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AMPHIBIAN FAUNA AND THEIR ECOLOGICAL STATUS IN SINDH, PAKISTAN

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Abstract

Habitat degradation is amongst major threats to amphibian populations worldwide; therefore we investigated the status of amphibian habitats into agricultural ponds of Sindh province from January to December 2021. Altogether 21 habitats of *Hoplobatrachus tigerinus, Euphlyctis cyanophlyctis, Allopa hazarensis* and *Bufo stomaticus* were explored for determination of their aquatic and physical characteristics. Water quality parameters included electric conductivity, total dissolved solids, total hardness, total alkalinity, chlorides, sulphate, phosphate, nitrite and nitrate were recorded within high value except pH and carbon dioxide. Water quality changes were prominent every month due to variation in values of physic-chemical parameters. Vegetation present in premises of amphibian habitat in Sindh included *Salvadora oleoides, Prosopis cineraria, Tamarix dioica, Tamarix aphylla, Typha latifolia, Typha elephantiana, Typha domingensis, Phragmites karka, Ipomoea aquatic and Salvinia molesta.* Higher values of physico-chemical parameters were recorded during shriving period (spawning, hatching and metamorphosing), hence such habitats may affect amphibian populations of study area.

Keywords: Frogs; Toads; Habitats; Water Quality; Sindh.

INTRODUCTION

Suitable environmental conditions are necessary for stable survival of amphibians as they have transparent skin that remains susceptible to dreadful pollutants which may affect their development and survival and may also make them vulnerable to mortality (Blaustein *et al*., 1994). The worldwide studies indicate that agricultural ponds which are main occupancies of amphibian fauna rank first at the pollution rate due to anthropogenic

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contamination (Alford and Richards, 1999). Amphibian eggs and larvae are more prone to non-optimal water quality as they remain confined there where they were spawned till developing into adulthood. Thus, spawns and tadpoles fail resist against contamination of their habitats by moving away and hence they eventually die even before being adult (Alford and Richards, 1999). The human encroachment is a main reason behind deterioration of water reservoirs which serve as shelter to several aquatic wild animal species (Davies, 2007). Biological degradation of the organic matter (Wetzel, 2001) and nitrogenous fertilizers have ability to accumulate in aquatic systems and interfere with physiological systems of aquatic animals (Miller *et al.,* 2002). The parameters selected for present study have great impact on amphibian populations worldwide (Wetzel, 2001). The electric conductivity (EC) shows concentration of electrolytes which make water conduct heat, whereas measurement of total dissolved solids (TDS) indicates cumulative concentration of all the inorganic and organic substances contained in water that may gradually kill eggs by desiccating them (Boyer *et al.*, 1995 and Boyd, 1999). Total hardness represents the overall concentration of divalent salts such as calcium, magnesium, iron and zinc etc, but mainly calcium and magnesium make water hard and hard may cause many physiological problems into amphibians (Wurts and Masser, 2004). Total alkalinity is a base neutralizing or “buffering” capacity of water and its measurement indicates that how much able water is to resist pH changes (Wurts and Durborow, 1992; Kaushal *et al.*, 2013). When Alkalinity fails to work properly, changes in pH may cause stress, poor growth and even death of tadpoles (Wurts and Durborow, 1992; EPA., 1976). The sulphate (SO_4) and phosphate (PO_4) are also greatly considered as major threat to amphibians as their high concentration may cause respiratory problems by supporting eutrophication and also damaging internal organs of permeable skinned animals (Wurts and Durborow, 1992). High concentration of physico-chemical parameters may hinder growth and development of amphibians and may induce into them variety of physical and physiological abnormalities (Wurts and Durborow, 1992; Kaushal *et al*., 2013). Considering the dreadful impact of water pollution, present study aimed to highlighting issues related with conservation of amphibians and their habitats and therefore Sindh province was explored to confirm whether amphibian habitats suffer from degradation or not.

MATERIAL AND METHODS

Amphibian habitats in agricultural pondsof District Khairpur, Larkana, Jamshoro, Hyderabad, Matiari, Naushahro Feroz, and Sukkurwere surveyed. Water sampling, ecological analysis and identification of amphibian species was determined once every month from January to December, 2021(Figure 1).

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Figure 1: Some views of amphibian habitats in Sindh.

Water samples were collected in sterilized Van Dorn plastic bottles of 1.5 liter capacity from 09 am to 05 pm and delivered to the laboratory where samples were kept at 4 °*C*until analyzed. Conductivity meter (Orion 115) was used to record value of EC and TDS, whereas T. Hard and T. Alk were analyzed through titration procedures by following instructions of Sunita, 2002. The concentration of non-metallic parameters: SO_4 and PO_4 was recorded using spectrophotometer (Hitachi, 200) as instructed by Denial, 1948. Water quality of habitats was identified using scientific literature (Boyer et al. 1995; EPA, 1976 and 1986; EPD, 2000; Wurts, and Durborow, 1992).

RESULTS

The area of Sindh province (140,914 km²) was recorded to provide massive habitats to four amphibian species: *Hoplobatrachus tigerinus, Euphlyctis cyanophlyctis, Allopa hazarensis* and *Bufo stomaticus* in agricultural fields where water quality issues were determined. Table 1 shows the value of physic-chemical parameters into aquatic habitats. All the habitats were analyzed and determined to have variable value of suspended physic-chemical parameters as indicated in figure 2-12.

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Table 1: Water analysis of habitats (H) in Sindh, Pakistan

Parameters	***pH***	***EC μS cm^{-1}***	***TDS mg L^{-1}***	***T-Hard mg L^{-1}***	***T-Alk mg L^{-1}***	***Cl mg L^{-1}***	***SO_4 mg L^{-1}***	***PO_4 mg L^{-1}***	***NO_2 mg L^{-1}***	***NO_3 mg L^{-1}***	***CO_2 mg L^{-1}***
H-1	8.0±0.6	2262.64±1181.7	1467.8±745.9	450.2±287.4	330.8±106.5	343.0±131.8	440.6±172.2	337.4±120.2	4.4±3.9	6.4±2.4	17.0±3.2
H-2	8.3±0.5	2363.5±1198.4	1518.9±667.6	512.0±255.2	376.5±82.0	363.8±80.8	490.9±161.6	401.1±48.9	5.9±3.3	8.4±2.7	17.1±3.1
H-3	8.2±0.6	2315.5±1114.3	1536.5±720.8	498.8±259.8	340.1±81.5	359.0±72.2	472.0±141.5	347.0±60.0	5.6±3.2	6.0±2.3	18.0±3.7
H-4	7.7±0.6	2241.1±773.6	1512.9±518.4	344.22±82.5	304.8±62.4	304.5±67.5	372.6±96.3	389.1±113.8	3.0±0.9	5.1±2.9	18.9±3.7
H-5	8.1±0.6	2334.4±727.2	1595.5±473.4	372.5±62.3	311.2±47.9	332.7±51.0	403.8±79.6	409.5±100.0	3.9±1.2	6.4±2.52	19.1±3.9
H-6	8.2±0.6	2265.7±713.8	1564.7±517.0	367.9±63.8	314.3±39.36	324.3±54.7	406.3±82.0	387.1±96.0	4.04±1.2	6.4±2.6	18.2±3.6
H-7	8.1±0.6	2864.7±1227.4	1892.1±812.0	365.7±57.2	356.8±57.0	401.2±141.8	484.3±150.1	475.1±140.0	1.7±1.7	6.4±4.7	18.0±3.3
H-8	8.0±0.7	2834.3±1212.2	1874.5±784.9	368.6±51.0	365.1±49.8	381.5±128.0	471.3±120.6	442.0±116.4	2.5±1.6	6.4±4.3	18.2±3.2
H-9	7.9±0.7	2766.4±1190.2	1818.8±688.6	368.8±60.6	333.1±53.7	350.0±133.9	435.7±97.8	400.6±107.0	2.6±1.4	5.3±3.9	18.4±3.5
H-10	7.8±0.6	2401.0±1023.9	1653.3±693.6	544.0±235.2	281.7±77.8	414.4±124.4	441.5±167.6	378.4±88.6	4.0±2.3	7.9±4.4	20.1±4.4
H-11	7.9±0.8	2660.0±1145.4	1809.7±694.0	606.7±231.4	337.9±74.2	474.7±118.2	492.9±167.2	441.6±94.6	6.0±3.0	9.1±4.1	17.9±3.8
H-12	7.8±0.7	2617.1±1089.8	1815.7±641.8	603.0±221.4	318.7±53.5	454.6±113.4	492.4±148.0	420.1±86.1	7.2±4.3	9.0±3.4	18.9±3.7
H-13	7.6±0.7	1982.0±500.4	1465.1±300.4	456.5±98.9	266.4±52.1	373.9±65.0	395.1±65.4	386.6±70.8	3.2±1.3	5.3±1.1	18.3±3.4
H-14	7.6±0.7	2070.7±526.6	1536.2±333.6	485.9±96.6	274.6±59.4	366.0±79.8	412.0±68.6	395.6±83.5	4.0±1.4	5.8±1.4	18.8±3.6
H-15	7.6±0.8	2030.6±531.5	1504.2±337.5	464.2±108.2	271.5±59.8	378.9±74.5	398.1±75.2	395.3±82.7	3.9±1.6	5.6±1.6	19.8±3.9
H-16	7.9±0.6	2686.1±1284.5	1838.8±676.6	575.2±157.8	298.1±55.1	448.3±101.5	500.5±115.8	474.7±82.5	4.1±1.7	8.8±11.7	15.7±3.6
H-17	7.7±0.8	2504.8±703.2	1735.9±407.1	545.9±101.8	262.5±55.9	444.8±64.2	460.0±85.6	476.4±82.1	4.4±1.7	6.4±1.6	17.4±3.2
H-18	7.7±0.8	2500.8±702.8	1737.3±404.6	546.5±103.9	265.0±47.3	445.8±68.3	461.8±83.2	479.4±83.2	4.6±1.9	6.6±1.6	17.8±3.5
H-19	8.1±0.5	2920.6±1615.1	1841.0±687.0	532.3±164.1	286.3±63.8	435.1±86.6	475.7±125.1	443.7±105.8	3.9±1.3	8.0±3.0	18.5±3.0
H-20	8.0±0.6	2966.0±1621.9	1864.5±685.2	519.6±176.2	267.2±74.1	431.6±87.8	455.8±127.8	441.9±98.3	4.2±1.4	7.7±3.4	19.5±3.3
H-21	8.0±0.8	2948.6±1649.1	1825.0±714.6	538.5±173.8	271.9±74.9	423.8±91.3	448.5±114.4	445.2±101.8	4.6±1.6	7.8±2.8	18.6±3.1

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Figure 2: Value of pH recorded from amphibian habitats (H)

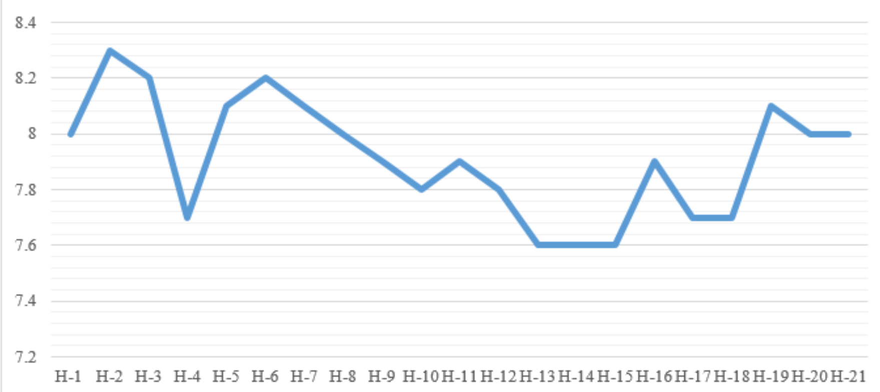

Figure 3: Value of electric conductivity recorded from amphibian habitats (H)

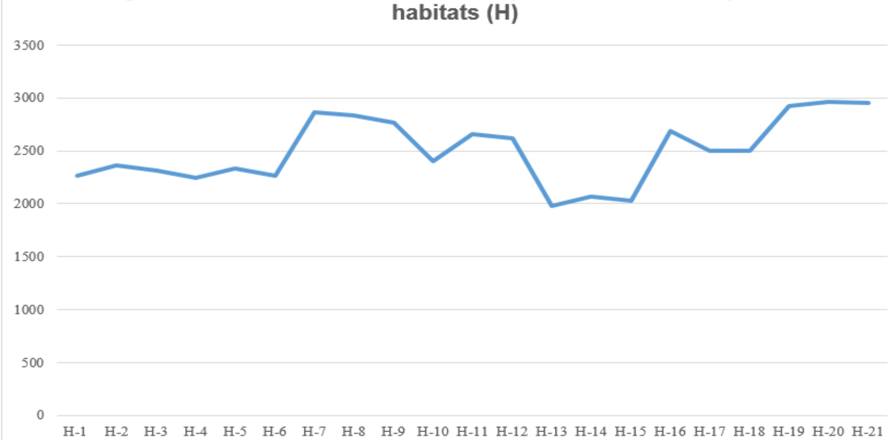

Figure 4: Value of total dissolved solids recorded from amphibian habitats (H)

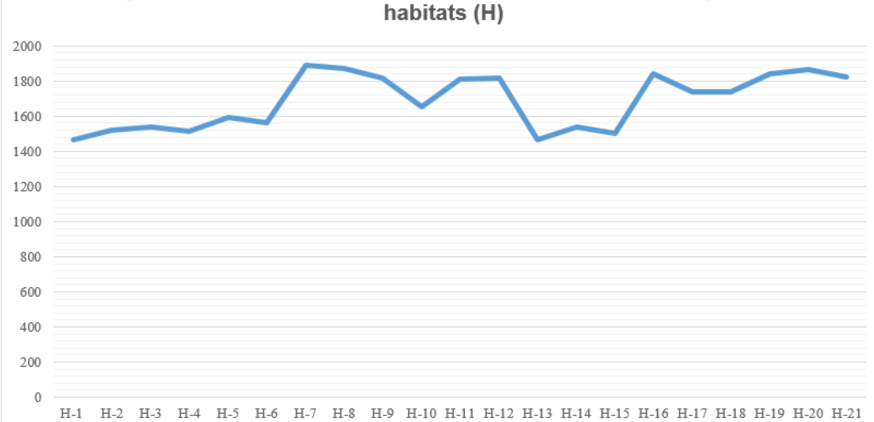

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Figure 5: Value of total hardness recorded from amphibian habitats (H)

Figure 6: Value of total alkalinity recorded from amphibian habitats (H)

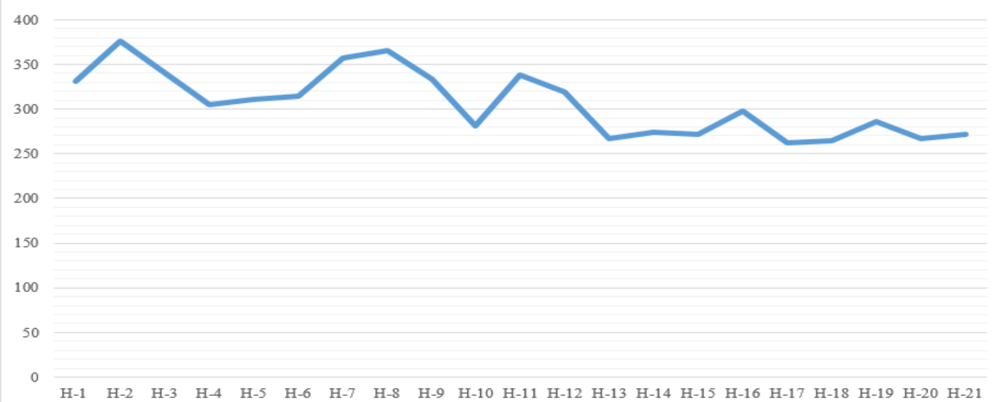
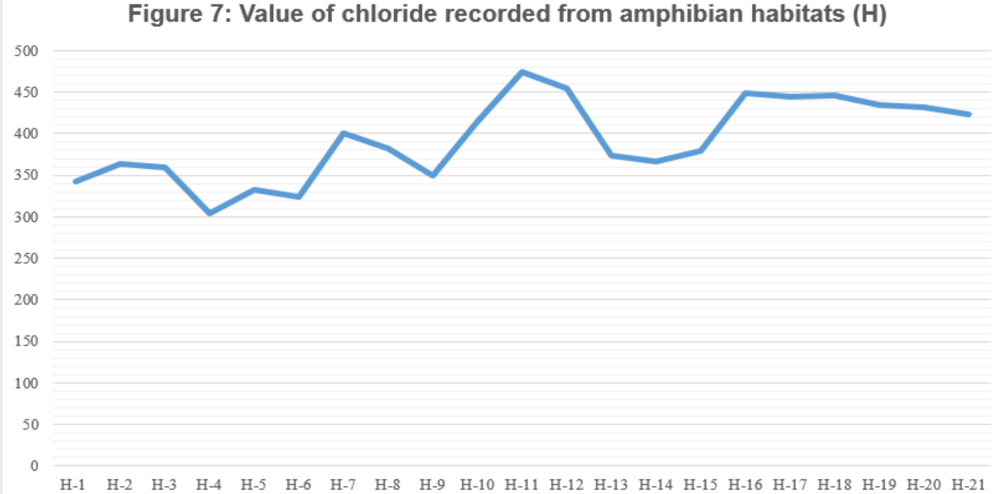


Figure 7: Value of chloride recorded from amphibian habitats (H)



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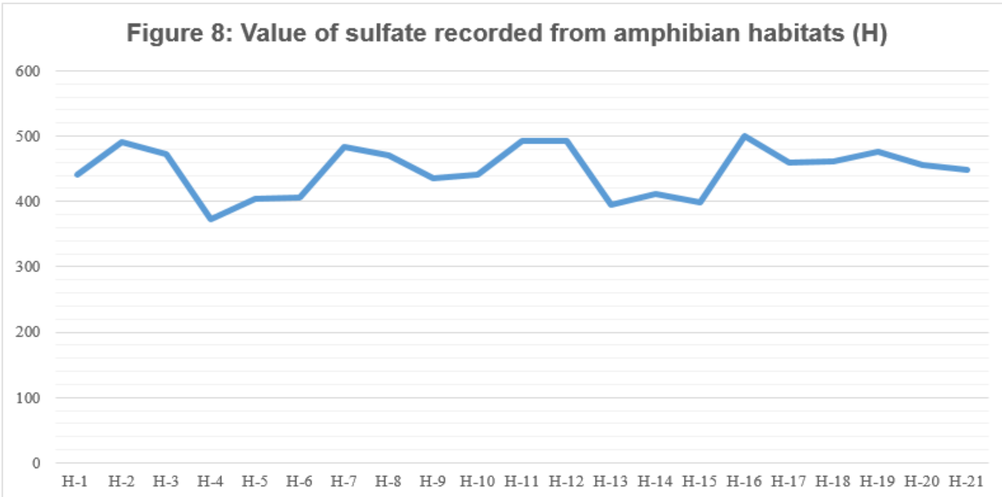

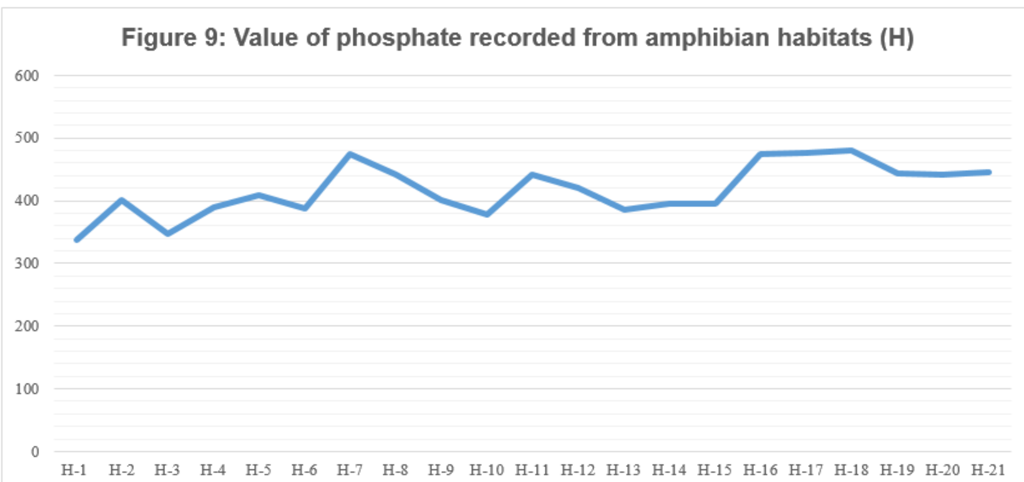

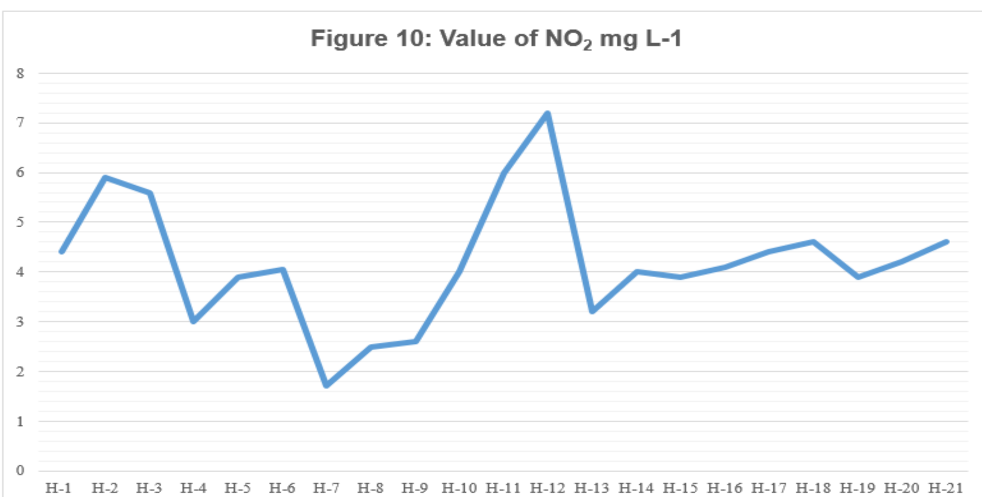

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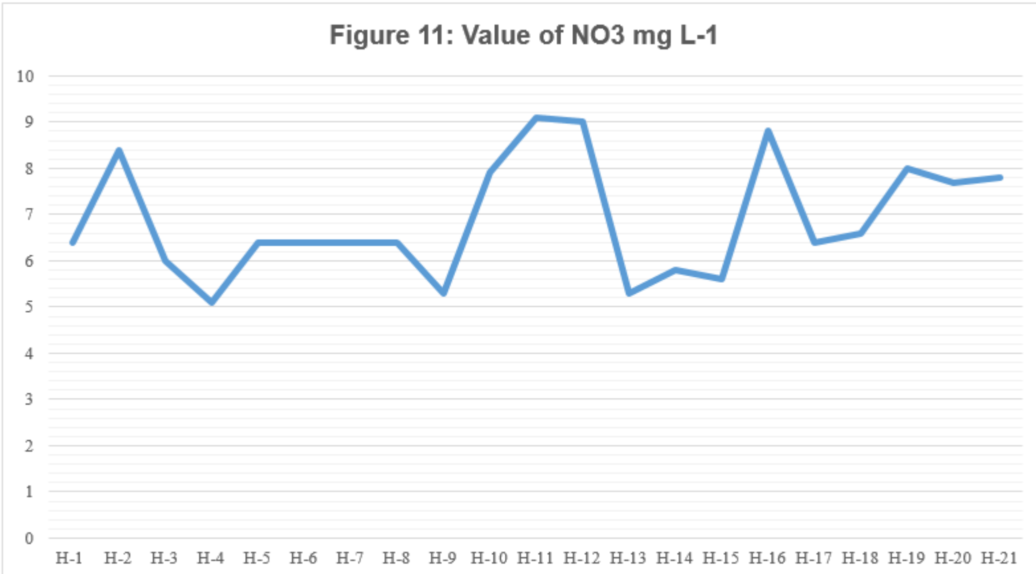

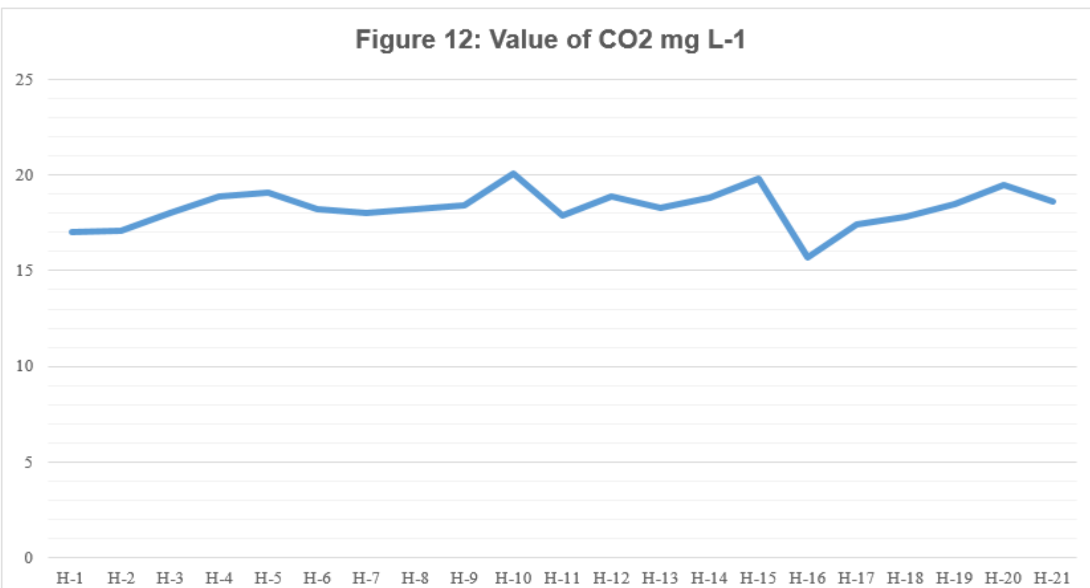

DISCUSSION

Water may appear clean and clear but the fact is there are millions of microscopic elements suspended in it which when increase in dangerous amounts are termed to be the pollutants and these pollutants are able to harm aquatic animals badly (Raven and Johnson, 1990). Thus aquatic environment with its water quality is considered to be the main factor influencing the health and survival of aquatic animals (Raven and Johnson, 1990). Climate of Sindh is less optimal for amphibian populations to thrive abundantly due to its arid climate that is not preferred by most of amphibian species especially those

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which are highly aquatic like species of family Ranidae. Arid environmental conditions fail to attract majority of amphibian species and therefore, Anura (frogs and toads) is the only order of class amphibia that exists here (Muhammad *et al.,* 2016).

Amphibian diversity of district Larkana is known to be extremely poor, whereas Jamshoro and Kashmore had richer diversity as compared to other areas of Sindh (Shaikh *et al*., 2014). Research conducted outside Sindh discovered enormous range of 24 amphibian species contained in four families including Bufonidae, Megophryidae, Microhylidae, and Ranidae (Khan, 2010), while some studies show that amphibians of pakistan are represented by 21 species within Bufonidae, Dicroglossidae, Megophryidae and Microhylidae families of order Anura (Muhammad *et al*., 2016).

Amphibian species of Himalayan highlands are dissimilar from the species of central and eastern areas (Muhammad *et al.,* 2016). Though amphibians of Pakistan have conservation status of least concern on the data list of IUCN (International Union for the Conservation of Nature) as they are not vulnerable to grave threats, but some species of family Ranidae including *Hoplobatrachus tigerinus* and *Euphlyctis cyanophlyctis* are facing various ecological problems including habitat loss and water contamination (Muhammad *et al.,* 2016). In this perspective, existence of poor amphibian diversity in District Larkana may be due to unsuitable habitats. Some studies in Sindh have analyzed amphibian habitats in relation to physico-chemical parameter and revealed contaminated status being responsible for miserable diversity (Kalsoom *et al.,* 2013; Robin and Christian, 1995). Present investigation also heighted the issues of water quality in habitations of amphibian fauna (Figure 1) and revealed unprotected status of amphibian populations due to high rate of contamination caused by high values of studied parameters (Figure 2-12).

The pH was recorded as normal in all the habitations (Figure 2, Table 1), though value of EC and TDS was recorded higher (Figure 3-4) than permissible limit of EPA, 1976; 1986 and EPD, 2000 that emphasize on keeping EC in habitats within 150.0- 500.0 uS/cm, while value: 50.0-250.0 mg/L is recommended for TDS. Concentration of total hardness was also found massive and beyond the standard criteria (75.0-200.0 mg/L), along with total alkalinity that is recommended to exist within 50.0 mg/L to 150.0 mg/L (Wurts and Durborow, 1992). Value of T. Hard and T. Alk remained persistently highest in habitations (Figure 5-6) and same was the consistency of Cl (Figure 7).

Value of SO_4 was also observed as unsatisfactory (Figure 8) and above the normal concentration: 50.0-100.0 mg/L which is considered as suitable range of sulfate in aquatic habitats to prevent loss of oxygen for aquatic animals in water bodies (EPD, 2000 and Wurts and Durborow, 1992). Meanwhile concentration of PO_4 also persisted beyond normal value 0.03-0.05 mg/L as studies of Boyer, et al. 1995 and EPD, 2000 call it alerting condition when phosphate value increases. Concentration of SO_4 and PO_4 persisted beyond the favorable limit in habitats (Figure 8-9).

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The value of NO_2 and NO_3 was recorded as slightly above the normal level as suggested by Claude, 1999(Figure 10-11) and they may have negative effect when accompanied with high value of other parameters (Figure 3-9). All the habitats remained constantly unfavorable to amphibians as value of physico-chemical parameters was above the normal level except pH and CO_2 (Figure 12) for the steady survival of amphibians.

CONCLUSION

Concentration of physico-chemical parameters was the indicative of pollution that may create conservation issues and may threaten amphibian populations of study area. Therefore conservation actions may urgently be implemented to save these neglected wild animals which play important role in maintaining ecosystem within balanced state.

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