Conservation Assessment of Endemic Plants from Chitral Region, Pakistan

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Abstract. Chitral has diverse importance and has designated as a biodiversity hotspot of the country due to junction of Hindu Kush, Himalayan and Karakorum ranges, thus supporting maximum number of endemic plants.
The conservation status of those endemic plants was assessed for three years, which have at least few points' data as per IUCN Red List Categories and Criteria 2011, 2017and relied more on B criterion using "GeoCat" for AOO and EOO assessment. Some of the taxa were also compared with their previous status assessed ten years ago. This guideline will assist in country's policies for conservation, threat assessment and sustainable management.
Assessing a total of fifteen endemic taxa (species and subspecies), most are endemic to Chitral except *Anaphalis chitralensis* and *Impatiens lemannii* (both country's endemic).Twelve species fall in the criteria for Endangered (*EN*) where as two species fall under Vulnerable (VU) and one falls in critically endangered (CE) threat category. The most CE (critically endangered) species is *Astragalus commixtus* with only 56 mature individuals while *Astragalus erionotus*, *Delphinium kohatense* were found to as VU (Vulnerable), rest all species like *Polygonum cognatum*, *Plocama asperuliformus* etc. are EN (Endangered).
These species need immediate strategies for in-situ and ex-situ conservation for survival.

Keywords: biodiversity, endemic taxa, flora, IUCN, threat assessment, nature conservation, Chitral.

1. Introduction

Pakistan has various topographic, altitudinal, climatic and phytogeographical variation supporting more than 6000 species of plants of which 428 are endemic(Ali-S.I., 1978; Ali-S.I. & Qaiser, 1986). Chitral is one of the biodiversity hotspots of the country with 173 endemics reported (Ali-S.I., 2008). The taxa distribution is like this: 67 plant species are

purely restricted to Chitral, 60 endemic to Pakistan but are also found in Chitral and 46 taxa are restricted to Asian countries but also extend their distribution to Chitral (Ali-S.I. & Qaiser, 1986; Ali-S.I., 2008).

Chitral's main valley is 354 km long with a maximum width c. 4800 m. However, at some places it is barely 180 m wide, while the side valleys are even narrower. Elevation of the area varies from about 1070 m (about 3500 ft) in the extreme south in Arandu to 7690 m (25,230 ft) at the summit of Tirich Mir in the Hindu Kush. High mountains and rough topography of the area have given rise to lot of narrow side valleys. The valley is narrower at the beginning along with the border of Afghanistan i.e. Arandu on one side and Lowari pass on the other side, then the valley expands its width and many smaller valleys are formed. In the middle the rivers coming from upper Chitral and "Gharum Chasman" meet at this point. Further to right side on the Mastuj-Yarkhun track the valley is bifurcated, and on the right side the valley leads to Shandur. Above, from the Yarkhun, the valley narrows further up till "Qaramber An" (Census, 1998; Hussain, 1994; Miller, 1997).

The recent climatic changes as well as anthropogenic factors are continuously contributing to decline of plants species, especially the narrower medicinal endemic ones (which have restricted distribution) and thus are more prone to these changes (Damschen et al., 2010; Damschen et al., 2012; Khanum et al., 2013; Khanum & Ahmed, 2019). At the moment the rate of extinction is considered to be high, if all of the species are currently supposed to be "threatened", they would become extinct by the next century, then the future extinction rates will be 10 times bigger than the recent rates (Pimm et al., 1995; Anacker & Leidholm, 2012; Zhang et al., 2014; Gómez et al., 2015).

The current assessment is based on an earlier work (Ali, 2010) adding four more endemic taxa. As per earlier work, 159 plants reported from Chitral are data deficient. The main objectives of the current work are i) to record the presence of species in their type localities, ii) find out new areas suitable for its occurrence and further present conservation status based on the data collected for three consecutive years.

2. **Study area**

The major valley of Chitral is 354 km long with 4800 m width. However at some places it is further narrowed while the side valleys are even more narrower. Elevation of the area also varies from about 1070-7690 m. Hence high mountain and rough topography of the area have given rise to lot of narrow side valleys. All the major valleys were included in study site as in shown in Figure 1.

Figure 1. Study area

3. Material and Methods

Field surveys were conducted during the study period which was for three years from early spring to late summer 2014 to 2017). spring until early winter for investigating the local species. The conservation status of fifteen plant taxa, out of whom twelve are local endemics, except *Anaphalis chitralensis* and *Impatiens lemannii* (which are endemic to Pakistan) based on IUCN criteria and guidelines (IUCN 2001, 2012, 2016). Previously assessed eleven taxa including *Astragalus erionotus, A. mirabilis, A. commixtus, Anaphalis chitralensis, Delphinium kohatense, D. nordhagenii, Silene longisepala, Plocama asperuliformus, Galium ghilanicum, Oxytropis gloriosa, Polygonum cognatum* by Ali (2010). Species like *Silene*

pseudoerticellata, *Psychrogeton chitralicus*, *Impatiens lemannii* subsp. *lehmanii* and *Strigosella toppinii* are assessed first time in this study. The IUCN criteria, regarding the threat levels, were continuously employed. The mature individuals were counted in each locality for population size. Those individuals were considered as mature which contained fruits or flowers. All of the coordinates of plant species were recorded through GPS (GARMIN, USA) of each of the individual taxa have been recorded, by using a global positioning system, to an accuracy of ±10 m. Comprehensive field notes like, habit, habitat, life form, phenological status and altitudinal range were studied in the field. Anthropogenic threats like grazing, agricultural land extension and deforestation were also studied as a main factor for degradation and trend in habitat change. Plant specimens collected were deposited at Pakistan Museum of Natural history (PMNH). EOO and AOO (Based on 2x2 km² following Bland et al. (2017) were obtained through Geocat (geocat.kew.org). By putting all of known localities coordinate and AOO was calculated by the presence of the taxon in a grid of 2 km^2 areas (Bland et al., 2017).The species that have been included based on IUCN criteria were used to evaluate the taxa belongings to a certain threat category (Bland et al., 2017).

The sites/localities were recorded along with GPS of each species (Annexes a & b) for the estimation of Extent of Occurrence (EOO) and Area of Occupancy (AOO). This species was found at an elevation range of 230–550 m

4. Results

Among the fifteen evaluated taxa, *Astragalus erionotus*, *Delphinium kohatense* have been categorized as Vulnerable, twelve as Endangered, and one as Critically Endangered (Table 1). The data analysis of these species shows extent of occurrence (EOO) range from medium in *Plocama asperuliformus* (3880), *Strigosella toppinii* (2773), maximum in *Astragalus erionotus* (7152) and with minimum value in *Astragalus commixtus* (2080) km^2. Similarly, area of occupancy (AOO) range from 84.0 km^2 (*Delphinium ohatense*), 40.0-44.0 km^2 (*Anaphalis chitralensis*, *Plocama asperuliformus*), 24-32.0 km^2 (*Oxytropis gloriosa*, *Galium ghilanicum*, *Polygonum cognatum)* and with the minimum value 8.0 km^2 in *Astragalus commixtus*.

Table 1. Proposed threat category of the fifteen endemic plant taxa being studied with quality trends, main factors contributing to loss/degradation.

S. No	Species name	EOO km²	AOO km²	Total population (2014-17)	Average Population (2014-17)	Main factors contributing to loss / degradation	Trend in habitat quantity	Trend in habitat quality	IUCN Category
1	*Anaphalis chitralensis* Qaiser & Abid	2473.6	40.0	543	181	Human activities	moderate	moderate	Endangered
2	*Astragalus commixtus* Bunge	2.11	8.00	56	18	Human activities	Decreasing	Decreasing	Critically Endangered
3	*A. erionotus* Bunge	7152.9	48.0	767	255	Human activities	Stable	Stable	Vulnerable
4	*A. mirabilis* Lipsky	1842.81	20.0	217	75	Narrow dispersal	Decreasing	Decreasing	Endangered
5	*Delphinium kohatense* (Brühl) Munz	5556.4	84	838	279	Human activities	Decreasing	Decreasing	Vulnerable
6	*Delphinium nordhagenii* Wendelbo	2288	36	456	152	Human activities	Decreasing	Decreasing	Endangered
7	*Plocama asperuliformis* (Lincz.) M.Backlund & Thulin	3880.4	44.0	878	292	Human activities	Stable	Stable	Endangered
8	*Galium ghilanicum* Stapf	730.4	32.0	143	43	Narrow dispersal	Decreasing	Decreasing	Endangered
9	*Oxytropis gloriosa* Ali	540.9	24.0	632	210	Human activities	Decreasing	Decreasing	Endangered
10	*Polygonum cognatum* (Rech.f. & Schiman-Czeika) Qaiser	358.7	12.0	407	135	Climatic changes	Decreasing	Decreasing	Endangered

11	*Silene longisepala* Nasir	4039.7	80.0	584	194	Human activities	Decreasing	Decreasing	Endangered
12	*Silene pseudoverticillata* Nasir	491.6	36.0	791	263	Narrow dispersal	stable	stable	Endangered
13	*Psychrogeton chitralicus* Gierson	2167.1	36.0	260	86	Human activities	Decreasing	Decreasing	Endangered
14	*Impatiens lemannii* Hook.f. & Thomson	1409.8	40.0	814	271	Human activities	stable	stable	Endangered
15	*Strigosella toppinii* (O.E.Schulz) Botsch	2773.2	48.0	1044	348	Human activities	Decreasing	Decreasing	Endangered

According to data observed in three years of population size, total of 543 mature individual plants were observed in *Anaphalis chitralensis* with average of 181 mature individual plants per year with moderate trend of habitat quantity as well as quality. While the species *Delphinium kohatense*, *D. nordhagenii*, *Galium ghilanicum*, *Silene longisepala* etc. also showed decreasing trend of habitat quality with total of mature individual 438, 456, 143, 584 with the average 146, 152, 43, 194 respectively. While the species *Astragalus commixtus*, *Oxytropis gloriosa*, *Polygonum cognatum* subsp. *chitralicum*, *Psychrogeton chitralicus* also showed decreasing habitat quality trend (Table 1). *Delphinium kohatense* with stable quality and quantity of habitat indicated in population trend after decade as well (Fig. 2). While species *Astragalus erionotus*, *Plocama asperuliformus*, *Silene pseudo-verticellata* and *Impatiens lemannii* etc. showed stable trend with total of population of 667, 878, 791, 814 with the average of 222, 292, 263, 271 respectively.

Main contributing factor is human activities/anthropogenic for most of species except *Astragalus mirabilis*and *Galium ghilanicum*. The narrow dispersal is main contributing factor between them (Table 1). Further the population trend from 2003 to 2017 of eleven taxa is indicated in Figure 2. Less difference in total number of mature individuals of *Anaphalis chitralensis* having total population of 548 in 2014-17 and 564 in 2003-07.While *Astragalus erionotus* proved to stable with sharp increase from 441 to 767 mature individuals after decade, rest eight taxa indicate clear reduction in population size (Fig. 2).

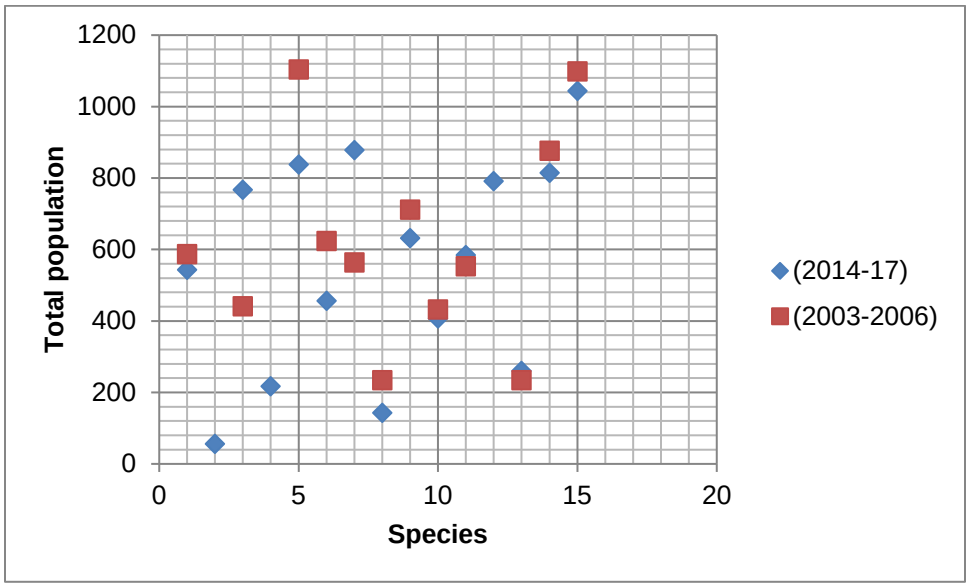

Figure 2. Population trend of endemic plants after decade

5. Discussion

Among the fifteen evaluated endemic taxa, two are vulnerable, one is critically endangered and rest twelve is endangered. The changes in habitat pose threats to plant species to become as vulnerable or threatened (Kingston & Waldren, 2005; Paré, 2008). The main threats to twelve categorized endangered taxa are human activities, limited dispersal/distribution and low number of mature individuals. Anthropogenic factor is possibly the most ominous threat to biodiversity including habitat degradation, over exploitation (Sheikh et al., 2002; Groom, 2006; Nowak et al., 2011; Cancio et al., 2016). Natural disasters especially climate change and flooding also pose serious threats to biodiversity especially rare plants (Khanum et al., 2013; Soomers et al., 2013; Kui et al., 2014).

The *Astragalus mirabilis* is categorized here as an endangered taxon. Ali and Qaiser (2010) reported populations of this species from Chaghbeni, Gokhshal and Ishpeder. But we also found this species from GahirtGol as reported from Ali-S.I. (1977). According to Ali and Qaiser (2010) it was categorized as critically endangered from Chitral while all the possible data has been gathered for this endemic species indicating good population in west of Gahirt as well and based on B1 and B2 criterions of the IUCN, the species can only be Endangered and not Critically endangered. Moreover, based on EOO and AOO (B1 and B2

IUCN criterions respectively), *Delphinium nordhagenii*, a species that grows on steep rocky slopes, categorized as Endangered, while same species have been treated as Critically endangered according to Ali et al. (2012). The Endangered categorized *Plocama asperuliformus* has showed stable population as indicated by Ali and Qaiser (2010). Similar with case of *Silene longisepala* (Ali & Qaiser, 2011). The taxa like *Galium ghilanicum*, *Oxytropis gloriosa* and *Psychrogeton chitralicus* also categorized as Endangered. While *Silene pseudoverticellata* though categorized as Endangered but proved to be narrow endemic (EOO 491, AOO 36: Table 1) with stable extensive populations in Chitral Gol National Park at various areas (Fig. 2).

The *Astragalus erionotus*, a species that grows on undulating grassy gentle slopes has beencategorized as Vulnerable based on EOO and AOO (B1 and B2 criterions of the IUCN) has four stable populations, three of them (in Chitral Gol National Park) has broad distribution area and a number of mature individuals. Thus, this speceis has also showed increase in population trend after ten years (Fig. 2). While Ali and Qaiser (2012) reported it as critically endangered, *Astragalus commixtus* is that grows mostly near to the easier asses access areas such as on rocky gentle slopes is the categorized as Critically Endangered (Fig. 3).

Figure 3. *Astragalus erionotus*, *Impatiens lemannii*, *Astragalus commixtus*, *Delphinium kohatense*, *Oxytropis* sp. (from left to right)

Anyway, as major threats are anthropogenic, thus in order to accomplish more sustainable solutions, a systematic and interdisciplinary approach on biodiversity conservation isrequired (Zisenis, 2009; Ture & Bocuk, 2010; Delibes-Mateos, 2017). Most of the species categorized here as endangered including *Astragalus commixtus* (Critically Endangered) need to be conserved, through both ex-situ, in-situ (Marriotti & Magrini, 2016; Kashimshetty et al., 2017) as well as reintroduction (IUCN, 1998; Godefroid et al., 2011; Volis, 2016). Number of other management measures could also be incorporated, such as, minimizing illegal wood logging and cutting, educating young people about the importance of nature conservation and biodiversity, capacity building of Park workers etc. (Young et al., 2014). There should be setting of lists of priorities and actions for integrated approach towards the conservation of

the endemic and endangered flora considering the limited resources for the efforts of species conservation based on IUCN criteria (Cowling et al., 2003; Forzza & Baumgratz, 2012; Treurnicht et al., 2017). Further detailed study for genetic variation, dispersal attributes, seed traits and other niche contributing factors could also be incorporated in species management plan especially for the narrow endemics (Lozano et al., 2005; Rossetto et al., 2008, Kadis et al., 2010).

The existing study could providea basisfor assessing priorities among species in for conservation Pakistan and particularly in Chitral which has high diversity among country's biodiversity hotspots) (Shaheen & Shinwari, 2012; Shaheen et al., 2019). Among the local endemic following taxa *Astragalus commixtus*, *A. mirabilis*, and *Galium ghilanicum* has only 18-75 average mature individuals. According to Ali (2010) *Astragalus commixtus* had 88 average mature individuals, while ten years later the number of species counts only 18 average mature individuals as result of human induced activities. Thus, population extremely reduced (Fig. 2, Annexe c).

Thus it is concluded that the biodiversity hotspot, Chitral with many endemic taxa needs to be protected crucially with high priority for conservation sites (for example Sosoom, Ojhar, Bakamak hill etc.). Among the fifteen taxa studied eight of them are found in Chitral Gol National Park except *Astragalus commixtus*, *A. mirabilis*, *Galium ghilanicum*, *Polygonum cognatum, Impatiens lemannii* and *Strigosella toppinii* found in hilly areas that are not protected. Thus, those areas also need protected management by including them under the National Park.

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