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PHYTOSOCIOLOGICAL ANALYSIS OF PINE FOREST AT INDUS KOHISTAN, KPK, PAKISTAN

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Abstract

The study was carried out to describe the pine communities at Indus Kohistan valley in quantitative term. Thirty stands of relatively undisturbed vegetation were selected for sampling. Quantitative sampling was carried out by Point Centered Quarter (PCQ) method. Seven tree species were common in the Indus Kohistan valley. *Cedrus deodara* was recorded from twenty eight different locations and exhibited the highest mean importance value while *Pinus wallichiana* was recorded from 23 different locations and exhibited second highest mean importance value. Third most occurring species was *Abies pindrow* that attained the third highest mean importance value and *Picea smithiana* was recorded from eight different locations and attained fourth highest importance value while it was first dominant in one stand and second dominant in four stands. *Pinus gerardiana, Quercus baloot* and *Taxus fuana* were the rare species in this area, these species attained low mean importance value. Six communities and four monospecific stands of *Cedrus deodara* were recognized. *Cedrus-Pinus* community was the most occurring community, which was recorded from 13 different stands. The second most occurring community in the study area was *Abies –Pinus wallichiana* which was recorded from six locations while *Cedrus-Picea* and *Abies-Picea* communities were observed at two locations each. *Pinus wallichiana - Picea* and *Cedrus-Pinus gerardiana* communities were restricted to one location.

Key words: Forest communities, *Cedrus deodara, Pinus wallichiana, Abies pindrow, Pinus gerardiana,* Indus Kohistan

Introduction

Various worker i.e., Chaudhri (1952, 1953, 1960); Khan (1960); Repp & Khan (1959, 1960); Khan & Repp (1961); Champion *et al.* (1965) and Beg (1975) conducted observational vegetation studies in different parts of Pakistan while quantitative phytosociological studies from different area of Pakistan started by Hussain & Qadir (1970); Shaukat & Hussain (1970); Shaukat & Qadir (1970, 1972). An extensive quantitative phytosociological work was carried out by Ahmed (1986, 1988). Hussain *et al.* (1992, 1993) explored the vegetation of lesser Himalayan regions of Pakistan. Siddiqui *et al.* (2009) conducted phytosociological studies of Chir pine of lesser Himalayan and Hindu Kush range of Pakistan. Ahmed *et al.* (2006) described different forest vegetation from different climatic zones of northern part of Pakistan. Wahab *et al.* (2008) investigated the quantitative phytosociology of some Pines forest of Afghanistan close to District Dir, Khyber Pakhtunkhwa Province. Hussain *et al.* (2010, 2013) carried out phytosociological studies and predicted future trends of the forests of Central Karakorum National Parks Gilgit-Baltistan. Siddiqui *et al.* (2013) described the floristic composition and found the relationship between environmental variable with the distribution of vegetation from different moist temperate coniferous forest of Himalayan and Hindukush region of Pakistan. Recently, Iqbal *et al.* (2014) described quantitative vegetation analysis of some pines forest from moist temperate area at district Shangla Khyber Pakhtunkhwa.

In Kohistan valley the ranges of Hindu Kush, Karakorum, and Himalayan mountains system meets and supporting natural vegetation of Asia. It is a remote area hence little plant and ecological information is available from this area (Saqib *et al.,* 2006) and no quantitative vegetational study of the forest was conducted to describe the floristic composition, plant communities and forest structure of this area. Therefore, it was necessary to carry out the detailed study of this area to explore the vegetation description and plant communities as carried out in this study.

Materials and Methods

Sampling was carried out in less disturbed forests of Indus Kohistan, with the help of Point centre quarter method of Cottam & Curtis (1956) with the modification of Ahmed & Ogden (1991). In each stand 20 points were taken at every 20 meter interval. Elevation and geographic coordinates was obtained with the help of potable GPS, while slope meter was used to record the slope angle of the forest. Species having the highest Importance value index (IVI) was considered the dominant species and the name of plant communities was assigned on the basis of first two dominant species. Phytosociological attributes (relative frequency, density and basal area**),** and absolute values (stand density ha^{-1} and basal area m^2ha^{-1}) were calculated following Ahmed & Shaukat (2012), while IVI was calculated by the method described by Brown & Curtis **(**1952) and the species were ranked on the basis of highest IVI.

Results and Discussion

Locations of 30 forest stands are shown in Fig. 1 while geographical coordinates (latitude & Longitude), ecological characteristics (elevation, slope, aspects and canopy of the forests) and tree communities of the study sites are described in Table 1. Study area forests were located between 1957 to 3380m elevation on 22° to 60° slope angles. Stands were distributed on all exposures, only 5 stands were considered least disturbed due to their closed canopy while 11 stands had moderate canopy (Table 1). Summary of quantitative sampling are shown in Table 2 while communities recognized at Indus Kohistan along with their associated species are given in Table 3. Conifer forests are located at various locations and climatic zones i.e., sub-tropical, moist temperate, dry temperate and timberline (Champion *et al.,* 1965; Ahmed *et al.*, 2006; Ahmed, 2014) and at many places no sharp distinction could be made (Hussain & Illahi, 1991).

Following are the quantitative description of each pine community and pure forests which was based on higher importance value index and floristic composition of dominant pine tree species.

1. *Cedrus-Pinus wallichiana* community: This community is distributed in thirteen different locations (Table 3; stands 1,8,10, 11, 12, 13, 14, 16, 18, 20, 29) on north, east, west and East facing steep slope of Indus Kohistan valley of KPK. The community was comprised of open, close and moderate canopy and the elevation range of this community at thirteen locations was from 1957-2780m above the sea level. In these stands *Cedrus deodara* and *Pinus wallichiana* are the dominant species however; *Quercus baloot, Abies pindrow* and *Picea smithiana* were recorded as associates. The *Cedrus deodara* contained from 20-93 to 79.36% mean importance value with density of 73 to 353 individuals ha^{-1} and 21.10 to 96.12 basal area $m^2 ha^{-1}$ while *Pinus wallichiana* occupied from 14.55-79.07% importance value with 47 to 377 plants ha-1 and 16.38 to 19.12 basal area m^2ha^{-1}. On the basis of higher importance value, at some stands this community may be designated as *Pinus-Cedrus* community, however, due to the same floristic composition of first two dominant species it is included under *Cedrus-Pinus wallichiana* community. It was concluded that numerical differences in these tree species may be due to the human disturbance i.e. illegal cutting of one species. Similar conclusions were also made by some previous workers i.e. Ahmed *et al.* (2010); Siddiqui *et al.* (2013). This type of community was also recognized by Khan (2011) from Bronshal Gol National park and Shehekuh valley at 2344 and 2217m elevation respectively. They recorded the density of *Cedrus deodara* from 275 to 278 individual ha^{-1} with 32 to 38 m^2 ha^{-1} basal area while *Pinus wallichiana* showed the density of 25 to 127 individuals ha^{-1} with 4.83 to 89 m^2ha^{-1} basal area. This type of community was also recognized by Bokhari (2011); Bokhari *et al.* (2013) from Azad Jammu and Kashmir. She described that this community was confined to Keran and Sharda location of Azad Jammu & Kashmir. The important value of *Cedrus deodara* was 15-89% while *Pinus wallichiana* showed 11-85% important value. *Cedrus deodara* attained the density of 9-132 plants ha^{-1} while *Pinus wallichiana* attained 4-57 plants ha^{-1}. The basal area of *Cedrus deodara* was 9-48 m^2ha^{-1} and *Pinus wallichiana* showed 4-57 m^2ha^{-1} basal area.

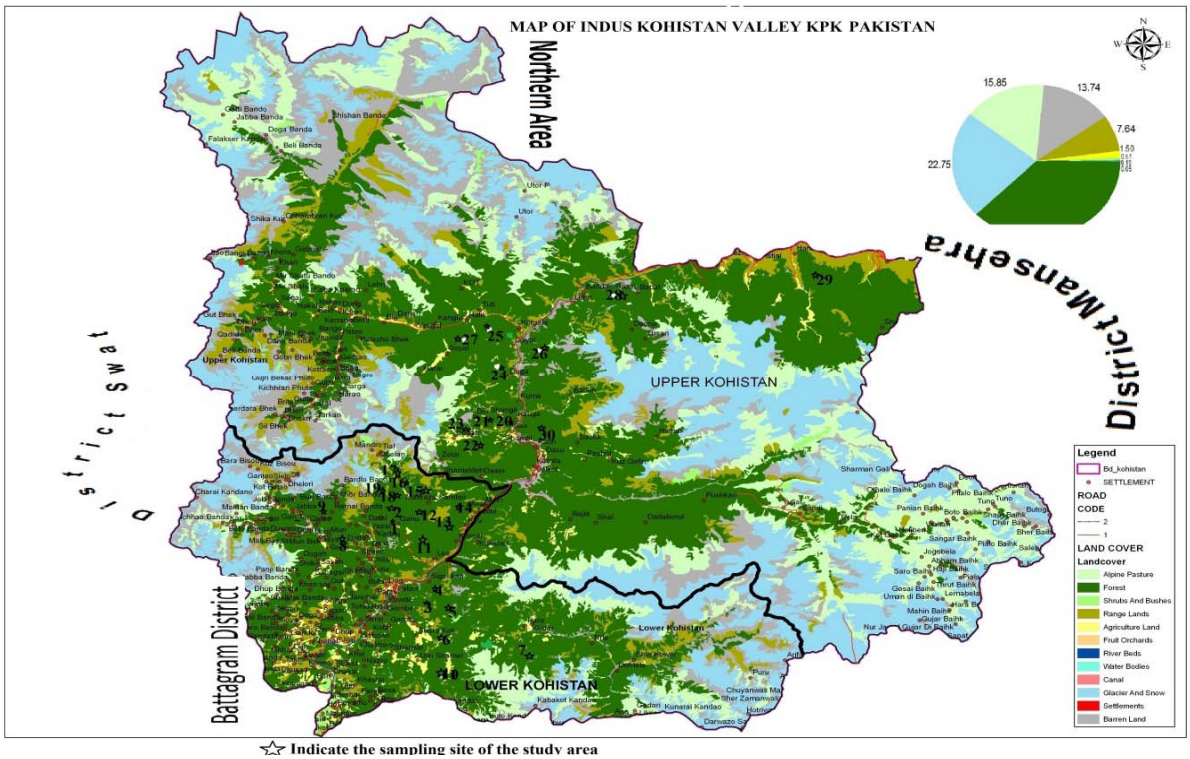

Fig. 1. Study area map, showing sampling sites from Indus Kohistan, of KPK.

Table 1. Geographical characteristics and distribution of pine tree species in thirty stands from Indus Kohistan KPK.

S. No.	Locations and sites	Latitude (N)	Longitude (E)	Elevation (m)	Slope (º)	Aspect	Canopy	Communities
1.	Pattan (Chawa dara)	72° 58 38.8	35°10 50.2´	1957	39°	N/W	Mod	*Pw / Cd*
2.	Pattan (Yazai)	72° 58 12.75´	35°10 05.59´	2082	33°	W	Open	*Cd / Pw*
3.	Sharakot (Kandao)	73° 03 18.2´	35 °01 52.7´	2369	44°	N/E	Open	*Pw /P.s*
4.	Sharakot	73° 04 01.9´	35°02 49.7´	2540	37°	N/W	Mod	*Cd /P.s*
5.	Sharakot Dot	73° 03 34.2´	35 °02 08.3´	2435	57°	E/S	Open	*Ap/ Pw*
6.	Khawargai	73° 03 28.9´	35 °01 47.8´	2727	48°	N/E	Mod	*Pw /A.p*
7.	Shirial (Kuz)	73° 03 34.2´	35 °02 08.3´	2369	30°	E/S	Open	*Pw / Cd*
8.	Dubair Bala (Kuz Gaya)	72° 53 49.9´	35°09 44.9´	2351	43°	E	Mod	*Pw / Cd*
9.	Dubair (Nilgai Dara)	72° 54 36.32´	35°12 49.44´	2671	35°	N/E	Open	*Ap/P.w*
10.	Kolai (Ujin shamal)	73° 00 44.80´	35°00 23.11´	2085	40°	E/N	Close	*Pw / Cd*
11.	Kayal (Balkun)	73° 01 25.81´	35°12 46.86´	2180	39°	E/N	Mod	*Cd / Pw*
12.	Kayal (Gahu)	73° 01 25.81´	35°12 46.86´	2390	49°	E/S	Mod	*Cd / Pw*
13.	Kayal (Shangol)	73° 01 35.81´	35°12 38.86´	2010	22°	E/N	Mod	*Pw/ Cd*
14.	Semo Dara	73° 01 25.81´	35°12 46.86´	2180	25°	W/N	Close	*Pw / Cd*
15.	Semo (Kayoun)	73° 01 35.71´	35°13 56.44´	2317	60°	E/N	Close	*Cd*
16.	Sanga Dara	73° 01 45.81´	35°44 46.86´	2475	59°	E	Open	*Pw / Cd*
17.	Sanga Dara (II)	73° 03 35.1´	35°22 76.86´	2690	29°	E	Open	*Pw / A.p*
18.	Sanga Galto	73° 03 77.81´	35°18 86.26´	2780	45°	E	Open	*Pw / Cd*
19.	Sanga (Khanki)	73° 01 55.81´	35°09 56.56´	2503	30°	E	Open	*Ap/ Pw*
20.	Seo	73° 03 34.2´	35 02 08.3´	2435	40°	E/S	Mod	*Cd / Pw*
21.	Raziqa (Dhar)	73°02 2.25´	35°02 65.7´	2540	47°	N/E	Close	*Ap/P.s*
22.	Dogah (I)	73°03 18.2´	35°01 52.7´	3044	53°	E/S	Close	*Ps/ Cd*
23.	Dogah (II)	73°51 .07´	35°53.036´	2635	58°	E/N	Close	*Cd* pure
24.	Dassu (Duga)	73°56 .64´	34°08 .56´	3110	45°	S/W	Open	*Ap/Ps*
25.	Gayal (I)	73°36 .50´	35°24 0.36´	3060	55°	E/N	Mod	*Cd /Pg*
26.	Gayal (II)	73°36 .09´	34°01 .75´	3380	60°	E	Mod	*Cd /Pg*
27.	Khandia (Seyal)	73°02 .562´	35°01 42.67´	2995	36°	E/S	Open	*Cd* pure
28.	Sazin	73°20 .06´	35°10 .54´	2680	60°	S/W	Open	*Cd* pure
29.	Harban	73°01 25.81´	35°12 46.86´	2317	29°	E	Open	*Cd / Pw*
30.	Jalkot (sasak)	73° 02 30.6´	35°01 44.5´	2375	37°	S/E	Mod	*Pw /Ap*

Key to abbreviations along with species authorship: Ap =*Abies pindrow* Royle, Ps= *Picea smithiana* (Wall.) Boiss., *Cd* = *Cedrus deodara* (Roxb. ex Lamb.) G. Don. & Pw = *Pinus wallichiana* A. B. Jackson Pg = *Pinus gerardiana* and Mod = Moderate

Table 2. Summary of phytosociological attributes, absolute density (ha^{-1}), basal area ($m^2\ ha^{-1}$) and dominant position of tree species in 30 stands from Kohistan valley of KPK.

S. No	Species names	Pst	Min IVI	Max IVI	Mean IVI	Min Den	Max Den	Mean Density ha^{-1}	Min B.A	Max B.A	Mean B.A $m^2\ ha^{-1}$	Rank 1st	Rank 2nd
1.	*Cedrus deodara*	28	3.28	100	45.79 ± 5.81	14.8	461.4	158.27 ± 21.25	2.84	96.6	38.81 ± 5.86	12	9
2.	*Pinus wallichiana*	23	5.49	87.04	43.95 ± 4.67	11.1	377.2	137.58 ± 18.8	7.86	96.6	41.80 ± 5.50	12	8
3.	*Abies pindrow*	13	6.25	70.00	32.97 ± 6.38	13.5	215.5	97.72 ± 19.69	3.23	92.13	33.74 ± 8.23	5	2
4.	*Picea smithiana*	8	5.00	42.50	24.84 ± 4.72	10.4	192.8	83.17 ± 21.43	1.64	55.07	22.90 ± 6.52	1	4
5.	*Pinus gerardiana* Wall. ex Lamb.	2	-	-	17.29 ± 5.81	31.7	85.4	58.55 ± 26.80	7.07	18.54	12.80 ± 5.73	-	2
6.	*Qurecus baloot*	2	7.50	27.50	14.92 ± 9.12	16.20	85.20	50.70 ± 34.50	1.13	7.84	4.48 ± 3.35	-	-
7.	*Taxus fuana*	1	-	-	14.87	-	48.75	48.75	-	8.81	8.80	-	-

Note: Pst = Number of stands in which a species was present. Species are ranked on the basis of importance value index (IVI) 1st = Number of stand of first dominant species, 2nd = Number of stands of 2nd dominant species

Table 3. Summary of communities and associate species of thirty stands from Indus Kohistan valley.

S. No.	Communities	Stands	Number of stand	Associated species
1.	*Cedrus-Pinus wallichiana* community	2, 11, 12, 20, 29/1, 7, 8, 10, 13, 14, 16, 18	13	*Qb, Ap, Ps*
2.	*Pinus wallichiana-Picea community*	3	1	*Cd, Qb, Ap*
3.	*Cedrus-Picea* community	4/22	2	*Pw, Tf, Ap*
4.	*Abies-Pinus wallichiana* community	5,9,19/6,17,30	6	*Cd,Ps*
5.	*Abies-Picea* community	21,24	2	*Pw,Cd*
6.	*Cedrus–Pinus gerardiana* community	25,26	2	*Ap*
7.	Monospecific *Cedrus* forest	15,23,27,28	4	_

2. *Pinus wallichiana-Picea* community: This community was recorded from one location (Table 3; stand, 3). The community was located at 2369m elevation on north east facing exposure with open canopy. *Pinus wallichiana* was dominant species showing 43.97 % importance value with 94 individuals ha^{-1} and 21.07 basal area m^2 ha^{-1} while *Picea smithiana* was the second dominant species with 28.2 % importance value, 60 plants ha^{-1} density and 15.22 m^2 ha^{-1} basal area. *Cedrus deodara, Quercus baloot and Abies pindrow* were the associated species which showed low value of importance value, density and basal area. This community was also recognized at Bagrot and Haramosh valley with *Juniperus excelsa* as an associated species by (Hussain *et al.*, 2011). They computed the density of 67 plants ha^{-1} with 17.4 m^2ha^{-1} basal area for *Picea smithiana* from Bagrot while 74.6 plants ha^{-1} density and 21.5 m^2ha^{-1} basal area from Haramosh. *Pinus wallichiana* density ha^{-1} was 17 and basal area was 5 at Bagrot while 29 density ha^{-1} and 7 m^2ha^{-1} basal area at Haramosh.

3. *Cedrus-Picea* community: This community was located at two different locations in the sampling area on 2340 & 3044 meter elevation on east-south and north-west facing aspect (Table 3; Stand 4 and 22). The canopy of this community was closed and moderate occupied on 37° & 57^0 steep slopes. In this community *Cedrus deodara* importance value ranged from 32.39 to 43.2% with the density of 122 to 146 plants ha-^{1} and 23.86 to 33.14 m^2ha^{-1} basal area while *Picea smithiana* showed 24.29 to 37.32% importance value with the density of 73 to 135 plants $ha^{-1}$and 16.79 to 42.01 m^2ha^{-1} basal area. Ahmed *et al*. (2010) recorded this community from Chitral on East facing steep slope while at Shogran and Kaghan on South facing steep slope on 2544m elevation with 68 to 392 ha^{-1} density and 36.39 to 86.45 m^2ha^{-1} basal area. Same community was also reported by Khan (2011) from Ziarat-Chitral with the density of 55 to 151 plants ha^{-1} density and 11.21 to 36 m^2ha^{-1} basal area while from Agriate 99 to 46 individuals ha^{-1} density with 28.62 to 14.96 m^2ha^{-1} basal area. At one location *Picea smithiana* showed high importance value than *Cedrus deodara,* it could be due to continuous cutting of *Cedrus* trees for timber and fuel purpose.

4. *Abies-Pinus wallichiana* community: This community was recorded at six different locations (stand. 5, 6, 9, 17, 19, and 30) from 2375 to 2727 meter elevation with 29°-57^0 steep slopes. In this community *Abies pindrow* attained importance value from 12.96 to 70.68%, density of 33.5 to 221.9 plants ha-^{1} with 9.83 to 68.66 m^2ha^{-1} basal area while co-dominant *Pinus wallichiana* attained 15.47 to 87.04% importance value, 31 to 210 plants ha^{-1} density with 19.69 to76.49 m^2ha^{-1} basal area. *Cedrus* and *Picea* are the associated species in the community. *Abies pindrow* showed the density of 83 individual ha^{-1} with 93 m^2ha^{-1} basal area while *Pinus wallichiana* had 4 individual ha^{-1} density with 15 m^2ha^{-1} basal area. Siddiqui *et al*. (2011) and Bokhari (2011) recognized this community as moist temperate and recorded from Suddhan Gali, Azad Kashmir. Bokhari *et al.* (2013) demonstrated that *Abies pindrow* showed 24-92% important value and 47-165 plants ha^{-1} density with 21-55 m^2ha^{-1} basal area. *Pinus wallichiana* attained 8-76% important value with the density of 19-158 plants ha^{-1} and 3-42 m^2ha^{-1} basal area. At district Shangla (Swat) this community was recognized by Iqbal *et al.* (2014), they observed 36 to 279 trees of *Pinus wallichiana* ha^{-1} with 91.08 to 109.4 m^2ha^{-1} basal area while *Abies pindrow* had the density of 19 to 93 individual ha^{-1} with 5.3 to 48.8 m^2 ha^{-1} basal area.

5. *Abies -Picea* community: *Abies-Picea* community was recorded from stand 21 and 24 at 2540 & 3310m elevation with 45° to 47^0 steep slope and N/E, S/W aspect (Table 3). Both the forests had open and closed canopies each. The importance values of *Abies pindrow* were 50.91 and 57.54% and *Picea smithiana* 33.69 and 39.84%. *Abies pindrow* density were 159 and 216 plants ha^{-1} with 78.97 & 92.13 m^2ha^{-1} basal area while *Picea* showed the density of 111 & 193 individual ha^{-1} with 31.60 & 55.07 m^2ha^{-1} basal area. *Pinus wallichiana* and *Cedrus deodara* were the associated species in these stands. Similar type of community were also recorded from moist temperate areas (Sri, Shogran and Malam Jabba) by Siddiqui *et al.* (2013; 2015) and Shangla district by Iqbal *et al*. (2014). They described that importance value of *Abies* at Malam Jabba to be 90% with the density of 288 plants ha^{-1} and 64 m^2ha^{-1} basal area, while at Sri, Shogran the importance value was 32% with 138 plants ha^{-1} density and 44 m^2ha^{-1} basal area. Similarly at Shangla *Abies pindrow* showed 63.3 to 77.2% importance value with the density of 242 to 290 plants ha^{-1} and 74.7 to 108.9 m^2ha^{-1} basal area.

6. *Cedrus –Pinus gerardiana* community: *Cedrus–Pinus gerardiana* community was recorded from East and East-North exposures at Gayal on high elevation (3060 and 3380m) and steep slope angles (55° & 60°), it had moderate canopy (Table 1; Stand. 25, 26). Importance value of *Cedrus deodara* was 76.9 to 78.96% with the density of 254 to 256 trees ha-^{1} while *Pinus gerardiana* showed 11.48 and 23.1% importance value with 38 and 77 plants ha^{-1} density. The basal area of *Cedrus deodara* was 37.64 and 77.45 m^2ha^{-1} and *Pinus gerardiana* was 7.07 and 18.54 m^2ha^{-1}. *Abies pindrow* was the associated species in this community which showed lowest importance value. This community was also recognized from dry temperate area of Chitral Gol National park and Kalash Bumburat (Khan, 2011). At first location *Cedrus deodara* occupied 502 density ha^{-1} with 153.5 m^2ha basal area while *Pinus gerardiana* showed 120 density ha^{-1} and 12.24 m^2ha^{-1} basal area and on second location *Cedrus deodara* occupied 52 plants ha^{-1} density & 20 m^2ha^{-1} basal area while *Pinus gerardiana* occupied 38 trees ha^{-1} density with 7.04 m^2ha^{-1} basal area.

7. Monospecific *Cedrus* community: Monospecific forests of *Cedrus deodara* was recorded from four different locations (Table 1; stand, 15, 23, 27, and 28) of the study area at the elevations of 2317 to 2995m with 36 to 60^0 slope angles on East and South aspects. The canopies of these forests were open and closed. *Cedrus deodara* attained 100% importance value because of monospecificity and the density ranged from 232 to 461 individuals ha^{-1} and 42.7 to 117.4 m^2ha^{-1} basal area. The *Cedrus deodara* species showed the highest mean IVI with mean density ha^{-1} and comprised the first dominant species in 12 stands while acted as the 2^{nd} dominant species in 9 stands.

Monospecific forests of *Cedrus deodara* were also recorded from different climatic zones such as moist temperate, dry temperate and timberline reported by many workers i.e., Ahmed *et al.* (1989, 1990, 1991 and 2006), Wahab *et al.* (2008); Siddiqui (2011); Khan (2011) and Siddiqui *et al.* (2010; 2013). Champion *et al.* (1965) stated that *Cedrus deodara* extended gradually into the dry inner valley of the Himalayan and ultimately shift to an entirely different dry forest. *Cedrus deodara* prefers the Mediterranean climate and avoids area, which received high summer rainfall therefore; he placed it under the Dry temperate forests (Beg, 1975).

The results of the current study showed that the entire area was composed of six pine and one angiospermic tree species, in which *Cedrus deodara* was widely distributed species, recorded from 28 different locations. *Cedrus deodara* forms community with other conifer and angiospermic species. At some locations it is reported as an associated species (Ahmed *et al.*, 2006; 2011). Highest density (502 trees ha^{-1}) and basal area (153 m^2ha^{-1}) of this species was recorded by Khan (2011) from Chitral Gol National Park while lowest density and basal area was reported by Wahab (2011) from district Dir, KPK.

The *Pinus wallichiana* was the 2nd dominant species in study area, recorded from 23 different stands; however this species was not recorded as monospecific forest. In 12 stands it occupied first dominant position second dominant in 8 stands and associated at three locations. Iqbal *et al.* (2014) recorded this species from 26 different stands out of 30 sites at district Shangla KPK. It occupied first dominant position in 23 stands which showed its wide abundance in Shangla district. The highest mean stand density (108.6±15.8) of this species was recorded from moist temperate area of Pakistan by Siddiqui (2011) while the highest mean basal area (27±14) of *Pinus wallichiana* was recorded by Khan (2011) from dry temperate area of district Chiral. Bokhari *et al.* (2013) observed the lowest basal area of this species from Chakothi Azad Kashmir.

Abies pindrow and *Picea smithiana* were recorded in 13 and 8 different location of the study area respectively. *Abies pindrow* showed the first dominant position at 5 different locations while the 2nd dominant in two different locations. Monospecific forest of *Abies pindrow* was observed by Iqbal *et al.* (2014) from Bahadar Sar, district Shangla with highest density (383.71 ha^{-1}) and basal area (145.37 m^2ha^{-1}). The lowest density (4 trees ha^{-1}) of *Abies pindrow* was recorded by Wahab (2011) from Dir and lowest basal area (0.76 m^2ha^{-1}) was recorded by Khan (2011) from Chitral.

The *Picea smithiana* showed the first dominant position in only one sites of the study area while the 2nd dominant position in four sites of the study area. Wahab (2011) recorded the highest density 137 ha^{-1}density and 85 basal area $m^2ha^{-1}$from district Dir. The lowest density of *Picea smithiana* was 4 trees ha^{-1}density (Khan, 2011 and Wahab, 2011) from Chitral Gol National Park and district Dir respectively while Bokhari (2011) observed the lowest basal area of *Picea smithiana* as compared to other researchers.

At some locations due to lowest importance value, *Cedrus deodara*, *Pinus wallichiana*, *Picea smithiana* and *Abies pindrow* were also designated as associated species as also observed by many workers i.e., Zarif (2004); Rehman (2003-2005); Ahmed *et al.* (2006) and Khan (2011).

Pinus gerardiana was recorded only from two locations of the study area because of its high economic value. Local peoples collect its cones to obtain edible seeds (Chilghoza) for commercial purpose and wood for fuel, so it is an endangered species in this area. Some workers suggested that *Pinus gerardiana* is extensively exploited for edible seed and fuel from last many decades i.e., Ahmed *et al.* (1990); Zarif, (2004); Rehman, (2003-2005). According to Khan *et al.* (2010) *Pinus gerardiana* overlapped with *Quercus baloot* due to its gradual extermination. An isolated pure stand of this species was sampled by Ahmed *et al.* (1990) from Zohab district, Balochistan, on 3000 m elevation at four aspect (North, South, West and East) facing slope with density of 24 to 930 plants ha^{-1} (mean: 266) and 2 to 69.4 m^2ha^{-1} basal area. This indicates the wider ecological amplitude of this species. This species obtained the 2nd dominant position in both sites.

Quercus baloot and *Taxus fuana* occupied lowest mean importance value, density and basal area, hence classified as associated species in Indus Kohistan. Khan *et al.* (2010) recorded 22 monospecific forests of *Quercus baloot* from Chitral district, KPK. *Taxus fuana* was also recorded by Siddiqui (2011) from Hazara division and Wahab (2011) from District Dir.

In general it is concluded that the forests of Indus Kohistan are extremely disturbed by the local community and future of these forest is under great threat. Related governmental agencies, NGOs, forest department should pay special attention to conserve and manage these forests from extermination.

Species authorship: *Qurcus baloot* Griffith and *Taxus fauna* Nan Li & R.R. Mill and refer to Table 1.

Reference

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