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An analytical study of habitat degradation for amphibians at Jamshoro and Larkana districts, Sindh Pakistan

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Abstract
The present study was proposed to evaluate quality of amphibian habitats in two main Districts: Jamshoro and Larkana of Sindh Province to determine whether they are protected from contamination or not. Present investigation consisted of field surveys and laboratory work conducted from March to October in year 2011, 2012 and 2013. At first, fields were explored to find amphibian habitations for water sampling from there, later on, water samples were shifted to the concerned laboratory for the analysis of parameters including pH, EC, TDS, T-Hard, T-Alk, Cl, SO_4, PO_4, NO_2, NO_3, CO_2 and K using analytical equipment. Values of all parameters were measured and identified as highly above than favorable level at all the habitats at both study zones. Amphibian habitats in Jamshoro district consisted of pH: 8.1±0.6, EC: 2472.0±1079.3, TDS: 1642.4±682.0, T-Hard: 405.4±172.5, T-Alk: 337.0±71.0, Cl: 351.1±104.8, SO_4: 441.9±131.5, PO_4:398.8±110.5, NO_2: 3.7±2.6, NO_3: 6.3±3.4, CO_2: 18.1±3.5 and K: 71.1±10.3. Meanwhile study conducted in Larkana district recorded the value of parameters as followed; pH: 7.8±0.7, EC: 2506.3±1139.1, TDS: 1712.1±581.2, T-Hard: 534.2±170.5, T-Alk: 284.4±65.9, Cl: 423.2±97.7, SO_4: 451.8±122.1, PO_4: 429.4±94.3, NO_2: 4.5±2.4, NO_3: 7.2±3.1, CO_2: 18.5±3.7, K: 74.3±9.8. This study recorded wide-ranging water quality problems which may affect amphibian population badly mainly during initial stage of their life when they are more sensitive to environmental degradation.

Keywords: Amphibian habitats, physico-chemical parameters, District Jamshoro, District Larkana, Sindh, Pakistan

1. Introduction

Water may appear clean but there are numerous physico-chemical parameters which when increase in high amounts are termed to be the pollutants which make amphibians susceptible to the variety of abnormalities and infections [1]. Amphibian decline is a global problem with complex causes occurring differently in different areas [2]. Ultraviolet radiation, habitat modification, predators, environmental toxicants and diseases are considered as destructors to amphibian populations but a ubiquitous factor that affects amphibians at large is chemical contamination in habitats [3]. Water contaminations, seasonal variability in environmental conditions, lake of management plans for conservation are a combination of a set of factors effecting amphibians badly [4]. Water pollution causes variety of disorders in physiological systems of amphibians and may also cause mortality into them [5]. The physiological defects leaving adverse effects including different kinds of cancers, retained growth, retarded development, abnormal behavior, disruption of endocrine system, digestive and respiratory deformities, reproductive system distortions, hermaphroditism [6-7]. High level of chemical elements can also weaken the immune system of amphibians which then ultimately are the reason of their mortality [8]. Water contaminants alter the central nervous system and make them completely inactive [2]. In this perspective the ecological dynamics of amphibian populations require an integrated research within unexplored parts of world [8]. Environmental status of amphibians is scarcely analyzed in Sindh province but determined successfully in several parts of the word to save this wildlife [9]. Worldwide studies blamed agricultural effluents responsible for the decline of amphibians and Environmental Protection Agency reported that agriculture ranks first as the leading source of water quality problems to wild animals [10].

Pakistan consists of vast fields which not only fulfil the requirement of crop production but also provide shelter to a vast variety of wild fauna in its different parts such as Jamshoro and

Larkana districts. District Jamshoro encompasses geographical area of 11,517 Km^2. It is located in south west of Sindh province at 25.43212°N Latitude 68.263171°E Longitude, consisting of rocky land and perched soil with small number of agricultural fields, whereas Larkana is located in the North-West of Sindh province at 27°33″ North Latitude 68°13″ East Longitude. It covers geographical area of 7,423 km^2 which consists of plain soil with extremely muddy and swamp fields full of agricultural fields with large number of water. Major ecological problems equally faced by both study zones include deforestation, air pollution, water pollution, deterioration and negligence towards sustainability of wild animals. Previous studies have revealed that the amphibian diversity of both study zones (Jamshoro and Larkana districts) is very poor. Among 7000 species of Class Amphibia [9-10], only four species: *Hoplobatrachus tigerinus*, *Euphlyctis cyanophlyctis*, *Bufo stomaticus* and *Allopa hazarensis* have been recorded from district Jamshoro, while in District Larkana three former species have been documented [11-13].

Considering the low diversity of amphibian in Sindh [14-18] and the adverse effects of water contamination on them [19-22], motivated present study was planned to delve into amphibian habitats in Jamshoro and Larkana districts from the ecological, hydrological and environmental perspectives.

Material and Methods

The present study consisted of two features: field surveys and laboratory analytical work. Exploration of Jamshoro and Larkana districts (Fig. 1) helped finding amphibian habitats (study/sampling sites) as indicated in fig. 2 and 3.

Fig 1: Map of Pakistan with location of study zones in Sindh province.

Fig 2: Map of District Jamshoro with study sites.

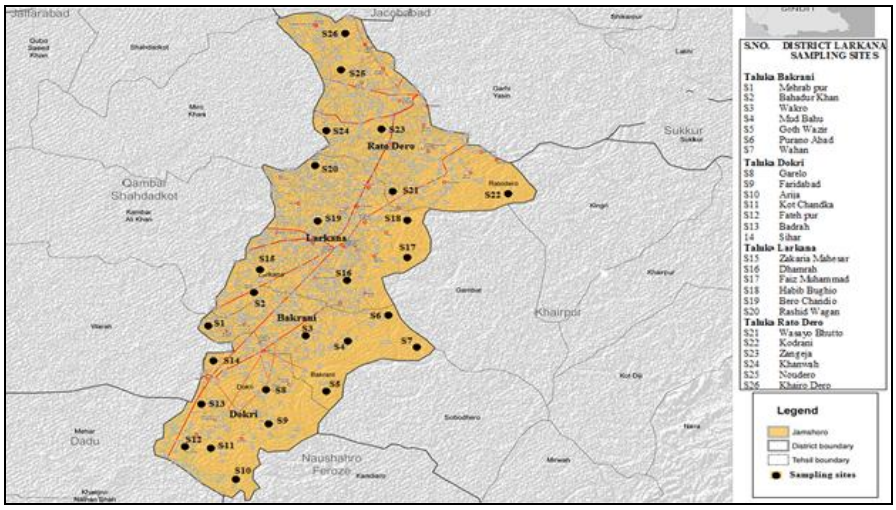

Fig 3: Map of District Larkana with study sites.

Water samples were collected from all amphibian habitats respectively from March to October in year 2011, 2012 and 2013. Water from study sites was collected from different places of same pond from the distance of few feet and mixed well with each other to make a gross water sample to evaluate the water quality of whole pond by following detailed sampling instructions [23]. Water samples were collected in well stoppered polyethylene plastic bottles and were kept at 4 °C prior to processing and analysis. Physico-chemical parameters including pH, electric conductivity (EC), total dissolved solids (TDS), total hardness (T-Hard), total alkalinity (T-Alk), chloride (Cl), sulphate (SO_4), phosphate (PO_4), nitrite (NO_2), nitrate (NO_3), carbon dioxide (CO_2) and potassium (K) were evaluated by following the scientific analytical procedures [24-27].

The scientific data of this analytical study was analyzed statistically using Microsoft Excel 2010 and application of T-Statistics was achieved in order to calculate the difference between variable quantities of physico-chemical parameters.

Results and Discussion

Values of physico-chemical parameters respectively in Jamshoro and Larkana Districts were recorded as mentioned in Table 1 and 2.

Table 1: Value of physico-chemical parameters in amphibian habitats at District Larkana.

Parameters	Year-2011		Year-2012		Year-2013	
	Mean value ± standard deviation	Total range	Mean value ± standard deviation	Total range	Mean value ± standard deviation	Total range
pH	7.8±0.7	6.5-9.4	7.8±0.8	6.5-9.5	7.8±0.8	6.4-9.5
EC µS cm^{-1}	2473.9±1198.2	1180.5-7472.6	2536.1±1112.5	1270.5-6639.8	2508.9±1109.1	1250.2-6610.2
TDS mg L^{-1}	1688.8±622.4	788.8-4309.2	1731.7±563.8	880.2-3508.5	1715.9±557.3	900.5-3475.2
T-Hard mg L^{-1}	525.0±176.2	200.5-980.7	540.0±168.0	300.0-960.3	537.7±167.6	265.9-950.8
T-Alk mg L^{-1}	282.4±63.8	150.2-455.6	287.1±73.0	221.5-470.0	282.8±63.1	157.5-477.5
Cl mg L^{-1}	416.1±100.4	200.2-745.1	428.6±98.9	175.3-690.2	425.1±93.6	200.0-685.2
SO_4 mg L^{-1}	450.5±129.5	200.8-800.8	454.9±122.2	250.1-817.9	449.8±114.5	255.3-780.2
PO_4 mg L^{-1}	417.9±95.4	200.0-780.8	437.3±93.8	228.5-760.7	432.9±93.1	258.0-750.1
NO_2 mg L^{-1}	3.8±1.7	0.9-9.2	4.7±2.1	1.0-19.5	5.1±2.9	1.0-19
NO_3 mg L^{-1}	7.4±6.4	1.3-19.4	7.3±3.1	3.0-20.5	7.2±2.8	2.8-20.6
CO_2 mg L^{-1}	18.2±3.9	10.0-26.0	18.4±3.6	12.0-25.9	18.8±3.6	12.0-25.8
K mg L^{-1}	73.7±9.4	50.8-95.7	75.2±10.3	55.0-98.5	74.0±9.7	50.9-99.5

Table 2: Value of physico-chemical parameters in amphibian habitats at District Jamshoro.

Parameters	Year-2011		Year-2012		Year-2013	
	Mean value ± standard deviation	Total range	Mean value ± standard deviation	Total range	Mean value ± standard deviation	Total range
pH	7.9±0.6	6.7-9.0	8.1±0.6	6.5-9.2	8.1±0.6	6.5-9.4
EC µS cm^{-1}	2456.1±1111.3	945.8-5130.0	2510.8±1087.0	1009.5-4730.8	2449.2±1045.1	1000.0-4577.5
TDS mg L^{-1}	1624.3±724.2	580.6-3437.1	1662.5±668.4	700.0-3250.7	1640.0±656.3	635.5-2982.0
T-Hard mg L^{-1}	386.7±180.4	130.0-920.0	417.7±167.4	200.0-950.9	411.8±169.0	150.0-900.5
T-Alk mg L^{-1}	330.8±80.8	145.5-537.0	351.0±67.8	200.0-500.0	329.2±61.4	162.8-465.5
Cl mg L^{-1}	349.6±124.1	177.5-685.15	359.4±93.8	200.5-630.4	344.4±93.8	180.5-580.2
SO_4 mg L^{-1}	432.5±149.4	200.0-780.8	455.3±129.8	250.0-800.0	438.0±112.5	237.2-685.5
PO_4 mg L^{-1}	400.5±136.7	150.8-800.0	417.5±94.0	180.9-650.7	378.2±92.2	159.4-566.5
NO_2 mg L^{-1}	3.0±2.7	0.1-14.6	4.1±2.6	0.2-11.9	4.1±2.5	0.5-11.1
NO_3 mg L^{-1}	6.0±3.5	1.3-15.8	7.1±3.4	1.8-14.0	5.9±3.0	1.0-12.8
CO_2 mg L^{-1}	18.0±3.5	12.0-25.0	18.1±3.5	12.0-26.0	18.2±3.6	12.0-25.5
K mg L^{-1}	69.1±10.5	50.0-105.7	72.6±10.5	50.5-98.5	71.6±9.6	46.8-95.0

In amphibian habitats of District Jamshoro and Larkana, value of physico-chemical parameters (EC, TDS, T-Hard, T-Alk, Cl, SO_4, PO_4, NO_2, NO_3 and K) was recorded variable during the year 2011, 2012 and 2013 and all those values were up to dreadful level, meanwhile value of only two parameters: pH and CO_2 was recorded within normal level. No major variation was recorded in water quality during years 2011, 2012 and 2013 in both districts, but contamination rate was recorded higher in year-2012, while comparatively less contaminated status prevailed during year-2011. All the study sites consisted of different values of physico-chemical parameters, however values fluctuated in synchronized manner during every year as concentration of parameter started rising high from March and stayed at the peak in July, then lowered down to minimum level in October; however value of CO_2 varied in contradictory manner to other parameters. Values of water quality parameters were studied comparatively and found different from each other at District Jamshoro and Larkana (Fig. 4-15), however value of each parameter was prominently out of auspicious level during entire study period (Table 3), meanwhile variation in water quality of both districts was insignificantly different as determined through T-Test (Table 4).

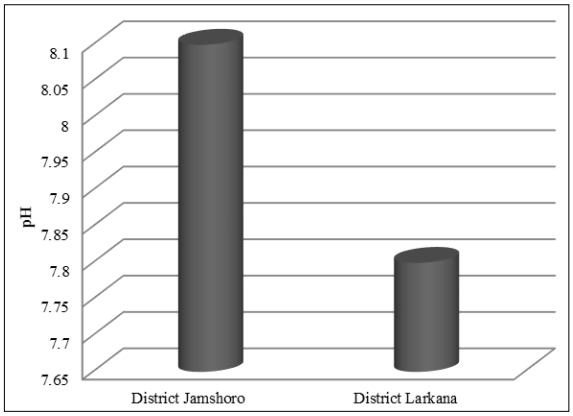

Fig 4: Value of pH

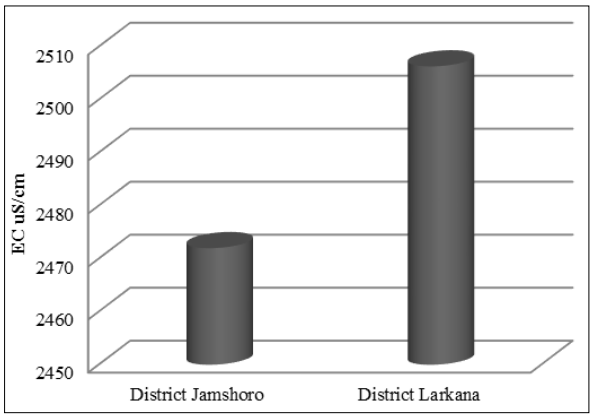

Fig 5: Value of electric conductivity

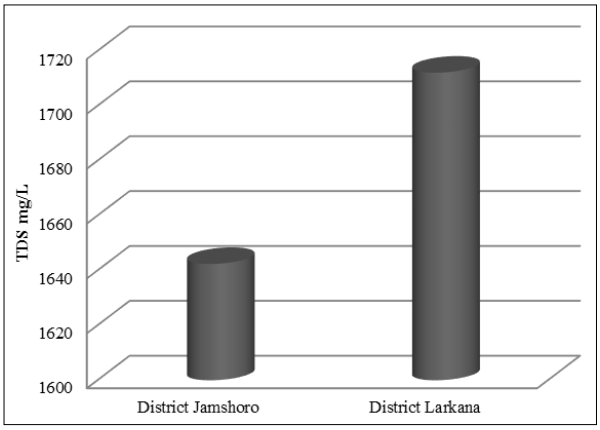

Fig 6: Value of total dissolved solids

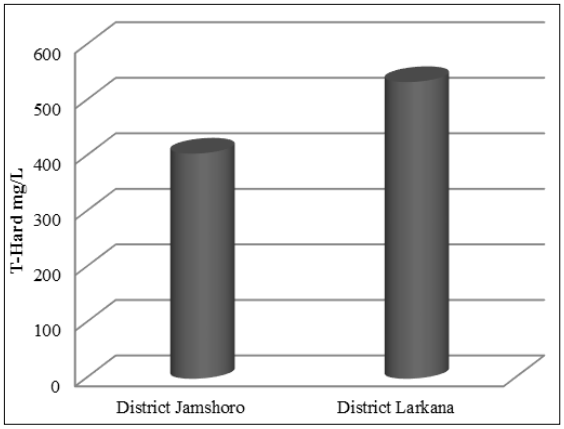

Fig 7: Value of total hardness

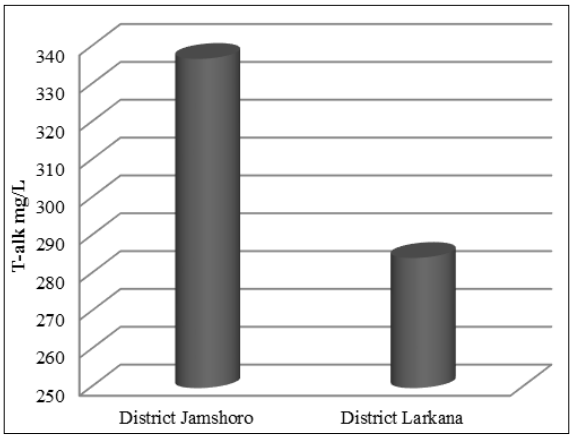

Fig 8: Value of total alkalinity

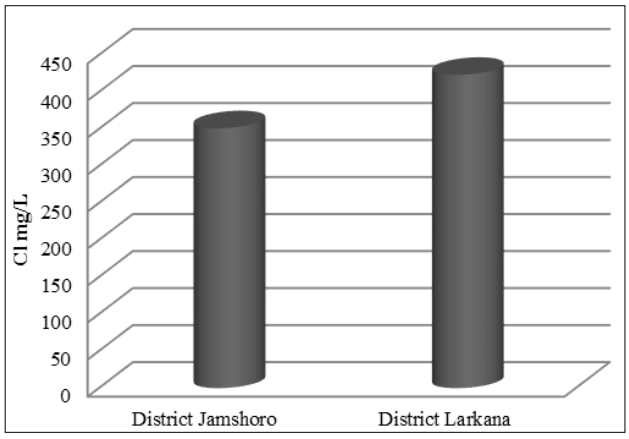

Fig 9: Value of chloride

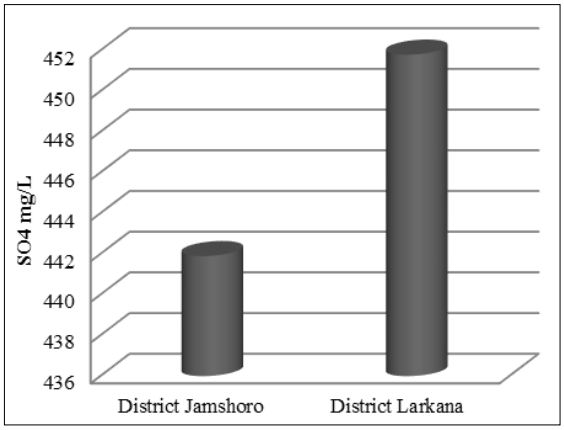

Fig 10: Value of sulphate

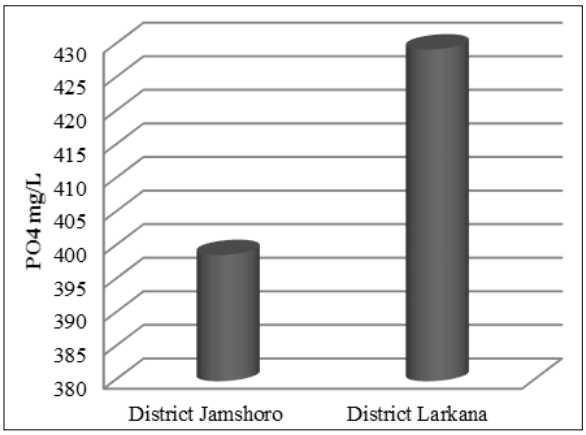

Fig 11: Value of phosphate

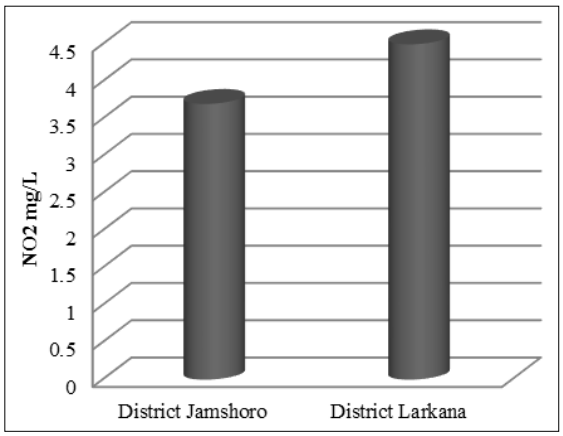

Fig 12: Value of nitrite

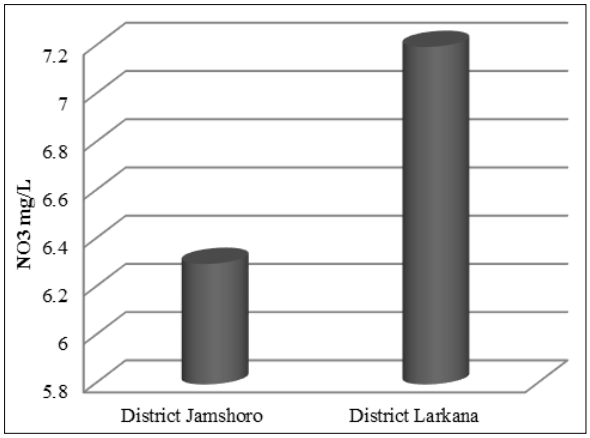

Fig 13: Value of nitrate

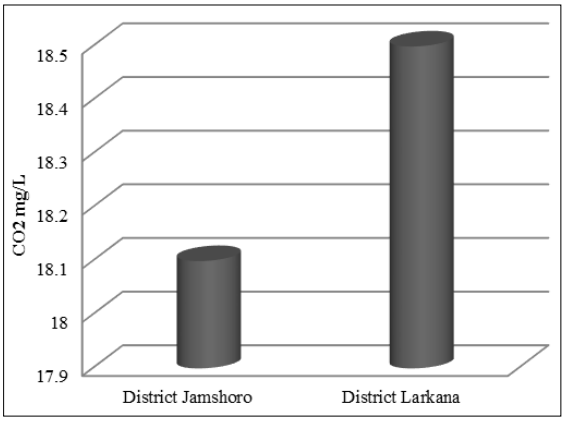

Fig 14: Value of carbon dioxide

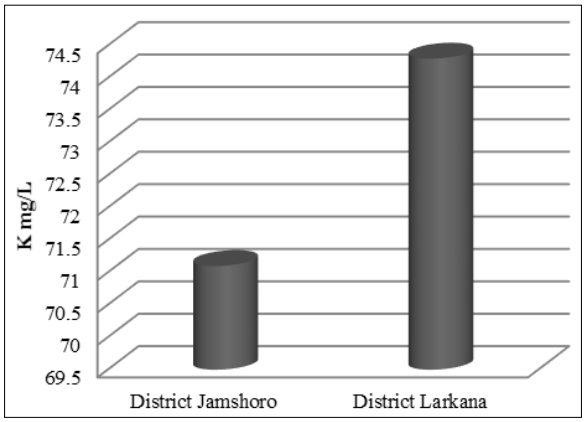

Fig 15: Value of potassium

All physico-chemical parameter were concentrated in high values than the favorable level at all the habitats of Jamshoro and Larkana districts (Table 3).

Table 3: Total range of each parameter in amphibian habitats of study zones.

Parameters	District Jamshoro	District Larkana	Favorable Level	Status
pH	6.5-9.4	6.4-9.5	6.0-9.0	Normal
EC µS cm^{-1}	945.8-5130.0	1180.5-7472.6	150.0- 500.0	High
TDS mg L^{-1}	580.6-3437.1	788.8-4309.2	50.0-250.0	High
T-Hard mg L^{-1}	130.0-950.9	200.5-980.7	75.0-200.0	High
T-Alk mg L^{-1}	145.5-537.0	150.2-477.5	50.0-150.0	High
Cl mg L^{-1}	177.5-685.15	175.3-745.1	50.0-150.0	High
SO_4 mg L^{-1}	200.0-800.0	200.8-817.9	50.0-100.0	High
PO_4 mg L^{-1}	150.8-800.0	200.0-780.8	0.03-0.05	High
NO_2 mg L^{-1}	0.1-14.6	0.9-19.5	1.0 - 2.0	High
NO_3 mg L^{-1}	1.0-15.75	1.3-20.6	1.0-2.5	High
CO_2 mg L^{-1}	12.0-26.0	10.0-26.0	12.0-25.0	Normal
K mg L^{-1}	46.8-105.7	50.8-99.5	25.0-50.0	High

Combined study of study zones: Jamshoro and Lrakan in relation to value of parameters showed that values of only pH and T-Alk were higher in District Jamshoro, though values of other parameters: EC, TDS, T-Hard, Cl, SO_4, PO_4, NO_2, NO_3, CO_2 and K were higher in amphibian habitats at District Larkana. How much values of physico-chemical parameters varied is mentioned in Table 3. For the confirmation of difference of values of parameters at two study zones, a statistical analysis was performed and variation recorded from their in tabulated in Table 4.

Table 4: T-Statistical study of values (mean) of physico-chemical parameters.

Parameters	District Jamshoro	District Larkana	T-TEST	95% Confidence Level 1.960
pH	8.1	7.8	1.6	Insignificant
EC µS cm^{-1}	2472.0	2506.3	0.3	Insignificant
TDS mg L^{-1}	1642.4	1712.1	0.0	Insignificant
T-Hard mg L^{-1}	405.4	534.2	3.6	Significant
T-Alk mg L^{-1}	337.0	284.4	6.2	Significant
Cl mg L^{-1}	351.1	423.2	4.6	Significant
SO_4 mg L^{-1}	441.9	451.8	0.1	Insignificant
PO_4 mg L^{-1}	398.8	429.4	1.6	Insignificant
NO_2 mg L^{-1}	3.7	4.5	5.6	Significant
NO_3 mg L^{-1}	6.3	7.2	1.1	Insignificant
CO_2 mg L^{-1}	18.1	18.5	0.0	Insignificant
K mg L^{-1}	71.1	74.3	1.9	Insignificant

According to present study all habitats consisted of normal value of pH as well as CO_2 as normal value of pH extends between 6.0-9.0 [26-28]. 12.0-25.0 mg/L value of CO_2 is determined as suitable for amphibian habitations [26-27]. However concentration of other parameters was out of permissible limit i.e. value of EC did not meet normal range (150.0 – 500.0 [26-29]. Present study confirmed that the concentration of TDS varied parallel to variation in value of EC and thus TDS concentration alike EC remained out of auspicious level (50.0 - 250.0) throughout the study period. High values of EC and TDS may induce variety of physiological abnormalities into amphibian fauna; they may also damage eggs and larvae [30]. Quality of habitats in all study sites was also worsened due to high values of T-Hard, T-Alk and Cl. T-Hard value is suggested to be maintained within 75.0-200.0 mg/L [30-31], while recommended value of T-Alk extends between 50-150 mg L^{-1} [30] and 50.0 - 150.0 mg/L concentration of Cl is recommended for amphibian habitats [32]. High value of Cl may be more detrimental especially when hardness concentration is simultaneously high [32], in this context, study areas being discussed here provided amphibians with massively contaminated habitats.

Water deals with some non-metallic properties such as sulphate, phosphate, nitrite and nitrate besides other hydrological characteristics which effect amphibians very badly. Presence of non-metallic parameters is a cause of increase in eutrophication in stagnant water bodies wherein algae grow rapidly. Therefore presence of non-metallic parameters creates respiratory problem for all the aquatic animals including amphibians [33]. Eggs and embryo stages of frog are sensitive to sulphate concentration especially when hardness and chloride level is also above the normal level as recorded from areas of present study. For the stable survival of aquatic animals, SO_4 concentration needs to be maintained within 50-100 mg L^{-1}. Present study analyzed PO_4 quantity and recorded its concentration also too high to support amphibian populations to flourish; making habitats intolerable to amphibians as value of PO_4 persisted between was always recorded high than normal range: 0.03-0.05 mg/L [26-27]. In excess amount, phosphate depletes dissolved oxygen levels by causing algal blooms through eutrophication which causes of destruction of aquatic animals [26]. Values of NO_2 and NO_3 were also out of normal range for the well survival of amphibian fauna [26-27, 34-35]. Aquatic organisms flourish, develop and respire in water hence its quality has great impact on their survival and when water has high concentration of nitrogenous parameters like NO_2 and NO_3 that may induce variety of disorders into amphibians. Nitrite is highly water soluble contaminant which creates potential problem in aquatic environments. Nitrite is known to disrupt the thyroid axis besides creating multiple physiological effects such as weakness, digestive deformities, edema and paralysis may also be induced into amphibians [37]. Present study recorded much higher level of nitrate than its recommended level (1.0 - 2.0 mg/L) [34-35]. Nitrate is also an influential parameter when it reaches up to high concentration, results the death of aquatic animals mainly of their larvae [36-38]. High level of nitrate and nitrite can inhibit growth, impair the immune system and cause stress in aquatic species [38]. It is a main cause of algal blooms in stagnant water bodies where lack of oxygen causes death of its inhabitants [36]. CO_2 is a most common source of acidity in water. When gaseous CO_2 becomes aqueous; the CO_2 will be converted into H_2CO_3 which will acidify the water. If any alkaline earth metals such as sodium are present, the carbonates and bicarbonate formed from the solubilization of CO_2 will interact with sodium and thus increasing the alkalinity [39]. The excesses of dissolved CO_2 will negatively affect the health of the aquatic organisms by creating hypercapnia. Water soluble CO_2 elicits acidosis not only in the water but also in tissues and body fluids of aquatic animals, which affect their metabolic functions [40]. The value of CO_2 parameters was recorded normal with slight variation, thus it may not can be harmful at population and species level to amphibian fauna. Analytical study of amphibian habitats in Sindh recorded concentration of potassium also higher up to dreadful level. Scientific studies suggest that the range of K should not exceed 25.0-50.0 mg/L [41], hence higher concentration of this parameter in amphibian habitats at District Jamshoro and Larkana may detrimental amphibians.

High concentration of parameters results from misuse of natural resources through negligent anthropogenic activities contaminating the water bodies which in turn affecting its inhabitants (aquatic animals). Pollution at amphibian habitats indicated the careless and negligent role of local people and concerned authorities towards wild animals. Pollution creates a major problem which affects the amphibians at population and species level as their eggs and larvae undergoes mortality, and diverse species get migrated from the unfavorable areas. The effects resulted by high values of parameters are severe

and even deadly [29, 33, 37, 42-45]. In this perspective, restrictions should be implemented on all adversative encroachments in wild habitats, amphibian localities should be visited regularly to maintain stress-free status and concerned authorities should contribute their services and must strengthen the management plans in collaboration with local people to resolve the conservation issues of amphibians.

Conclusion

Present study determined status of all amphibian habitats highly deplorable due to massive chemical contamination. High rate of pollutants may contribute to decline of amphibian diversity of both study zones and may cause detrimental impact on their populations in future. In this perspective, wildlife department and environmental protection agency should take urgent efforts for the conservation of amphibians in Jamshoro and Larkana Districts.

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References

1. Boone MD, Semlitsch RD. Interactions of an insecticide with competition and pond drying in amphibian communities. Ecological Applications. 2002; 12:307-316.
2. Kiesecker JM. pH mediated predator-prey interactions between *Ambystoma tigrinum* and *Pseudacris triseriata*. Ecological Application. 1996; 6:1325-1331.
3. Gendron AD, Marcogliese DJ, Barbeau S, Christin MS, Brousseau P, Ruby S *et al*. Exposure of leopard frogs to a pesticide mixture affects life history characteristics of the lungworm *Rhabdias ranae*. Oecologia. 2003; 135:469-476.
4. Daszak P, Cunningham AA, Hyatt AD. Infectious disease and amphibian population declines. Diversity and Distributions. 2003; 9:141-150.
5. Bridges CM. Tadpole swimming performance and activity affected by acute exposure to sub lethal levels of carbaryl. Environmental Toxicology and Chemistry. 1997; 16:1935-1939.
6. Bridges CM. Effects of a pesticide on tadpole activity and predator avoidance behavior. Journal of Herpetology. 1999; 33:303-306.
7. Bridges CM. Long-term effects of pesticide exposure at various life stages of the southern leopard frog (*Rana sphenocephala*). Archives of Environmental Contamination and Toxicology. 2000; 39:91-96.
8. Christin MS, Gendron AD, Brousseau P, Menard L, Marcogliese DJ, Cyr D *et al*. Effects of agricultural pesticides on the immune system of *Rana pipiens* and on its resistance to parasitic infection. Environmental Toxicology and Chemistry. 2003; 22:1127-1133.
9. Alford RA, Richards SJ. Global amphibian declines: A problem in applied ecology. Annual Review of Ecology and Systematics. 1999; 30:133-165.
10. Cogger HG, Zweifel RG, Kirschner D. Encyclopedia of Reptiles and Amphibians. Fog City Press Publishers. ISBN 1-877019-69-0. 2004, 72-90.
11. Krogh Biology D. A guide to the natural world. New Jersey: Prentice-Hall Publishers. 2nd Edition. 2002, 72-90.
12. Shaikh K, Gachal GS, Shaikh MY, Qadri AH. Dispersal of Ranids in District Jamshoro and Larkana Sindh, Pakistan. Flora and Fauna. 2014a; 20:331-338.
13. Shaikh K, Gachal GS, Shaikh MY, Rajpar GN, Qadri AH, Afghan A. Checklist and Distribution of Amphibian fauna in Sindh, Pakistan. Sindh University Research Journal. 2014b; 46:159-162.
14. Shaikh K, Gachal GS, Shaikh MY, Qadri AH. Diversity, Morphology, Distribution and Population of Amphibian Fauna in District Jamshoro and Larkana, Sindh-Pakistan. Journal of Entomology and Zoological Studies. 2015; 3:475-479.
15. Khan MS, Ahmed N. On a collection of amphibians and reptiles from Baluchistan Pakistan. Pakistan Journal of Zoology. 1987; 19:361-370.
16. Khan MS. Annotated Checklist of amphibians and reptiles of Pakistan. Asiatic Herpetological Research. 2004; 10:191-201.
17. Khan MS. Amphibians and Reptiles of Pakistan. Krieger Publishers, 2006, 40-47.
18. Khan MS. Amphibians of Pakistan. Reptilia. 2008; 56:60-66.
19. Khan MS. Checklist of Amphibians of Pakistan. Pakistan Journal of Wildlife. 2010; 1:37-42.
20. Shaikh K, Gachal GS, Memon SQ, Sodho NA, Shaikh MY. Assessment of physico-chemical parameters in wild amphibian environment of Taluka Kotri, District Jamshoro, Sindh-Pakistan. Pakistan Journal of Wildlife. 2016a; 72:1-10.
21. Shaikh K, Gachal GS, Memon SQ, Sodho NA, Shaikh MY. Assessment of environmental issues of amphibian fauna in Taluka Thano Bula Khan district Jamshoro Sindh-Pakistan. International Journal of Conservation Science. 2016b; 72:579-588.
22. Shaikh K, Gachal GS, Memon SQ, Sodho NA, Shaikh MY, Qadri AH. Analysis of non-metallic contaminants from amphibian environment in Sindh, Pakistan. International Journal of Fauna and Biological Studies. 2014c; 1:54-58.
23. Shaikh K, Gachal GS, Memon SQ, Brohi RZ, Sodho NA, Shaikh MY. Assessment of amphibian environment through Physico-chemical analysis in Pakistan. Journal of Biodiversity and Environmental Sciences. 2014d; 5:255-261.
24. Environmental Impact Assessment Ordinance, (EIAO) Cap. 499. Methodologies for Terrestrial and Freshwater Ecological Baseline Surveys. EIAO Guidance Note No. 10. 2004.
25. Denial CH. Quantitative chemical analysis. 3rd edition, 1948, 52-57.
26. Sunita R. Experiments in Applied Chemistry. 2nd Edition, 2002, 77-93.
27. American Public Health Association (APHA). Standard Methods for the Examination of Water and Wastewater. 18th Edition, 1992, 35-50.
28. Environmental Protection Agency (EPA-USA). Quality Criteria for Water (Gold Book). EPA-USA 440/5-86-001. Washington D.C. 1986, 477.
29. Pierce BA. Acid tolerance in amphibians. Biosceince. 1985; 35:239-243.
30. Boyer Robin, Christian EG. The Need for Water Quality Criteria for Frogs. Environmental Health Perspectives. 1995; 103:352-357.
31. Wurts WA, Durborow RM. Interactions of pH, carbon dioxide, alkalinity and hardness in fish ponds. Southern Regional Aquaculture Center Publication No. 464. 1992,

60-83.
32. Environmental Protection Agency (EPA-USA). Quality Criteria for Water. 1976, 534.
33. Karrakar NE. Impacts of road deicing salts on amphibians and their habitats. Urban Herpetology. 2008; 20:183-196.
34. Murrell W, Ringer S. On the Effects of Sulphate of Atropia on the Nervous System of Frogs. Journal of Anatomy & Physiology. 1877; 11:321-331.
35. Adolfo M, Blaustein AR. The effects of nitrite on behavior and metamorphosis in cascades frogs (*Rana cascadae*). Environmental Toxicology and Chemistry. 1999; 18:946-949.
36. Kerry L, Griffis K. Sublethal effects of nitrite on eastern tiger salamander (*Ambystoma tigrinum tigrinum*) and wood frog (*Rana sylvatica*) embryos and larvae: implications for field populations. Aquatic Ecology. 2007; 41:119-127.
37. Ansar A, Khad F. Eutrophication: An Ecological Vision. The Botanical Review. 2005; 71:449-82.
38. Bakker j, Waights V. The effect of sodium nitrate on the growth and survival of toad tadpoles (*Bufo bufo*) in the laboratory. Journal of Herpetology. 1993; 3:147-148.
39. Romano N, Zeng C. Effects of potassium on nitrate mediated changes to osmoregulation in marine crabs. Aquatic toxicology. 2007; 85:202-208.
40. Cameron JN, Iwama GK. Compromises between ionic regulation and acid-base regulation in aquatic animals. Canadian Journal of Zoology. 1989; 67:3078-3084.
41. Burleson ML, Smatresk NJ. Bronchial chemoreceptors mediate ventilatory response to hypercapnic acidosis in channel catfish. Comparative Biochemistry and Physiology. 2000; 125:403-414.
42. Shirley ES, Shaw FH, Susanne B, Margaret M. The Relationship between Sodium, Potassium and Chloride in amphibian Muscles. The Journal of General Physiology. 1956; 23:753-777.
43. Chapman PM, Bailey H, Canaria E. Toxicity of total dissolved solids associated with two mine effluents to chironomid larvae & early life stages of rainbow trout. Environmental Toxicology and Chemistry. 2000; 19:210-214.
44. Lori S. Hazard Identification for Human & Ecological Effects of Sodium Chloride Road Salt. State of New Hampshire, Department of Environmental Services, Water Division Watershed Management Bureau. 2nd Edition, 2007, 01-14.
45. Crocker CE, Cech JJ. Effects of hypercapnia on the growth of juvenile white sturgeon. *Acipenser transmotanum.* Aquaculture. 1996; 147:293-299.