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VEGETATION COMPOSITION AND THREATS TO THE MONTANE TEMPERATE FOREST ECOSYSTEM OF QALAGAI HILLS, SWAT, KHYBER PAKHTUNKHWA, PAKISTAN

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Abstract

The remnant temperate forests in Qalagai hills, district Swat, Khyber Pakhtunkhwa is under severe anthropogenic pressure in the form of logging, deforestation, over-grazing and clearance of forest for terrace cultivation. The present endeavours were undertaken to assess the structure and composition of the existing vegetation of the area with an aim to pinpoint strategies for the conservation of this threatened ecosystem. A total of 160 stands were sampled by using 10x10m, 2x2m and 1x1m quadrats for tree, shrub and herb layers, respectively adapting random stratified design. Frequency, density and crown coverage of each species were recorded and converted to relative values to obtain importance values. In all, floristic composition comprised of 209 species of vascular plants belonging to 167 genera and 75 families. On the basis of highest importance values, similarity index, topography, physiognomy and edaphic factors, eight stratified plant communities viz., 1) *Populus-Debregeasia-Nasturtium*, 2) *Olea-Plectranthus-Micromeria*, 3) *Pinus roxburghii-Plectranthus-Rumex,* 4) *Quercus-Indigofera-Amaranthus,* 5) *Pinus wallichiana-Indigofera-Galium,* 6) *Cedrus-Indigofera-Thymus,* 7) *Cedrus-Viburnum-Pteridium* and 8) *Pinus wallichiana-Viburnum-Leucas* were established in the area. Reclamation and conservation of original ecosystem need a long term strategy with active involvement of the local inhabitants.

Introduction

Globally, every third plant species is hosted by the mountainous regions (Namgail *et al.,* 2012). Forest ecosystems cover almost 5.01% of the land in Pakistan, which is far beyond the international standard on a per capita basis. The natural forest cover is decreasing at a rate of 0.75% annually (Anon., 2009). Montane temperate forests in Pakistan are predominantly coniferous nature with some broad leaved species (Hussain & Ilahi, 1991). The structure, composition and function of forest ecosystem change in response to climatic, topographic, edaphic and anthropogenic influences (Timilisina *et al.,* 2007; Ahmed *et al*., 2010; Shaheen *et al*., 2011; Namgail *et al.,* 2012). Like other forest types temperate forests are experiencing severe anthropogenic pressure (Ahmad *et al.,* 2006; 2008; Singh *et al.*, 2008; Shaheen *et al*., 2011). Deforestation, logging, overgrazing and clearing of land for terrace cultivation are the major threats responsible for the overall degradation of these forests (Hussain *et al*., 1997; Sher *et al*., 2010; Ahmad *et al.*, 2010; 2011). The coniferous forests in the northern mountain regions particularly are under the heavy social and economic pressure of tree felling (Siddiqui *et al.,* 1999).

The vegetation of Swat and adjoining areas is a mosaic of different community types and has been studied sporadically (Beg & Khan, 1984; Hussain *et al.,* 1992; Hussain *et al*., 1995; Sher & Al-Yameni, 2010; Ahmad *et al*., 2010; Rashid *et al.,* 2011; Khan, 2012).

Qalagai hills are situated in the North West of District Swat at a distance of about 30 km from Saidu Sharif. The area lies between latitude $34^{\circ}51'$ to $34^{\circ}55'$ North and longitude$72^{0}05'$ to $72^{0}10'$ East in Swat district. The average elevation of the area varies from 1450 m to 2892 m from the mean sea level. The site is a part of Hindu Kush mountain range (Ahmed & Siraj ud Din, 1996). The hills are zigzag in shape forming different ridges and furrows, which face differently to the incident light. Geologically the hills are of recent origin and forms part of the southern stretch of Kohistan Island arc, which is delineated on the South from the northern tip of the Indian plate marginal mass by a Himalayan megashear called the Main mantle thrust, the southern suture (Tahirkheli, 1982). Climatically the area falls within the subtropical zone but due to variation in the topography, altitude, aspect and vegetation cover the climate gradually change into montane temperate zone. The natural vegetation of Qalagai hills can be classified as: montane subtropical forest at lower altitudes and montane temperate forests at higher altitudes (Champion *et al*., 1965; Beg, 1975). The area was recently hit by a worst type of religious extremism, in which alongside other sectors of society the forest resources were badly affected (Sharar, 2009).

Considering the augmented pressure and threat to ecology and biodiversity of Qalagai hills, the present study was undertaken to provide baseline information on the community structure, species diversity and governing factors thereof, for proper conservation measures of the existing vegetation in the area.

Materials and Methods

The study was conducted in summer seasons (May-September) of 2007-2009. The area was divided into different zones on the basis of physiognomy, altitude, aspect and topography. Random stratified design was used for vegetation survey of the area. Soil was collected form at least three randomly selected areas in each site up to a depth of 15cm and thoroughly mixed to make a composite mix. The soils were analyzed for texture, pH, and percentage of calcium carbonate, organic matter, phosphorus, potassium and nitrogen using methods described in Hussain (1989), Jackson (1962) and Haluschak (2006). Quadrat method of vegetation sampling (Hussain 1989) was used to analysis the vegetation of Qalagai hills. The size of quadrants were 1x1 (1 m^2) for herbs, 2 x 2 (4 m^2) for shrub layer and 10 x 10 (100 m^2) for trees determined by species area curve as explained by Cox (1967). Twenty quadrants each were laid randomly in each site for tree, herb and shrub layers in a nested manner (Hussain, 1989). Frequency and density of each species was recorded according to Hussain (1989). Canopy coverage was determined according to Daubenmire (1959). The recorded values were changed to relative values and summed up to achieve importance values (Hussain, 1989). Each community was named after species having highest importance value in each stratum, i.e., tree, shrub and herb layer, respectively. This method was preferred because of the stratified nature of vegetation of Qalagai hills. Index of similarity was calculated according to Motyka Index of similarity (Motyka *et al*., 1950).

Results

a. Community structure: Eight stratified communities were established in Qalagai hills. The different phytosociological attributes of these communities are described as follows (Table 2).

1. *Populus-Debregeasia-Nasturtium* community (PDN): This community consisting of 58 species mostly with hydrophytic features was present along the water courses found in the depressions and low lying areas of Qalagai hills at an elevation of 1450 to 1600m. *Populus nigra* (IV=16.44), *Debregeasia salicifolia* (IV=15.46) and *Nasturtium efficinale* (IV =31.15) were the dominants in tree, shrub and herb layers, respectively. The soil is silt loam and slightly alkaline with pH 7.4. Organic matter is less than other communities. $CaCO_3$ is 9.25%, nitrogen 0.069%, phosphorus 1.91 ppm and potassium 150 ppm (Table 1). The soils are alluvial and prone to water erosion.

Table 1. Physico-chemical analysis of soils of different communities in Qalagai hills.

S. No.	Community	Physical analysis				Chemical analysis					
		Clay %	Silt %	Sand%	Textual class	pH	$CaCO_3$ %	O.M %	N %	P (ppm)	K (ppm)
1.	PDN	15.2	48.0	36.8	Silt loam	7.4	9.25	1.38	0.069	1.91	150
2.	OPM	2.0	33.2	64.8	Sandy loam	6.1	5.75	4.09	0.204	45.38	130
3.	PPR	2.4	41.2	56.4	Sandy loam	6.6	5.63	6.07	0.303	4.16	270
4.	QIA	1.6	57.2	41.2	Silt loam	5.5	6.00	6.07	0.303	2.75	210
5.	PIG	2.0	53.2	44.8	Silt loam	5.9	6.00	5.01	0.251	2.05	130
6.	CIT	0.8	41.2	58	Sandy loam	5.8	8.13	6.20	0.310	5.92	290
7.	CVP	0.8	25.2	74	Loamy sand	6.1	9.80	6.13	0.307	12.26	270
8.	PVL	2.4	39.2	58.4	Sandy loam	6.1	5.95	6.13	0.307	1.70	220

Key for communities: PDN = *Populus-Debregeasia-Nasturtium* community, OPM = *Olea-Plectranthus-Micromeria* community, PPR = *Pinus roxburghii-Plectranthus-Remux* community, QIA = *Quercus-Indigofera-Amaranthus* community, PIG = *Pinus wallichiana-Indigofera-Galium* community, CIT = *Cedrus-Indigofera-Thymus* community, CVP = *Cedrus-Viburnum-Pteridium* community, PVL = *Pinus wallichiana-Viburnum-Leucas* community Key: O.M = Organic matter, N= Nitrogen, P = Phosphorus, K = Potassium.

2. *Olea-Plectranthus-Micromeria* community (OPM): This community was established on the southern slopes at an elevation of 1450 to 1650 m. Fifty seven species of vascular plants were recorded in this community. The community is highly degraded with scattered trees. *Olea ferruginea* (IV=4.74), *Plectranthus rugosus* (IV=26.9) *and Micromeria biflora* (IV=21.05) were the leading dominants in tree, shrub and herb layers. The soil was sandy loam type and acidic in nature with pH=6.1, $CaCO_3$ contents were 5.75% and organic matter 4.09 percent. Nitrogen constituted 0.024% while phosphorus and potassium were 45.38 and 130 ppm, respectively. The phosphorus contents are higher in comparison to other communities. The community is under server biotic pressure in the form of deforestation, fuel wood extraction and overgrazing. The community is degraded with poor and scattered tree layer. The original community may have *Pinus roxburghii* and *O. ferruginea* as the leading dominants. Due to easy access the community has been changed as apparent from the low importance values of the woody species.

3. *Pinus roxburghii-Plectranthus-Rumex* community (PPR): At an altitude of 1650 to 1850 m on the southern slopes, *Pinus roxburghii (IV=21.76), Plectranthus rugosus (IV=20.73)* and *Rumex hastatus (IV=14.63)* were the dominant plant species in tree, shrub and herb layers, respectively. The soil was slightly acidic (pH=6.6) and sandy loam in texture. Organic matter contents were high (6.07%). The community is less accessible and safe from severe biotic interference. The vegetation is stratified with complete tree, shrub and herb layers. The community represents original vegetation of the altitudinal zone. Most of the species show xerophytic adaptations, because the southern slopes are comparatively drier and steeper than the rest.

4. *Quercus-Indigofera-Amaranthus* community (QIA): This community harboured south western and eastern slopes at an altitude of 1450 to 1800m. The species diversity was highest (96) due to microclimatic variation in the site. *Quercus dilatata* with importance value 16.75 in tree layer *Indigofera heterantha* with importance value 16 in shrub layer and *Amaranthus viridis* with importance value 10.46 in herb layer were the dominants. The soil of this community was silt loam and acidic in nature. Organic matter and Nitrogen contents are high i.e. 6.07 and 0.303 percent respectively. Calcium carbonate was 6%, Phosphorus 2.75 ppm and potassium 210 ppm. This community is facing the biotic pressure in the form of deforestation, fuel wood extraction, terrace cultivation and overgrazing. The severely suffered species in this zone are *Quereus dilatata, Quercus ilex* and *Diospyros lotus*. The agricultural lands produced by terrace cultivation are productive and suitable for maize crop, wheat and potatoes. The slopes are less steep in this community.

Table 2. Importance values of different plant communities harbouring Qalagai Hills, Swat.

S. No.	Name of species	Communities							
		PDN	OPM	PPR	QIA	PIG	CIT	CVP	PVL
1.	*Achyranthus aspera*	-	4.79	4.60	2.29	-	-	-	-
2.	*Acorus calamus*	5.40	-	-	-	-	-	-	-
3.	*Adiantum capillus-veneris*	6.75	-	-	1.99	-	-	-	-
4.	*A. venustum*	-	-	-	-	6.45	4.40	6.66	7.42
5.	*Aegopodium burtii*	-	1.34	1.69	1.45	2.03	-	-	-
6.	*Aesculus indica*	-	-	-	-	-	-	1.92	-
7.	*Agrostis pilosula*	-	-	1.34	1.15	-	-	-	-
8.	*Ailanthus altissima*	-	-	2.17	2.42	-	-	-	-
9.	*Ajuga parviflora*	-	-	-	-	1.70	-	2.92	-
10.	*Alnus nitida*	3.55	-	-	-	-	-	-	-
11.	*Amaranthus spinosus*	3.02	2.68	1.69	4.52	-	-	-	-
12.	*A. viridis*	5.20	2.25	2.27	10.46***	-	4.93	-	-
13.	*Andrachne cordifolia*	-	-	-	5.87	2.16	3.30	-	-
14.	*Andropogon nardus* var. *stracheyi*	-	-	1.91	2.11	1.01	-	-	-
15.	*Androsace rotundifolia*	-	-	-	-	2.71	1.95	3.47	5.18
16.	*Angelica glauca*	-	-	0.56	-	-	-	-	-
17.	*Apluda mutica*	-	5.87	3.89	3.26	-	-	-	-
18.	*Aquilegia pubiflora*	-	-	-	-	1.38	-	3.81	5.68
19.	*Arisaema flavum*	-	-	-	-	2.71	5.24	1.29	4.12
20.	*A. jacquemontii*	-	-	-	0.97	3.05	-	2.72	1.55
21.	*Artemisia vulgaris*	-	-	1.13	1.63	5.72	6.87	-	4.64
22.	*Asplenium adiantum-nigrum*	-	-	-	0.97	1.01	-	-	-
23.	*A. trichomanes*	-	1.59	-	1.81	-	-	-	-
24.	*Barleria cristata*	-	0.67	0.56	-	-	-	-	-
25.	*Berberis lyceum*	-	15.67	14.63	11.53	3.96	-	-	-
26.	*Bergenia ciliata*	-	-	-	-	2.39	-	2.58	-
27.	*Bidens biternata*	1.71	-	-	0.97	-	-	-	-
28.	*Bidens cernua*	-	-	-	-	-	1.95	1.63	3.45
29.	*Bothricloa ischaemum*	-	-	-	1.15	1.51	-	-	-
30.	*Brachiaria ramosa*	-	-	1.13	1.93	-	-	-	-
31.	*Buddleja crispa*	-	-	2.09	2.65	-	-	-	-
32.	*Bupleuram falctum* var. *hoffmeisteri*	-	2.25	3.40	5.01	-	3.28	-	-
33.	*Calamintha umbrosa*	-	3.60	2.82	1.45	-	-	-	-
34.	*Campanula colorata*	-	-	-	-	-	-	0.74	1.82
35.	*Cedrella serrata*	-	-	-	1.77	-	-	-	-
36.	*Cedrus deodara*	-	-	-	-	13.18	29.94*	28.42*	-
37.	*Celtis australis*	-	-	2.94	2.49	-	-	-	-
38.	*Cenchrus ciliaris*	-	2.93	2.70	3.26	-	-	-	-
39.	*Ceterach dalhousiae*	4.74	3.18	2.34	1.45	-	-	-	-
40.	*Chenopodium album*	-	-	1.34	3.74	1.19	-	-	-
41.	*C. ambrosoides*	3.42	-	-	1.93	-	-	-	-
42.	*C. botrys*	5.37	-	1.69	1.45	-	-	-	-
43.	*C. murale*	-	1.34	1.13	0.97	-	-	-	-
44.	*Chrysopogon serrulatus*	-	2.93	1.34	1.45	-	-	-	-
45.	*Cichorium intybus*	0.85	-	1.34	2.60	-	-	-	-
46.	*Clematis connata*	-	-	1.04	-	0.96	1.36	-	-
47.	*C. grata*	1.77	-	1.90	1.77	-	-	-	-
48.	*C. montana*	-	-	-	-	0.96	1.36	1.92	-
49.	*Conyza canadensis*	2.56	4.28	5.10	3.90	-	-	-	-
50.	*Cornus macrophylla*	-	-	-	0.88	-	-	-	-
51.	*Cotoneaster microphylla*	-	11.86	5.10	1.37	-	-	-	-
52.	*C. numularia*	-	-	-	2.25	5.79	3.17	-	-
53.	*Cynanchum jacquemontianum*	-	-	-	-	1.32	-	-	1.91

Table 2. (Cont'd.).

S. No.	Name of species	Communities							
		PDN	OPM	PPR	QIA	PIG	CIT	CVP	PVL
54.	*Cynodon dactylon*	5.27	3.69	-	-	-	-	-	7.21
55.	*Cynoglossum glochidiatum*	-	-	-	2.90	1.32	-	1.83	4.22
56.	*C. lanceolatum*	-	3.35	4.54	4.70	-	-	-	-
57.	*Cyperus globosus*	4.18	-	-	-	-	-	-	-
58.	*C. niveus*	-	6.63	4.75	-	-	-	-	-
59.	*C. rotundus*	4.35	-	-	-	-	-	-	-
60.	*Dactylis glomerata*	-	-	-	-	1.70	-	2.38	-
61.	*Debregeasia salicifloia*	15.46**	-	2.48	0.88	-	-	-	-
62.	*Delphinium denudatum*	-	-	-	-	3.05	4.40	7.29	-
63.	*Desmodium motorium*	-	-	2.17	1.37	-	-	-	-
64.	*Desmostachya bipinnata*	2.17	-	-	-	-	-	-	-
65.	*Dichanthium annulatum*	-	7.55	11.69	5.01	-	-	-	-
66.	*Dicliptera roxburghiana*	2.56	-	1.91	3.56	-	-	-	-
67.	*Digitaria violascens*	1.71	-	-	-	1.19	-	-	1.82
68.	*Dioscroria deltoidea*	-	-	-	0.48	0.96	-	-	-
69.	*Diospyros lotus*	-	-	-	11.71	-	-	-	-
70.	*Dryopteris odontoloma*	-	-	-	-	1.51	3.30	3.88	-
71.	*Duchesnea indica*	-	-	-	-	3.55	4.10	-	-
72.	*Eclipta alba*	2.40	-	-	-	-	-	-	-
73.	*Epilobium hirsutum*	1.94	-	-	-	-	-	-	-
74.	*Equisetum arvense*	4.18	-	-	-	-	-	-	-
75.	*Eragrostis pilosa*	-	-	1.13	1.15	-	1.64	-	-
76.	*Eryngium biebersteinianum*	3.42	2.01	-	-	-	-	-	-
77.	*Euphorbia granulata*	4.97	-	-	2.60	-	-	-	-
78.	*E. prostrata*	-	3.60	1.69	-	-	-	-	-
79.	*E. wallichii*	-	-	-	-	-	-	4.48	8.64
80.	*Ficus carica*	-	3.56	2.09	6.27	-	-	-	-
81.	*F. foveolata*	4.40	-	-	3.55	1.93	-	-	-
82.	*Fragaria nubicola*	-	-	-	-	6.28	5.24	6.06	14.20
83.	*Galinosoga parviflora*	3.65	-	1.13	2.90	-	-	-	-
84.	*Galium aparine*	-	-	1.91	1.63	13.84***	11.72	8.24	-
85.	*G. asperuloides*	-	-	-	-	-	-	1.29	4.12
86.	*Geranium nepalense*	-	-	-	0.48	1.01	-	1.63	-
87.	*Hackelia macrophylla*	-	-	-	2.60	4.06	4.10	-	10.41
88.	*Hedera nepalensis*	-	-	-	7.55	3.96	12.25	4.81	-
89.	*Hypericum perforatum*	-	5.62	5.31	3.26	-	1.95	-	-
90.	*Hypodematium crenatum*	-	-	1.69	1.15	-	-	-	-
91.	*Impatiens brachycentra*	-	-	-	3.00	1.70	-	-	-
92.	*I. glandulifera*	8.80	-	-	2.21	-	-	-	-
93.	*Imerata cylindrica*	4.48	-	-	-	-	-	-	-
94.	*Indigofera heterantha*	-	14.49	10.45	16.00**	19.75**	29.58**	8.70	16.98
95.	*Ipomoea purpurea*	-	-	-	0.97	-	-	-	-
96.	*Jasminum humile*	-	5.41	1.60	-	2.49	-	-	-
97.	*J. officinale*	-	-	-	-	1.47	6.72	-	-
98.	*Juglans regia*	-	-	-	1.77	-	-	-	-
99.	*Launaea secunda*	-	3.35	1.13	-	-	1.64	-	-
100.	*Lepedium rudirale*	4.50	-	1.91	-	-	-	-	-
101.	*Lespedeza juncea*	-	6.29	3.61	-	1.70	3.59	-	-
102.	*Leucas cephalotes*	-	-	1.34	-	4.75	-	5.86	14.84***
103.	*Malva neglecta*	-	-	-	1.45	1.70	-	-	-
104.	*Marrubium vulgare*	3.88	-	-	3.56	-	-	-	-
105.	*Marsilea minuta*	2.87	-	-	-	-	-	-	-
106.	*Mentha arvensis*	-	-	-	1.99	-	-	-	-

Table 2. (Cont'd.).

S. No.	Name of species	Communities							
		PDN	OPM	PPR	QIA	PIG	CIT	CVP	PVL
107.	*M. longifolia*	15.39	-	-	-	-	-	-	-
108.	*Micromeria biflora*	-	21.05	7.10	7.37	-	10.66	-	-
109.	*Mirabilus jalapa*	-	-	-	1.55	-	-	-	-
110.	*Morus alba*	-	-	-	2.65	-	-	-	-
111.	*Morus nigra*	-	-	-	5.33	-	-	-	-
112.	*Muhlenbergia dutheiana*	-	-	-	-	1.19	-	1.09	1.55
113.	*Myrsine africana*	-	5.56	7.05	-	-	5.77	-	-
114.	*Nasturtium officinale*	31.15***	-	-	-	-	-	-	-
115.	*Nepeta erecta*	-	-	-	-	4.06	4.10	4.02	6.05
116.	*Oenothera rosea*	3.72	-	1.91	1.63	-	-	-	-
117.	*Olea ferruginea*	-	4.74*	5.22	4.66	-	-	-	-
118.	*Onopordum acanthium*	-	2.01	1.13	-	-	-	-	-
119.	*Ophiopogan intermedius*	-	-	-	-	0.68	-	-	-
120.	*Orgianum vulgare*	-	17.51	13.17	-	7.92	19.15	-	-
121.	*Orobanche alba*	-	-	-	2.35	-	-	-	-
122.	*Oxalis corniculata*	-	4.28	7.02	-	4.75	-	-	-
123.	*Paeonia emodi*	-	-	-	-	5.04	-	-	-
124.	*Parrotiopsis jacquemontiana*	-	-	-	-	-	-	1.92	-
125.	*Persikaria alata*	3.31	-	-	-	-	-	-	-
126.	*Pilea umbrosa*	3.31	-	-	2.69	-	-	-	-
127.	*Pinus roxburghii*	-	2.37	21.76*	4.43	-	-	-	-
128.	*P. wallichiana*	-	-	2.09	-	24.55*	22.00	17.71	23.47*
129.	*Pistacea integerrima*	-	3.56	-	1.77	-	-	-	-
130.	*Plantago lanceolata*	-	2.93	1.91	5.07	-	-	-	-
131.	*P. major*	1.71	-	-	0.97	-	-	-	-
132.	*P. ovata*	-	-	-	-	7.30	-	9.47	9.58
133.	*Plantanus orientalis*	3.42	-	-	-	-	-	-	-
134.	*Plectranthus rugosus*	-	26.90**	20.73**	-	-	12.56	-	-
135.	*Poa annua*	-	-	-	-	6.46	-	8.79	14.49
136.	*P. pratensis*	-	-	-	2.78	5.26	-	6.66	9.85
137.	*Polygala abyssinica*	-	2.25	1.13	1.15	-	-	-	-
138.	*Polygonum amphibium*	18.53	-	-	-	-	-	-	-
139.	*P. amplexicaule*	-	-	-	-	5.21	1.95	6.28	3.09
140.	*P. hydropiper*	13.18	-	-	-	-	-	-	-
141.	*P. plebejum*	2.56	-	-	-	2.39	-	-	1.82
142.	*Polypogon fugax*	0.85	-	-	-	-	-	-	-
143.	*Populus nigra*	16.44*	-	-	-	-	-	-	-
144.	*Potentilla gerardiana*	-	-	1.77	-	1.70	-	-	-
145.	*Poterium polygonum*	-	-	-	1.45	-	1.64	-	-
146.	*Prunella vulgaris*	7.15	-	-	3.56	2.21	2.76	-	-
147.	*Prunus cerasioides*	-	-	-	-	-	-	1.92	-
148.	*P. cornuta*	-	-	-	-	1.93	1.36	-	-
149.	*Pseudomertensia parviflora*	-	-	-	-	-	-	1.09	1.55
150.	*Pseudostellaria himalaica*	-	-	-	-	-	-	3.88	5.00
151.	*Pteracanthus alatus*	2.85	-	-	1.77	-	-	-	-
152.	*Pteridium aquilinum*	-	-	-	1.37	7.57	5.44	26.89***	3.29
153.	*Pteris cretica*	8.44	-	-	2.03	-	-	-	-
154.	*Pyrus pashia*	-	1.34	1.60	-	-	-	-	-
155.	*Quercus dilatata*	-	2.37	2.09	16.75*	1.93	-	-	-
156.	*Q. ilex*	-	-	3.13	4.43	-	-	-	-
157.	*Q. incana*	-	-	-	7.95	3.86	3.69	-	-
158.	*Ranunculus hirtellus*	-	-	-	-	-	-	6.80	7.00
159.	*Ranunculus scleratus*	2.85	-	-	-	-	-	-	-

Table 2. (Cont'd.).

S. No.	Name of species	Communities							
		PDN	OPM	PPR	QIA	PIG	CIT	CVP	PVL
160.	*Rhus chinensis*	-	-	-	1.06	0.96	-	-	-
161.	*R. cotinus*	-	4.21	1.60	-	1.01	-	-	-
162.	*Rosa brunonii*	-	-	-	-	-	-	1.92	-
163.	*Rubia cordifolia*	-	-	-	2.65	-	-	-	-
164.	*Rubus ellipticus*	-	2.37	1.04	-	-	3.17	-	-
165.	*R. fruticosus*	-	3.56	2.09	-	-	-	-	-
166.	*R. niveus*	-	4.72	1.81	-	1.65	1.36	-	-
167.	*Rumex dentatus*	-	-	-	-	3.05	4.10	5.87	10.41
168.	*R. hastatus*	-	13.54	14.63***	-	-	-	-	-
169.	*Sageretia brandriethiana*	-	4.74	3.13	-	-	4.00	-	-
170.	*Salix alba*	5.33	-	-	-	-	-	-	-
171.	*Saliva lanata*	-	6.29	3.40	4.04	2.03	-	-	-
172.	*Sarcococca saligna*	-	-	-	-	8.68	-	7.90	-
173.	*Scrophularia polyantha*	-	-	-	1.45	1.19	-	-	-
174.	*Scutellaria chamaedrifolia*	-	-	1.13	2.47	1.38	-	-	-
175.	*Sedum adentrichum*	-	4.10	2.48	-	1.74	-	-	-
176.	*Senecio chrysanthemoides*	-	-	-	-	-	-	3.27	10.95
177.	*Setaria viridis*	1.94	1.59	-	-	-	-	-	-
178.	*Smilax glaucophyla*	-	-	-	1.37	-	-	-	-
179.	*Solanum nigrum*	4.50	-	0.56	2.90	-	-	-	-
180.	*Sonchus arvensis*	-	2.50	1.13	-	0.50	-	-	-
181.	*S. asper*	3.42	-	-	2.60	-	-	-	-
182.	*Sorbaria tomentosa*	-	-	-	-	2.52	-	-	-
183.	*Sorgham halepense*	-	-	3.53	3.96	-	-	-	-
184.	*Spiraea canescens*	-	4.79	7.22	-	5.75	4.95	-	-
185.	*Swertia cordata*	-	-	-	-	-	-	2.03	1.04
186.	*Tagetes minuta*	3.88	-	-	-	-	-	-	-
187.	*Taraxaxum officinale*	-	-	-	-	-	-	2.58	8.01
188.	*Taxus wallichiana*	-	-	-	-	-	-	4.81	-
189.	*Themeda anathera*	-	7.39	4.75	-	-	-	-	-
190.	*Thymus serphyllum*	-	-	-	-	12.11	32.55***	7.06	13.69
191.	*Tragopogon gracilis*	-	0.67	1.34	-	-	-	-	-
192.	*Trifolium repens*	-	-	-	-	-	-	2.23	4.64
193.	*Tripogon purpurascens*	-	-	1.34	0.66	-	-	-	-
194.	*Urtica dioica*	2.79	-	2.48	-	-	-	-	-
195.	*Valeriana jatamansi*	-	-	-	-	8.48	-	9.47	11.87
196.	*V. pyrolifolia*	-	-	-	-	-	-	-	5.41
197.	*Verbascum thapsus*	1.71	1.34	0.56	-	-	1.64	-	-
198.	*Verbena officinalis*	2.79	-	1.13	-	-	-	-	-
199.	*Vernoica anagallis- aquatic*	4.65	-	-	-	-	-	-	-
200.	*V. laxa*	-	-	-	-	-	-	0.74	2.06
201.	*Viburnum cotonifolium*	-	-	-	-	2.47	-	2.66	-
202.	*V. foetens*	-	-	-	-	2.89	1.36	25.64**	23.20**
203.	*Viola canescens*	-	-	-	-	3.23	-	4.22	-
204.	*Vitex negundo*	1.77	-	2.09	-	-	-	-	-
205.	*Wikstroemia canescens*	-	-	-	-	3.17	8.54	8.32	-
206.	*Xanthium strumarium*	2.56	-	-	-	-	-	-	-
207.	*Zanthoxylum armatum*	-	3.56	3.13	-	-	-	-	-
208.	*Ziziphus jujuba*	-	-	-	1.37	-	-	-	-
209.	*Ziziphus oxyphylla*	-	4.74	4.21	-	-	-	-	-
	Total species	**58**	**57**	**85**	**96**	**76**	**46**	**52**	**41**

Key for communities: See Table 1. *, ** and *** represent dominants in tree, shrub and herb layers respectively

5. *Pinus wallichiana-Indigofera-Galium* community (PIG): The community is situated on southern slopes at an altitude of 1800 to 2000 m. *Pinus wallichiana* (IV=24.55), *Indigofera heterantha* (IV=19.75) and *Galium aparine* (IV=13.84) were the leading dominants in tree, shrub and herb layers, respectively. *Cedrus deodara* in tree layer and *Thymus serphyllum* in herb layer were the other associates. The total number of species in this community was 76. The soil was silt loam and acidic with pH 5.9. The soil was rich in organic matter measuring to 5.01% and Nitrogen (0.251%) Calcium Carbonate constituted 6% while phosphorus and potassium were 2.05 and 130 ppm. *Pinus wallichiana* and *Cedrus deodara* in the community are prone to cutting and lopping because of their valuable timber.

6. *Cedrus-Indigofera-Thuymus* community (CIT): This community harboured southern slopes of Qalagai hills at an elevation of 2001 to 2200 m. The community was established on Sandy loam soil, which was acidic with pH 5.8. Organic matter content of the soil in this community were highest (6.2%) and also nitrogen content (0.31%). Amount of potassium was also highest (290 ppm). With 8.13% $CaCO_3$ and 5.92 ppm phosphorus this soil type supported a community which was dominated by *Cedrus deodara* (IV=29.94) in tree layer, *Indigofera heterantha* (IV=29.58) in shrub layer and *Thymus serphyllum* (IV=32.55) in herb layer. This community was safe from severe biotic interference and the rate of regeneration was highest as there were abundant young plants of *Cedrus deodara* and *Pinus wallichiana.*

7. *Cedrus-Viburnum-Pteridium* community (CVP): On the northern slopes with mesic conditions on altitudinal zone ranging from 2201 to 2400 m harboured a community dominated by *Cedrus deodara* in tree layer, *Viburnum foetens* in shrub layer and *Pteridium aquilinum* in herb layer with importance values of 28.42, 25.64 and 26.89, respectively. The soil had highest proportion of sand (75% and was loamy sand containing a very low fraction (0.8%) of clay. The soil was slightly acidic (pH=6.1) and contained the highest amount of $CaCO_3$ (9.8%). Organic matter contents and nitrogen were higher i.e., 6.13 and 0.307%, respectively. Phosphorus and potassium contents of the soil were moderate. Due to high altitude and thick vegetation cover the rate of grazing is low and the soil remains moist. The thickness of vegetation provides a safe place for a variety of wildlife.

8. *Pinus wallichiana-Viburnum-Leucas* community (PVL): This community is found on the tops of Qalagai hills with some parts facing south, some west and others north east. The altitude ranges from 2401 to 2892 m. Tree layer is missing at some places but as a whole the community is stratified with *Pinus wallichiana* as the leading dominant in tree layer with importance value 23.47, V*iburnum foetens* with IV=23.3 in shrub layer and *Leucas cophalotes* (IV=14.84) in herb layer. Sandy loam soil with pH 6.1 and organic matter 6.13% supported this community. $CaCO_3$ contents were 5.95%, nitrogen 0.307, phosphorus 1.7 ppm and potassium 220 ppm. Because of high altitude the community faces harsh climatic conditions especially in winter season when the herb layer is covered with a thick layer of snow. Wind velocity is high resulting in flag from trees in the exposed, steep slopes. Because of the harshness of climatic conditions, the species diversity is low. Only 41 species have been recorded from the site.

B. Indices of similarity and dissimilarity (Motyka's index): The similarity between pairs of communities ranged between 0-68.8%. Dissimilarity index ranged between 31.2-100%. Communities occupying the same aspect and altitude showed maximum similarity (Table 3).

Table 3. Matrix of indices of similarity (IS) and dissimilarity (ID) in percentage for the plant communities of Qalagai hills.

	Communities	Communities								
		PDN	OPM	PPR	QIA	PIG	CIT	CVP	PVL	
Index of similarity (IS)	PDN	X	93.6	90.5	80.8	97.4	96.9	100	97.1	Index of dissimilarity (ID)
	OPM	**6.4**	X	31.2	67.7	83.4	74.0	97.1	93.9	
	PPR	**9.5**	**68.8**	X	57.7	80.3	74.8	95.3	95.0	
	QIA	**19.2**	**32.3**	**42.3**	X	77.5	79.0	92.5	90.6	
	PIG	**2.6**	**16.6**	**19.7**	**22.5**	X	44.7	44.5	52.0	
	CIT	**3.1**	**26.0**	**25.2**	**21.0**	**55.3**	X	58.8	68.7	
	CVP	**0.0**	**2.9**	**4.7**	**7.5**	**55.5**	**41.2**	X	42.7	
	PVL	**2.9**	**6.1**	**5.0**	**9.4**	**48.0**	**31.3**	**57.3**	X	

Discussion

The climate and vegetation of Qalagai hills as a whole is of Montane temperate type (Champion *et al*, 1965, Beg, 1975). However due to the marked differences in edaphic, physiographic and local climatic conditions in different slopes at different elevations, they support different communities (Ahmad, 1986). In all eight different stratified communities were established in Qalagai hills on the basis of species composition and similarity index at different elevations and slopes. Seven communities were having distinct tree, shrub and herb layers and were clearly stratified while one community, i.e., *Olea-Plectranthus-Micromeria* community had a poor and incomplete tree canopy layer due to excessive deforestation. Stratification is determined by the life forms of plants (Hussain & Ilahi, 1991). The upper most stratum was dominated by *Pinus wallichiana, P. roxburghii, Quercus incana* and *Cedrus deodara* while the middle stratum of shrubs was dominated by *Plectranthus rogusus, Indigofera heterantha*, *Viburnum foetans* and *Debregeasia salicifolia* at different elevations and aspects. The herb layer contained *Micromeria biflora, Rumex hastatus, Thymus serphyllum, Pteridium aquilinum, Amaranthus viridis, Leucas cephalotes* and *Galium aparine* as dominant species. With slight deviation the present findings are in line with those of Hussain & Ilahi (1991), Beg (1975), Ahmad (1986) and Shaheen *et al*., (2011). The distribution and composition of plant communities in the surveyed area seem to be controlled by a complex of environmental factors including climate, topography, soil and biotic influence. These all undergo changes of different degrees due to their own interactions and may result in micro-gradients (Hanson and Churchill, 1965). Soil characteristics influence plant distribution on smaller scale i.e. more local scale (Bakkenes *et al.*, 2002). Topography is one of the main factors that play important role in structural characteristics of vegetation. Different altitudes, aspects and slopes support different communities in Qalagai hills. North facing slopes are moist than South facing slopes and thus support thick vegetation with high species diversity than south facing slopes. Same results were obtained by Hussain *et al*., (1995), Hussain *et al*., (1997) and Rashid *et al*., (2011). Slope and exposure also influence amount and type of soil accumulated (Monsen *et al.*, 2004). Consequently topography affects the vegetation indirectly by modifying other factors of the environment. The drier, more steep, south facing slopes in Qalagai hills contain heliophytes like *Pinus roxburghii, Cedrus deodara, Micromera biflora,* etc., while the moist, less steep, northern slope have sciophytes like *Pteridium aquilinum, Viburnum foetans* and *Prunus cornuta*.

The similarity indices and matrix of the number of common species quantitatively determines the similarity between the communities. The co-efficient depends upon the number and importance values of common species in two communities (Hussain & Tajul Malook, 1984). In Qalagai hills high values of similarity indices were recorded between communities harbouring the same slopes and valued 68.8%. Same results were obtained by Hussain & Tajul Malook (1984), Hussain *et al*., (1992) and Hussain *et al*., (1995). The high values of similarity index indicate similar climatic conditions at the same slopes.

The main biotic and anthropogenic factors influencing the vegetation of Qalagai hills are the improper land use in the form of terrace cultivation, deforestation and overgrazing. The biotic interference completely upsets the natural process of interaction between climatic, edaphic and topographic factors to control growth and occurrence of individuals and results in quite an unpredictable pattern of distribution of vegetation (Kapur & Sarin, 1985). The species composition as well as vegetational patterns is mainly determined by man's impact and only to a minor extent by natural site factors (Asmus, 1990; Hussain & Ilahi, 1991; Hruska, 1991). One of the practices in the area is to change the forest into agricultural land by clearing it. Terrace cultivation is beneficial in the beginning because of the available rich organic matter but the land becomes susceptible to wind and water erosion and to slumping off (Daubenmire, 1974) thus reducing the fertility and vegetation cover of the area.

Deforestation is the other important factor affecting the vegetation of Qalagai hills. Defined broadly deforestation can include not only conversation to non-forest but also degradation that reduces forest quality, the density and structure of the trees, the ecological services supplied, the biomass of plants and animals, the species diversity and genetic diversity. By narrow definition, deforestation is the removal of forest cover to an extent that allows for alternative land use (Seligman & Perevolotsky, 1994). Deforestation has multiple causes with the particular mix of causes varying from place to place (Helmut & Lambin, 2001). The main reasons for deforestation in Qalagai hills are fuel wood extraction, timber wood extraction, occasional fires and clearing of forest for terrace cultivation. The situation further intensified during the terrorist uprising of 2006-09 (Sharar, 2009). Deforestation is the fore runner of many associated and subsequent ecological problems which ultimately merges with the socio-economic problems (Hussain, 1981).

Another important ecological problem of Qalagai hills is the overgrazing and browsing of cattle's including goats, sheep, cows and donkeys. The problem is more severe in the lower hill elevations than the higher ones. It is generally accepted that in ecosystems, grazing inhibits the development and growth of woody vegetation and that intensive grazing may reverse the course of succession in such systems (Seligman & Perevolotsky, 1994). Yet several studies have indicated that grazing may play a more complicated role in determining the dynamic relationships between herbaceous and woody vegetation components (Sher *et al*., 2010). For example grazing may open niches for woody seedling establishment by reducing biomass of competing herbaceous vegetation (Mitchell & Kibry, 1990). Stresses such as overgrazing, browsing and trampling are more important than edaphic factors in determining the community composition (Rajwanshi *et al.*, 1985) and modifies the original vegetation pattern (Karajiana Kidou & Kokkini, 1988). Soil erosion is a side effect of the ill managed grazing, which causes loss of top fertile soil (Hussain, 1981) resulting in marked differences between the overgrazed and non grazed areas (Hussain *et al.*, 1997).

The present study indicated that a Qalagai hill has great potentialities for biodiversity conservation in the form of ecosystem diversity, species diversity and genetic diversity. If the anthropogenic and other biotic interferences continue in the area at the present pace, the valuable bio resources of Qalagai hills may be wasted and lost soon like it has happened to other hilly areas of the Swat like Docut hills (Hussain *et al.*, 1992). The area needs proper attention by government agencies, naturalists and nongovernmental organizations for protection, management, sustainable use and improvement. Any effort directed for improving the area cannot be successful without the cooperation and involvement of local inhabitants. The indigenous people have a comprehensive ability to recognize, classify, name and perceive nature that lead them to understand the ecology, reproductive biology and uses of organism in their ecosystem (Hu Huabin, 2002; Pei & Luo Peng, 2002). Thus it is suggested that the conservation of biodiversity and cultural diversity should be considered as integral needs in the process of development today (Pei & Luo Peng, 2002). If handled with a true spirit, the improvement of the forest resources of Qalagai hills will not only improve the socioeconomic condition of the present people but will also serve as a valuable gift for generations to come.

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