded as followed: EC -  $1180.5\text{-}7472.6\mu\text{S}\cdot\text{cm}^{-1}$ , TDS -  $788.8\text{-}4309.2\text{mg}\cdot\text{L}^{-1}$ , T-Hard -  $200.5\text{-}980.7\text{mg}\cdot\text{L}^{-1}$ , T-Alk -  $150.2\text{-}477.5\text{mg}\cdot\text{L}^{-1}$ ,  $\text{Cl}^-$  -  $175.3\text{-}745.1\text{mg}\cdot\text{L}^{-1}$ ,  $\text{SO}_4^{2-}$  -  $200.8\text{-}817.9\text{mg}\cdot\text{L}^{-1}$ ,  $\text{PO}_4^{3-}$  -  $200.0\text{-}780.8\text{mg}\cdot\text{L}^{-1}$ ,  $\text{NO}_2^-$  -  $0.9\text{-}19.5\text{mg}\cdot\text{L}^{-1}$ ,  $\text{NO}_3^-$  -  $1.3\text{-}20.6\text{mg}\cdot\text{L}^{-1}$  and  $\text{K}^+$  -  $50.8\text{-}99.5\text{mg}\cdot\text{L}^{-1}$ .

Aquatic habitats in each subdivision consisted of different values of physico-chemical parameters each year (Fig. 2-13), while yearly status of all amphibian habitats in whole District Larkana in relation to concentration of parameters is distinctively detailed in Table 1.

**Table 1.** Water quality of all amphibian habitats in whole District Larkana

Parameters	Year-2011	Year-2012	Year-2013
pH	$7.8\pm0.7$	$7.8\pm0.8$	$7.8\pm0.8$
EC ( $\mu\text{S}\cdot\text{cm}^{-1}$ )	$2473.9\pm1198.2$	$2536.1\pm1112.5$	$2508.9\pm1109.1$
TDS ( $\text{mg}\cdot\text{L}^{-1}$ )	$1688.8\pm622.4$	$1731.7\pm563.8$	$1715.9\pm557.3$
T-Hard ( $\text{mg}\cdot\text{L}^{-1}$ )	$525.0\pm176.2$	$540.0\pm168.0$	$537.7\pm167.6$
T-Alk ( $\text{mg}\cdot\text{L}^{-1}$ )	$282.4\pm63.8$	$287.1\pm73.0$	$282.8\pm63.1$
$\text{Cl}^-$ ( $\text{mg}\cdot\text{L}^{-1}$ )	$416.1\pm100.4$	$428.6\pm98.9$	$425.1\pm93.6$
$\text{SO}_4^{2-}$ ( $\text{mg}\cdot\text{L}^{-1}$ )	$450.5\pm129.5$	$454.9\pm122.2$	$449.8\pm114.5$
$\text{PO}_4^{3-}$ ( $\text{mg}\cdot\text{L}^{-1}$ )	$417.9\pm95.4$	$437.3\pm93.8$	$432.9\pm93.1$
$\text{NO}_2^-$ ( $\text{mg}\cdot\text{L}^{-1}$ )	$3.8\pm1.7$	$4.7\pm2.1$	$5.1\pm2.9$
$\text{NO}_3^-$ ( $\text{mg}\cdot\text{L}^{-1}$ )	$7.4\pm6.4$	$7.3\pm3.1$	$7.2\pm2.8$
$\text{CO}_2$ ( $\text{mg}\cdot\text{L}^{-1}$ )	$18.2\pm3.9$	$18.4\pm3.6$	$18.8\pm3.6$
$\text{K}^+$ ( $\text{mg}\cdot\text{L}^{-1}$ )	$73.7\pm9.4$	$75.2\pm10.3$	$74.0\pm9.7$

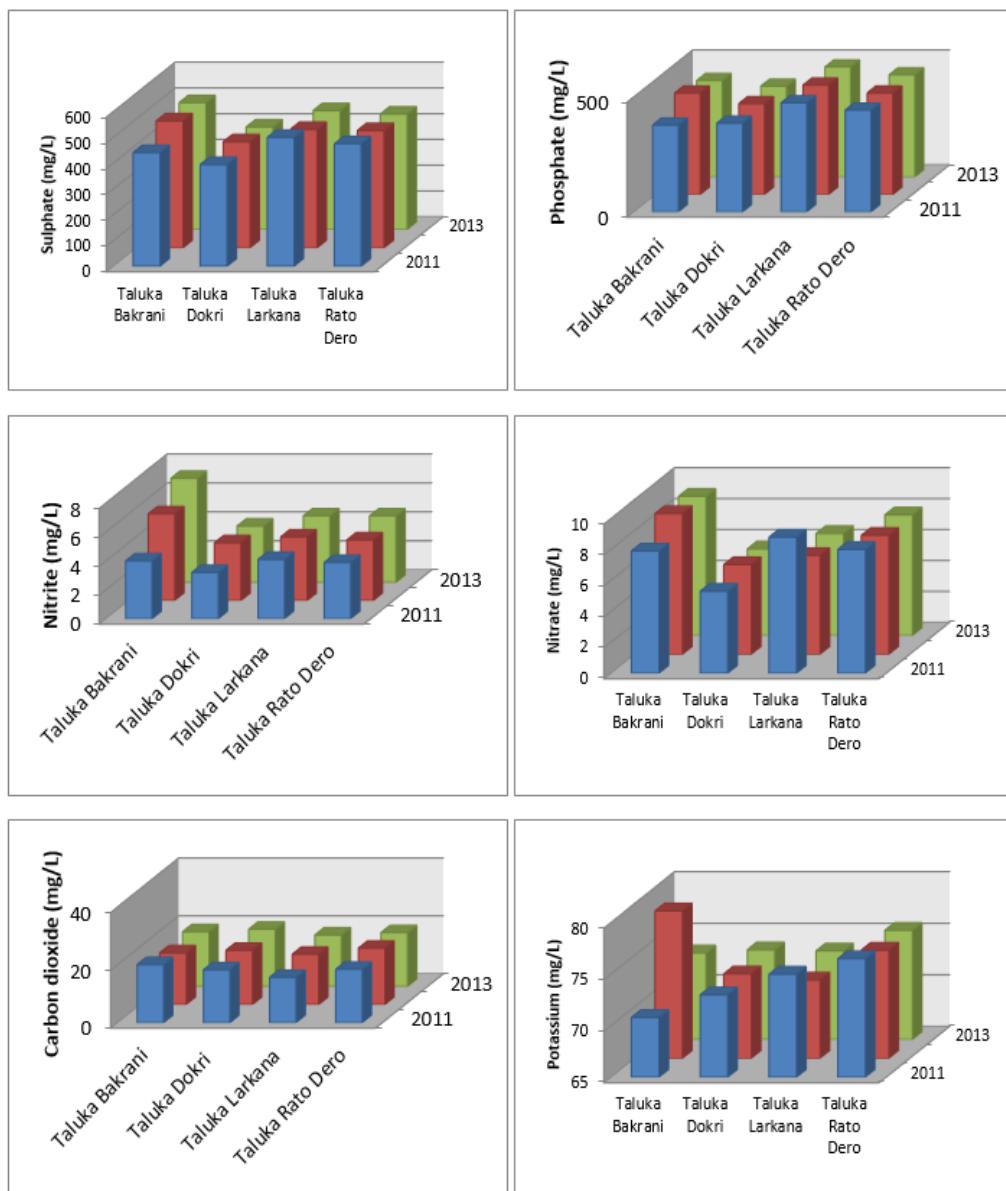
pH value of study sites (6.4-9.5) was within favorable limit for most of the time [13-17] but exceeded slightly higher during some instances. Monthly and yearly variations in value of pH of each subdivision were insignificant, while slightly inconstant value of this parameter was recorded at different subdivisions of District Larkana (Fig. 2). Meanwhile, value of EC was recorded entirely out of normal level i.e.  $150.0\text{-}500.0\mu\text{S}/\text{cm}$  [14-18]. Highest value of EC ( $2945.1\pm1617.4\mu\text{S}/\text{cm}$ ) was recorded from Taluka Rato Dero, wherein habitats of Taluka Dokri lowest level ( $2027.8\pm517.8\mu\text{S}/\text{cm}$ ) of the parameter in question were measured. Concentration of total dissolved solids remained out of normal limit with variation in its quantity parallel to the value of EC (Fig. 3-4). TDS value was highly above the normal range i.e.  $50.0\text{-}250.0\text{mg/L}$  [19]. Higher value of this parameter ( $1843.5\pm691.1\text{mg/L}$ ) was thoroughly recorded from Taluka Rato Dero, while in the Taluka Dokri  $1501.8\pm323.6\text{mg/L}$  value of this parameter was recorded. All habitats were found concentrated with high value of T-Hard in an uneven manner at different subdivisions of District Larkana (Fig. 5).



**Fig. 2.** Variations of different parameters in habitats at specific subdivisions (Bakrani, Dokri, Larkana and Ratodro) of District Larkana: a – pH, b – EC, c – TDS, d - T-Hard, e - T-Alk, f - Cl<sup>-</sup>

Amphibian habitats did not contain normal level of hardness [14, 19] especially in Taluka Bakrani where  $584.6 \pm 229.9$  value of this parameter was prominently noted, whereas amphibian habitats in Taluka Dokri were concentrated with comparatively lesser concentration ( $468.8 \pm 101.5$  mg/L) of the parameter in question. Value of T-Alk also remained inauspiciously high for the survival of amphibians in entire study area where its higher value ( $312.8 \pm 72.8$  mg/L) was analyzed from Taluka Bakrani, while other three subdivisions did not exhibit any major variation in value of this parameter but habitats in Taluka Dokri consisted of comparatively lesser value ( $270.8 \pm 57.0$  mg/L) as indicated in Figure 6. Concentration of Cl<sup>-</sup> did not vary significantly in four Talukas and remained too high to maintain normal standard of

water quality of amphibian habitats [14, 20]. Value of  $\text{Cl}^-$  was extremely high during all the years with very minute difference (Fig. 7), while a slight variation in concentration of  $\text{Cl}^-$  was recorded into amphibian habitats of Taluka Bakrani and Taluka Larkana where respective values were recorded as  $447.9 \pm 120.7$  and  $446.3 \pm 79.2 \text{ mg/L}$ , while in Taluka Dokri  $373.0 \pm 73.1 \text{ mg/L}$  value of  $\text{Cl}^-$  was recorded to persist throughout the study period (Figs. 2 and 3).



**Fig. 3.** Variations of different parameters in habitats at specific subdivisions (Bakrani, Dokri, Larkana and Ratodro) of District Larkana: a –  $\text{SO}_4$ , b –  $\text{PO}_4$ , c –  $\text{NO}_2$ , d -  $\text{NO}_3$ , e -  $\text{CO}_2$ , f - K

Whole study area was evaluated to contain  $\text{SO}_4^{2-}$  quantity extremely opulent with comparable value of  $\text{PO}_4^{3-}$  during three year study period. Higher value of  $\text{SO}_4^{2-}$  ( $475.6 \pm 162.0 \text{ mg/L}$ ) was recorded from Taluka Bakrani, while habitats in Taluka Dokri consisted of its lesser value ( $401.7 \pm 69.8 \text{ mg/L}$ ), whereas higher value of  $\text{PO}_4^{3-}$  ( $476.8 \pm 82.0 \text{ mg/L}$ ) was recorded from Taluka Larkana throughout the study period but its lesser value i.e.  $392.5 \pm 78.9 \text{ mg/L}$  was recorded from amphibian habitats of Taluka Dokri. Both of these non-metallic parameters were out of favorable level for stable survival of amphibians [21].

Value of nitrite was highly variable fluctuating randomly from high to low but its value stayed normal for short time and remained unfavorable for most of the time, hence it may have effectual impact mainly from May to August which is amphibian's breeding and hatching duration. Maximum value of  $\text{NO}_2^-$  ( $5.7 \pm 3.5 \text{ mg/L}$ ) was recorded from Taluka Bakrani, while  $3.7 \pm 1.4 \text{ mg/L}$  value (comparatively lower value) was recorded from Taluka Dokri (Fig. 10). Like  $\text{NO}_2^-$ , value of  $\text{NO}_3^-$  was also recognized as most fluctuating parameter as its concentration was recorded occasionally normal and frequently out of normal level (Fig. 11). Inauspicious value of  $\text{NO}_3^-$  continuously prevailed from May to August during which amphibians breed, thus highly dissipating quality of this nitrogenous compound may have negative impact on survival of amphibian eggs and larvae. Analytical study revealed that the habitats of Taluka Bakrani were more concentrated with  $\text{NO}_3^-$  value ( $8.6 \pm 4.0 \text{ mg/L}$ ), while habitats situated in Taluka Dokri consisted of comparatively lower value i.e.  $5.6 \pm 1.4 \text{ mg/L}$  of the parameter in question.

Like pH, value of  $\text{CO}_2$  was also within normal level in all the subdivisions of District Larkana (Fig. 12). Value of  $\text{CO}_2$  was recorded identical ( $19.0 \pm 4.0 \text{ mg/L}$ ) in Taluka Bakrani and Dokri from, while in Taluka Rato Dero and Taluka Larkana very slight difference was measured in quantity of  $\text{NO}_3^-$  respectively as  $18.9 \pm 3.2$  and  $17.0 \pm 3.5 \text{ mg/L}$ . Concentration of potassium was also recorded very high and approximately same in all the subdivisions as followed: Taluka Bakrani ( $74.5 \pm 11.3 \text{ mg/L}$ ), Dokri ( $74.5 \pm 11.3 \text{ mg/L}$ ), Larkana ( $73.8 \pm 10.0 \text{ mg/L}$ ) and Rato Dero ( $75.9 \pm 8.8 \text{ mg/L}$ ), while variation in concentration of  $\text{K}^+$  is highlighted in Figure 13.

Mean value of parameters from entire 26 amphibian habitats of District Larkana (EC,  $2506.3 \text{ mS/cm}$ ; TDS,  $1712.1 \text{ mg/L}$ ; T-Hard,  $534.2 \text{ mg/L}$ ; T-Alk,  $284.4 \text{ mg/L}$ ;  $\text{Cl}^-$ ,  $423.2 \text{ mg/L}$ ;  $\text{SO}_4^{2-}$ ,  $451.8 \text{ mg/L}$ ;  $\text{PO}_4^{3-}$ ,  $429.4 \text{ mg/L}$  and  $\text{K}^+$ ,  $74.3 \text{ mg/L}$ ) was entirely above the auspicious level, while values of  $\text{NO}_2^-$  ( $4.5 \text{ mg/L}$ ) and  $\text{NO}_3^-$  ( $7.2 \text{ mg/L}$ ) varied within normal and harmful level, whereas pH and  $\text{CO}_2$  values were recorded normal throughout the study period of three years. Value of all the parameters (except  $\text{CO}_2$ ) varied synchronizing at all study sites as they rose to maximum concentration in July each year (2011, 2012 and 2013), whereas lowest level of all the physico-chemical parameters was noted in October. Value of  $\text{CO}_2$  fluctuated in opposite manner i.e. increased to uppermost level in October and lessened to bottom in July.

## Conclusion

Contamination found at all aquatic habitats of amphibian fauna due to massive amounts of physico-chemical parameters including EC, TDS, T-Hard, T-Alk,  $\text{Cl}^-$ ,  $\text{SO}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NO}_2^-$ ,  $\text{NO}_3^-$  and  $\text{K}^+$  especially in year 2012, though value of pH and  $\text{CO}_2$  remained within normal level throughout the study period. It was thoroughly determined that the water quality of habitats was unsuitable for the survival of amphibians that must be checked and balanced more importantly during breeding season as spawns and larvae are highly susceptible to water quality of their

habitats. In this circumstance, amphibian habitats need to be treated well regularly to save amphibian diversity and population in the study area.

## References

- [1] S.N. Stuart, J.S. Chanson, N.A. Cox, *Status and trends of amphibian declines and extinctions worldwide*, **Science**, **306**, 2004, pp. 1783–1786.
- [2] Kalsoom, G.S. Gachal, S.Q. Memon, N.A. Sodho, M.S. Yusuf, *Assessment of physico-chemical parameters in wild amphibian environment of Taluka Kotri, District Jamshoro, Sindh-Pakistan*, **Pakistan Journal of Wildlife**, **7**, 2016, pp. 1-10.
- [3] S. Kalsoom, G.S. Gachal, S.Q. Memon, N.A. Sodho, M.S. Yusuf, *Assessment of environmental issues of amphibian fauna in Taluka Thano Bula Khan (district jamshoro) Sindh-Pakistan*, **International Journal of Conservation Science**, **7**, 2016, pp. 579-588.
- [4] S. Kalsoom, G.S. Gachal, S.Q. Memon, M.S. Yusuf, *Hardness and alkalinity in amphibian environment at District Hyderabad Sindh, Pakistan*, **Flora and Fauna**, **21**, 2015, pp. 3-8.
- [5] S. Kalsoom, G.S. Gachal, S.Q. Memon, M.S. Yusuf, *Evaluation of water quality and seasonal variation in aquatic environment of amphibians in District Hyderabad Sindh, Pakistan*, **Journal of Entomology and Zoological Studies**, **3**, 2015, pp. 331-335.
- [6] S. Kalsoom, G.S. Gachal, S.Q. Memon, N.A. Sodho, M.S. Yusuf. A.H. Qadri, *Analysis of non-metallic contaminants from amphibian environment in Sindh, Pakistan*, **International Journal of Fauna and Biological Studies**, **1**, 2014, pp. 54-58.
- [7] S. Kalsoom, G.S. Gachal, S.Q. Memon, R.Z. Brohi, M.S. Yusuf, *Assessment of Physico-chemical parameters in the amphibian environment in District Hyderabad Sindh, Pakistan*, **Journal of Entomology and Zoological Studies**, **2**, 2014, pp. 241-245.
- [8] S. Kalsoom, G.S. Gachal, S.Q. Memon, R.Z. Brohi, M.S. N.A. Sodho, *Assessment of amphibian environment through Physico-chemical analysis in Pakistan*, **Journal of Biodiversity and Environmental Sciences**, **5**, 2014, pp. 255-261.
- [9] S. Kalsoom, G.S. Gachal, S.Q. Memon, N.A. Sodho, M.S. Yusuf, A.H. Qadri, *Impact of Non-optimal Environmental Conditions on Survival of Amphibians in Pakistan*, **International Journal of Advanced Research**, **1**, 2013, pp. 140-146.
- [10]\* \* \*, **Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wale**, Environmental Protection Agency (EPA-USA), (ISBN 1 74137 051 5), 2004, pp. 42-70.
- [11] C.H. Danial, **Quantitative Chemical Analysis** (third edition), 1948, pp. 7-51.
- [12] R. Sunita, **Experiments in Applied Chemistry** (second edition), 2002, pp. 77-93.
- [13] L.J. Vitt, J.P. Caldwell, H.M. Wilbur, D.C. Smith, *Amphibians as harbingers of decay*, **Bioscience**, **40**, 1990, pp. 418-422.
- [14] Environmental Protection Agency (EPA-USA), **Quality Criteria for Water**, 1976, p. 534.
- [15] Environmental Protection Agency (EPA-USA), **Quality Criteria for Water** (Gold Book), EPA 440/5-86-001, Washington D.C., 1986, p. 477.
- [16] B.A. Pierce, *Acid tolerance in amphibians*, **Bioscience**, **35**, 1985, pp. 239-243.
- [17] American Public Health Association (APHA), **Standard Methods for the Examination of Water & Wastewater** (eighteenth edition), 1992, pp. 35-50.
- [18] R. Boyer, E.G. Christian, *The Need for Water Quality Criteria for Frogs*, **Environmental Health Perspectives**, **103**, 1995, pp. 352–357.
- [19] W.A. Wurts, R.M. Durborow, Interactions of pH, carbon dioxide, alkalinity and hardness in fish ponds, **Southern Regional Aquaculture Center Publication No. 464**, 1992, pp.

60-83.

[20] N.E. Karrakar, *Impacts of road deicing salts on amphibians and their habitats*, **Urban Herpetology**, **20**, 2008, pp. 183-196.

[21]\* \* \*, **Ambient Water Quality Guidelines for Sulphate, Overview Report, Environment Management Act-1981**, Environmental Protection Division (EPD), 2000.

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