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Anthropogenic impacts on the diversity and distribution of amphibian and reptiles in the vicinity of Dhirkot, Azad Jammu and Kashmir, Pakistan

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SUMMARY

Fragmentation and habitat loss are the main threats to herpetofauna populations, while, many researchers have not given clear concept into their population level implications. There is a need to examine the methods that underlie examples of abundance and distribution. In order to know the population and species level implications of fragmentation and habitat loss, it is essential to move from site-specific inferences to evaluations of how the impacts of various factors interrelate across wide landscapes to impact population size and population connectivity. These points kept in mind and developed the research objectives of the study area as; to know the human impact on the diversity and distribution of amphibian and reptiles species. Direct (i.e. physical count by camera, binocular and naked eye) and Indirect Methods (i.e. questionnaires and semi-structured interviews (n=100) are applied to collect data of Dhirkot. Anthropogenic impact data are analyzed by different diversity indices. Total 23 species of herpetofauna are documented; out of total, 22 are recorded from the forest, 12 from rural, 10 from agriculture and 3 from urban habitats of Dhirkot. Anthropogenic impact produced negative impact on the herpetofauna diversity.

Keywords: Distribution, Richness, Anthropogenic impact, Herpetofauna

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INTRODUCTION

Total 195 species of reptiles (Khan, 2006), while 24 amphibian species are documented in Pakistan by Khan (2010). Whole, out of total 44 species of reptiles and 12 amphibian species are document till now by Khan (2006) from Azad Jammu and Kashmir. Pakistan is the sixth most populated country in the world with an estimated 208 million in 2017. The country population growth rate of 2.40 percent is the highest in South Asia and stands in sharp contrast to the 1.0 to 1.5 percent growth rate of other South Asian countries. Population of Pakistan has increased by more than six-fold since the first post-independence census held in 1951. This huge growth in population puts severe challenges for socio-economic development of this country (UNDP, 2019). At the same time Pakistan is considered amongst the most diversity

rich countries (Roberts, 1997). The exponential human population growth creates negative impact on the diversity as well as distribution. Increased human populations need food, residence and luxury things; to fulfill the demands leads to urbanization, agriculture intensification, industrialization resulting in pollution (Bouma and Droogers, 1998; Altaf *et al.*, 2013).

Pakistan lost an average of 41,100 hectares of forest per year, between 1990 and 2000 and average annual deforestation rate of 1.63%. The rate of forest change was increased by 24.4% to 2.02% per annum, between 2000 and 2005. Pakistan lost almost 15 of its forest and woodland habitat. Pakistan has some 1027 known species of amphibians, birds, mammals and reptiles. Of these, 3.5% are endemic, meaning they exist in no other country, and 5.5% are threatened. Pakistan is home to at least 4950 species of vascular plants, of which 7.5% are endemic. 4.0% of Pakistan is protected under IUCN categories I-V (Mongabay, 2006).

To know diversity patterns it is necessary to recognize ecosystem first choice of taxa (Riem *et al.*, 2012). This is a wrong perception that diversity always decreases with increase in human population growth e.g. few of them like to extant in close of human resident area (Saito and Koike, 2013; Manzoor *et al.*, 2018) and richness is mostly higher in the ecotone landscape (Magura *et al.*, 2004). Animal diversity changes from natural to intensive anthropogenically affected ecosystems. Considerable study on diversity, distribution and habitat preferences of animal species has been conducted in American and European continents while very few researches are documented in Asian continent.

Human population is increasing day by day, so fulfill the requirement of human; they modify the natural landscape into rural, urban agriculture landscapes. Therefore we have planned to recognize the diversity and distribution of herptile in various landscapes; either species is positively or negatively correlating with existing landscape in the vicinity of Dhirkot, Azad Jammu and Kashmir, Pakistan.

MATERIALS AND METHODS

Dhirkot is present in lesser Himalayas. The study area lies in moist area in access of monsoon. There is a bundle of difference in rainfall and humidity in dissimilar parts of the region by the variations in the altitudes. The summer (average temperature 37ºC) is moderate while the winter (average temperature 4ºC) is harshly cold; and snowfall occurs at higher elevations. Occasionally, snowfall also recorded in lower areas i.e. Chmiati (i.e. Forest), Salian (i.e. rural), Dhirkot (i.e. urban) and Arja (i.e. agriculture). The average rainfall is recorded as; 150mm (Figure 1) (Bibi *et al.*, 2013). The vegetation of the Dhirkot is moist temperate and subtropical humid type. The main tree species are *Pinus wallichiana* (blue pine) and *Pinus roxburghii* (chir pine). Due to the humid and cool condition, the vegetation is consist of a large variety of herbs, shrubs, and trees (Farooq *et al.*, 2019).

The linear count method is applied to know anthropogenic impact on diversity and distribution of amphibian and reptilian in study area; both direct (i.e. physical presence) and indirect (burrows, carcasses and meeting) methods. The data are collected from August 2017 to July 2018. Khan (2006) and Masroor (2012) is used for species identification. For the statistical analysis PAST version 2.17C is used to

compute the "Dominance index", "Simpson diversity index", "Evenness index", "Richness index" and Principal component analysis (PCA) (Hammert, 2001).

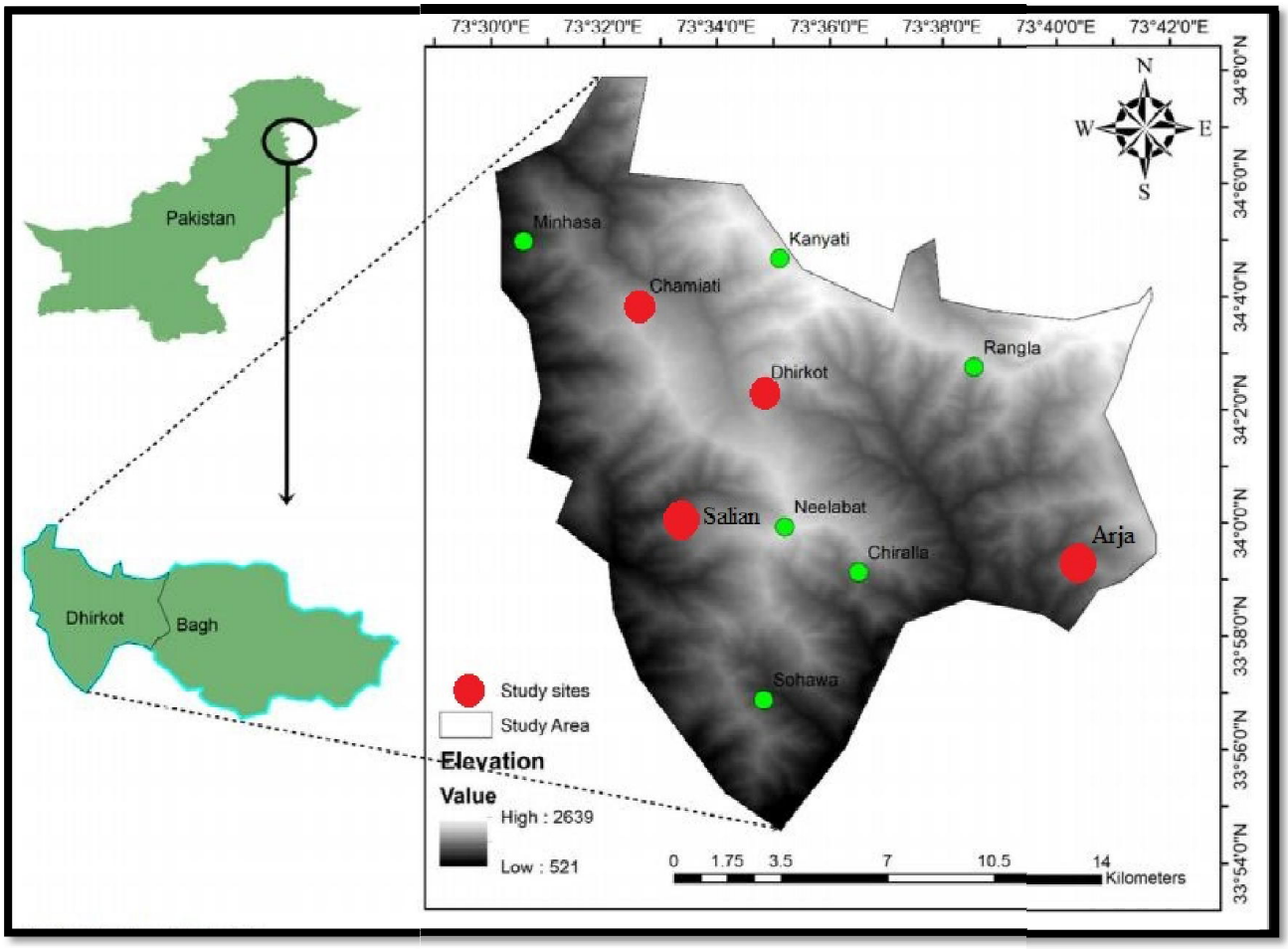

Figure 1: Map of Dhirkot (Farooq *et al.*, 2019).

RESULTS AND DISCUSSION

Respondents of the study area consist of male (36%) and female (64%), many of the respondents are educated (84%) while other are illiterate (16%). Data collected from the peoples having different occupation i.e. government employee (9%), non-government employee (26%), labor (1%), students (24%) and housewives (40%). Respondents casts from the study area is as; Abbasi (86), Awan (9); Raja (4) and Mughal (1) (Figure 2).

Total 23 species are recorded, out of total 22 are recorded from the forest, 12 from rural, 10 from agriculture and only 3 (i.e. *Bufo himalayanus, Calotes versicolor* and *Hemidactylus flaviviridis*), out of total 22 are reptiles and only one species is amphibians i.e. *Bufo himalayanus* from urban habitats of Dhirkot (Table 1). Out total, 8 species i.e. *Amphiesma stolatum, Calotes versicolor, Daboia russelii russelii, Oligodon arnensis, Hemidactylus flaviviridis, Laudakia agrorensis, Spalerosophis diadema diadema* and *Swaligekko battalensis* recorded first time from study area.

Highest number of individuals is recorded from forest (41) and further reduced in rural (36), urban (18) and agriculture (17). Highest dominance (0.4136)

and Evenness (0.889) showed that less diversity and similar individuals are highest in urban habitats as compared with others. While highest diversity and population are documented highest Simpson diversity (0.7623) in rural habitat as compared with other habitats. Highest diversity and population are recorded from the forest habitat as compared with other habitats (Table 2).

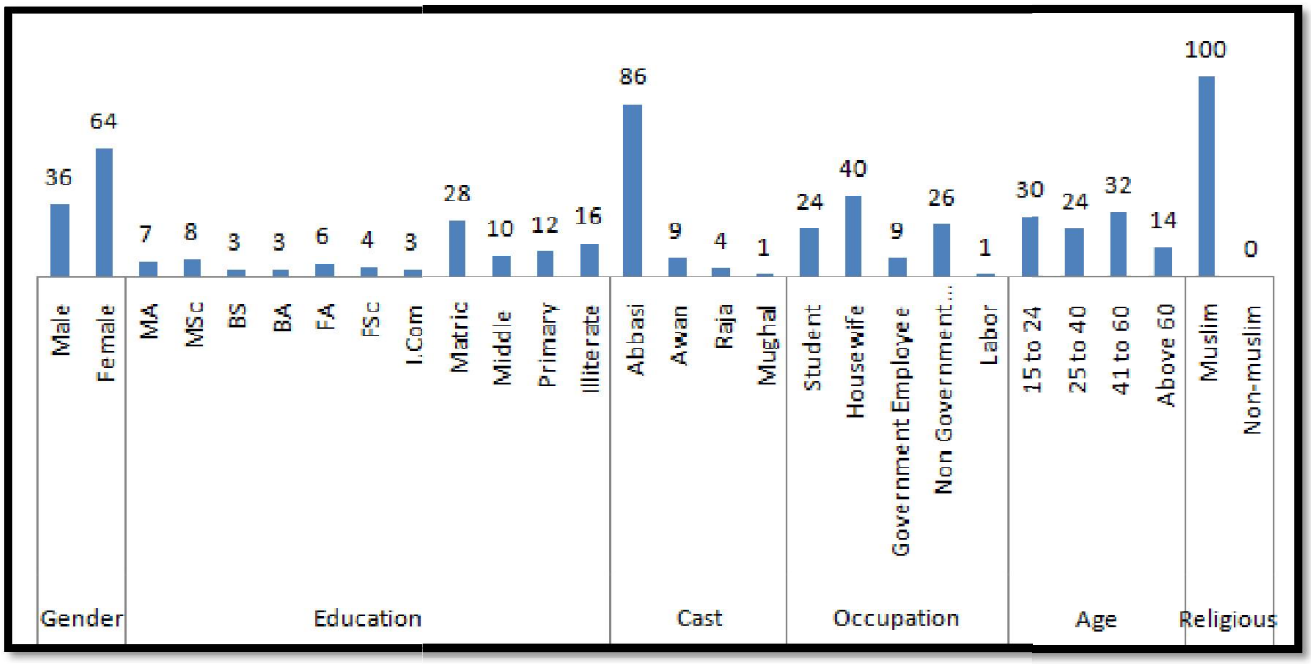

Figure 2: Profile of the respondents of the study area.

Ptyas mucosus is the most abundant in natural and anthropogenically impacted landscape (Table 1). This species are terrestrial, diurnal and occur in a different of ecosystems (Manthey and Grossmann, 1997).

We have documented only 3 species (i.e. *Bufo himalayanu, Calotes versicolor* and *Hemidactylus flaviviridis*) and 18 specimens from urban landscape. 10 species (i.e. *Amphiesma stolatum, Bufo himalayanus, Bungarus caeruleus caeruleus, Eryx johnii, Laudakia agrorensis, Laudakia himalayana, Ptyas mucosus mucosus, Spalerosophis diadema diadema, Varanus bengalensis* and *Xenochrophis piscator*) and 17 specimens are documented from agriculture landscape during present research. On the other hand 12 species (i.e. *Amphiesma stolatum, Bufo himalayanus, Bungarus caeruleus caeruleus, Calotes versicolor, Daboia russelii russelii, Eryx johnii, Oligodon arnensis, Hemidactylus flaviviridis, Lycodon mackinnoni, Laudakia himalayana, Swaligekko battalensis, Xenochrophis piscator*) and 36 specimens are observed from rural landscape. Out of 23 species, 22 species such as (*Amphiesma stolatum, Bufo himalayanus, Bungarus caeruleus caeruleus, Calotes versicolor, Daboia russelii russelii, Eryx johnii, Oligodon arnensis, Eublepharis macularius, Gloydius himalayanus, Hemidactylus brookii, Laudakia agrorensis, Lycodon mackinnoni, Laudakia himalayana, Laudakia pakistanica, Laudakia tuberculata, Naja oxiana, Ptyas mucosus mucosus, Scincella himalayana, Spalerosophis diadema diadema, Swaligekko battalensis, Varanus bengalensis* and *Xenochrophis piscator*)

and 41 specimens of herptiles are documented. Result showed that urban landscape is more negatively impact on herptile diversity, on the other hand rural and urban landscapes moderately impact on the diversity of herptiles in the study area. Only one species i.e. *Hemidactylus flaviviridis* has move from forest to urban and rural landscapes.

Both axes (i.e. "Axis 1" and "Axis 2") of the PCA explained 95.303% of dissimilarity in sampled herpetofauna taxa (Axis 1: 87.268%; Axis 2: 8.035%). Variables loading onto "Axis 1" included Urban(r=0.5648), Rural (r=0.82184), Agriculture (r=-0.03529) as well as Forest (r=-0.06579). The magnitude and direction of these links shows that "Axis 1" creates the reaction of the herptiles communities natural to disturbed habitats documented. Each ecosystem also written in "Axis 2" Urban (r=0.078345), Rural (r=0.035475), Agriculture (r=-0.3231) and Forest (r=-0.94245). Herptiles community model taken out by "Axis 2" are not linked to those described by "Axis 1". All habitats do not similar with each other, showing that human involvement affect is the main reason altering the diversity and distribution of amphibian and reptiles (Figure 3).

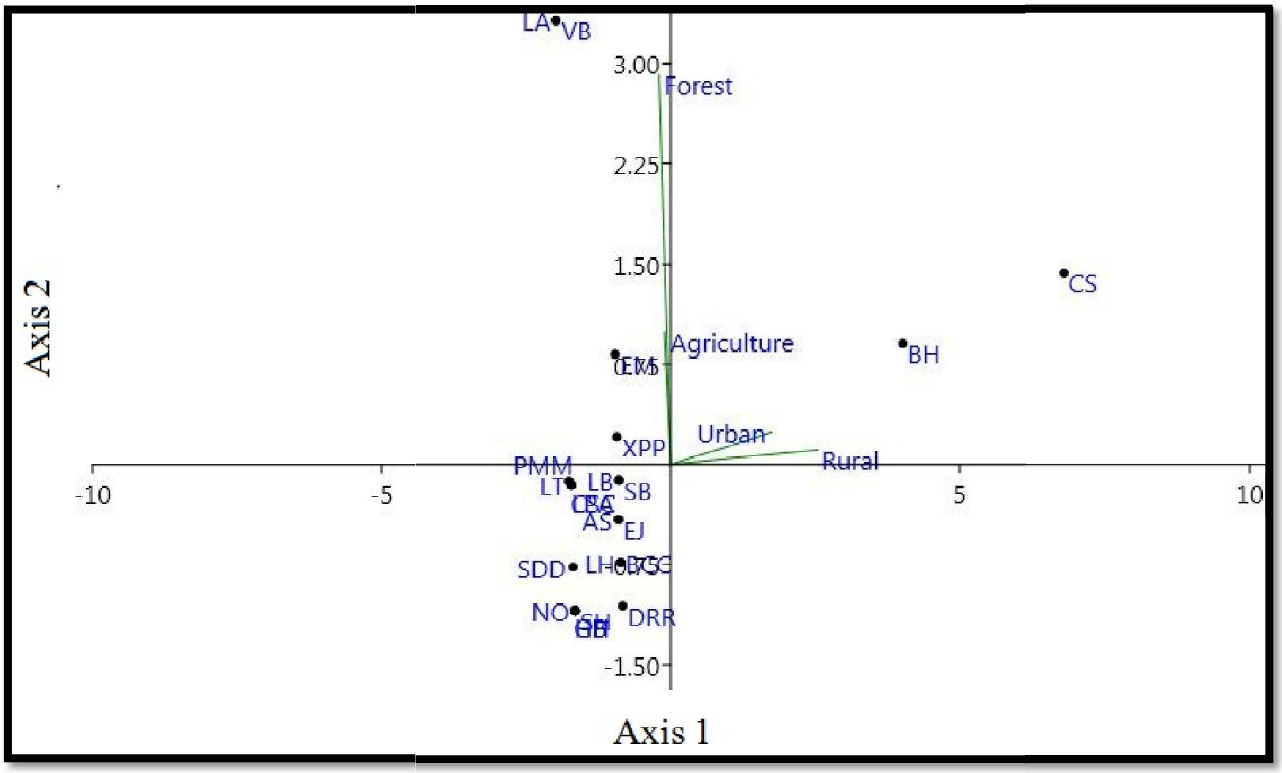

Figure 3: Principal components analysis shows the distribution with code of herptiles species (Table 1) in different habitats. Positions of the arrows relative to axis 1 and 2 show how strongly independent variables are correlated with each habitat i.e. agriculture, forest, rural and urban.

Deforestation may be one reason through which urban and rural expansion influence herpetofauna diversity in natural ecosystem Scientist also find out that (Cushman, 2006) that decrease in diversity of amphibian and reptile that specialize in habitats as well as feeds due to human influence, but this pattern may also be

connected to alters in diversity of insect, plants, or predator; same outcomes are documented.

Habitat loss contributes directly to most of these threats. Recent research has provided information on the relationships between different herpetofauna and different attributes of fragmentation and habitat loss. This study provide information multiple factors are impacting the diversity of herpetofauna and how multiple factors interact across large spatial extents to influence diversity and distribution. While most of the species are Not Evaluated by IUCN and only species is documented as Data Deficient. Many folklore and negative thoughts are also present against herpetofauna among the people of Pakistan. Although data is deficient and are not evaluated by IUCN, but there are threats due to anthropogenic impacts in study area.

The level of degradation of land and abundance of resources are the main reasons impacting the distribution of herpetofauna species. Statistical analysis reveals that herpetofauna species respond quickly to human influence affect. Management plans for herpetofauna species, especially in forest should be calculated in the huge scale. But, little green areas and passageways are essential for herpetofauna management in the anthropogenic impacted ecosystems from where huge natural areas have declined.

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Table 1: The diversity of the herpetofauna of Dhirkot of Azad Jammu and Kashmir- Pakistan.

Sr.	Scientific name Common name	Code	Order Family	U	R	A	F	Status
1	*Amphiesma stolatum* Linnaeus, 1758 Striped Keelback	AS	Squamata Colubridae	0.00	0.03	0.12	0.03	NE
2	*Bufo himalayanus* Gunther, 1864 Himalayan toad	BH	Anura Bufonidae	0.17	0.14	0.12	0.05	LC
3	*Bungarus caeruleus caeruleus* Schneider, 1801 Common krait, Kala sup	BCC	Squamata Elapidae	0.00	0.03	0.06	0.03	NE
4	*Calotes versicolor* Daudin, 1802 Oriental Garden Lizard	CS	Squamata Agamidae	0.28	0.20	0.00	0.08	NE
5	*Daboia russelii russelii* Shaw and Nodder, 1797 Russell's chain viper	DRR	Squamata Viperidae	0.00	0.03	0.00	0.03	NE
6	*Eryx johnii* Russell, 1801 Common Sand boa	EJ	Squamata Boidae	0.00	0.03	0.12	0.03	NT
7	*Oligodon arnensis* Shaw, 1802	CSC	Squamata	0.00	0.03	0.00	0.08	LC

8	Common kukri snake *Eublepharis macularius* Börner, 1981 Leopard gecko	EM	Colubridae Squamata Eublepharidae	0.00	0.00	0.00	0.05	NE
9	*Gloydius himalayanus* Giinther, 1864 Himalayan pit viper	GH	Squamata Viperidiae	0.00	0.00	0.00	0.03	NE
10	*Hemidactylus brookii* Gray, 1845 Brooke's house gecko	HB	Squamata Gekkonidae	0.00	0.00	0.00	0.03	NE
11	*Hemidactylus flaviviridis* Ruppell, 1835 Yellow belly common house gecko	HF	Squamata Gekkonidae	0.56	0.43	0.00	0.00	NE
12	*Laudakia agrorensis* Stoliczka, 1872 Agror agama	LA	Squamata Agamidae	0.00	0.00	0.12	0.13	NE
13	*Lycodon mackinnoni* Wall, 1906 Mackinnon’s Wolf Snake	LB	Squamata Colubridae	0.00	0.03	0.00	0.05	NE
14	*Laudakia himalayana* Steindachner, 1869 Himalayan agma	LH	Squamata Colubridae	0.00	0.03	0.06	0.03	NE
15	*Laudakia pakistanica auffenbergi* Baig and Bohme, 1996 North-Pakistan Agma	LPA	Squamata Agamidae	0.00	0.00	0.00	0.05	NE
16	*Laudakia tuberculata* Hardwicke and Gray, 1827 Blue rock Agma	LT	Squamata Agamidae	0.00	0.00	0.00	0.05	NE
17	*Naja oxiana* Eichwald, 1837 Brown cobra	NO	Squamata Elapidae	0.00	0.00	0.00	0.03	DD
18	*Ptyas mucosus mucosus* Linnaeus, 1758 Rope-snake	PMM	Squamata Colubridae	0.00	0.00	0.18	0.03	NE
19	*Scincella himalayana* Gunther, 1864 Himalayan skink	SH	Squamata Scinidae	0.00	0.00	0.00	0.03	NE
20	*Spalerosophis diadema diadema* Schelegel, 1837 Red spotted diadem snake	SDD	Squamata Colubridae	0.00	0.00	0.06	0.03	NE
21	*Swaligekko battalensis* Khan, 1993 Reticulated plump-bodied Gecko	SB	Squamata Gekkonidae	0.00	0.03	0.00	0.05	NE
22	*Varanus bengalensis* Daudin, 1802	VB	Squamata Varanidae	0.00	0.00	0.12	0.13	LC

23	Bengal monitor *Xenochrophis piscator* Schneider, 1802 Chekered keelback	XPP	Squamata Colubridae	0.00	0.03	0.06	0.05	NE

Note: U (urban); A (agriculture); R (rural); F (Forest); NE (Not Evaluated); LC (Least Concern); DD, (Data Deficient); NT (Near Threatened)

Table 2: Diversity Indices of the study area.

Diversity Indices	**Urban**	**Rural**	**Agriculture**	**Forest**
Species	3	12	10	22
Individuals	18	36	17	41
Dominance (D)	0.4136	0.2377	0.1142	0.06365
Simpson diversity (S)	0.5864	0.7623	0.8858	0.9363
Evenness (E)	0.889	0.5317	0.9315	0.8458
Margalef/Richness (R)	0.692	3.07	3.177	5.655

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Authors' contributions: Altaf has designed this project, collected data and written this article; while Abbasi and Adil have critically analyzed this article and approved as final.