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DIVERSITY, DISTURBANCE AND REGENERATION STATUS OF FORESTS ALONG AN ALTITUDINAL GRADIENT IN PADDAR VALLEY, NORTHWEST HIMALAYAS

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ABSTRACT

The present study deals with the phytosociological analysis, anthropogenic impacts and regeneration status of tree species in five dominant forest types along an altitudinal gradient in Paddar valley of Northwest Himalaya. The tree density varied between 179 to 245 trees/ha whereas the total basal area varied between 24.7 and 37.7 m²/ha in five forest types. The value of Shannon-Weiner index (H') was found maximum for western mixed coniferous forest (1.75) whereas Concentration of dominance (Cd) and Evenness (J') were found maximum for dry temperate deciduous forest (0.41) and dry deodar forest (0.32) respectively. The maximum disturbance was found in the dry temperate deciduous forests due to heavy dependence of the locals on oak, *Quercus baloot* for fuelwood and fodder. The results pertaining to regeneration status of 18 tree species shows 4 species with good regeneration, 6 species with fair regeneration and 5 species with poor regeneration status whereas 3 tree species were found to have no regeneration at all. The regeneration was good for mixed coniferous forest and birch fir forests, poor for broadleaved and coniferous forest and fair for dry temperate deciduous forest and dry deodar forests.

Key words : Anthropogenic disturbance, Regeneration, Phytosociology, Temperate forests.

Introduction

Himalayas are well known for their diverse and characteristic vegetation distributed over a wide range of topographical variations. Western Himalayas are rich in tree diversity but the effects of human influences on the vegetation like tree felling and lopping, over grazing, surface mining, defense and developmental activities and road building activities are severe in the region and these activities have damaged the flora of the region very severely (Gupta, 2004). The temperate and sub-alpine forests of western Himalayas are also suffering from the vagaries of human influences as well as climatic changes (Gairola *et al.,* 2008). The temperate and sub-alpine forests in the Paddar valley, situated in Greater Himalayan region of J&K, is endowed with some ecologically as well as economically important tree species like *Pinus gerardiana*, *Taxus wallichiana*, *Betula utilis*, *Abies pindrow*, *Cedrus deodara*, etc. which are being heavily exploited by locals. The high sub-alpine and low temperate forests of the area have unique biodiversity importance in terms of conservation and economic value.

Material and Methods

Study area

The study was carried out in the temperate and sub-alpine forests of Paddar valley in Greater Himalayan region of Northwest Himalayas, J&K. The study area lies between 33^0.10´ to 33^0.40´ N latitude and 76^0.10´ to 76^0.50´ E longitude having altitudinal variations from 1800 to 3200 m. The Paddar valley is bounded by Pangi valley of Himachal Pradesh, Zanskar valley of Ladakh and Marwah-Wadwan valley of J&K. The area lies in the forest jurisdiction of Chenab Forest Division in J&K. The area is composed of crystalline rocks like granites and geneissis and sedimentary formations like shale, sand stone and lime stones. The soils in steep slopes are alkaline with high organic carbon whereas soils of the lower valley are neutral to slightly alkaline having medium to high carbon contents (Anon., 1988). Due to presence of the area in the deep valleys of inner Himalayas the area is not influenced by the monsoons and thus the main source of precipitation is western disturbances in winters. The area assigned with the status of a teshil is inhabited by 32 villages with a population of about 19000 people. The people around the study area are basically agro-pastoralists thus having a remarkable impact on the surrounding forests.

Methodology

The forests within the altitudinal range of 1800 to 3200m around treeline were assessed and five dominant forest types were identified according to Champion and Seth (1968) survey. A total of 100 quadrats of size 0.1ha each were randomly laid with 20 quadrats in each forest type. The circumference at breast height (cbh) of each

Tree density along an altitudinal gradient in Paddar valley of Northwest Himalaya ranges from 179 to 245 trees/ha with 18 tree species having regeneration of varied status.

tree (above 30cm) was recorded in each quadrat alongwith number of trees of each species. The quantitative characters such as frequency, density, basal area were analyzed (Phillip, 1959) and relative values of frequency, density and dominance were calculated following Curtis (1959). The Importance Value Index (IVI) of the species was calculated by summation of relative value of density, frequency and dominance (Misra, 1968). The synthetic characters i.e. Shannon and Wiener index (H'), Concentration of dominance (Cd) and Equitability or Evenness (J') were calculated following Shannon-Wiener (1963), Simpson (1949) and Pielou (1966) respectively. Information regarding number of seedlings and saplings was collected from four quadrats of size 3m ×3m, laid at four corners of every sample plot. The plants were categorized as seedlings and saplings based on their girth ranging between 1-17cm and 18-30 cm, respectively. The plants having girth more than 30cm were regarded as adults. The status of regeneration for various tree species in different forest types was assessed based on the following categories: (a) 'good', if seedlings > saplings > adults; (b) 'fair', if seedlings > saplings adults; (c) 'poor', if species survives only in sapling stage but not as seedling (though saplings may be less, more or equal to adults); (d) 'none', if a species is absent both in seedling and sapling stage but present as adult.

Disturbance scores were obtained by assessing the degree of disturbances (felled stems, lopped trees, fire incidence, grazing, litter removal and soil erosion) and were ranked into three classes i.e. rare (1), occasional (2) and frequent (3) level of disturbance. The cumulative disturbance scores for each indicator in the 5 forest types and all the indicators in each forest type were calculated.

Results and Discussion

The study area was classified into five dominant forest types along an altitudinal gradient of 1800-3200m for the assessment of phytosociological parameters, disturbance and regeneration status of tree species. A total of 18 tree species of 15 genera and 8 families were encountered during the study with Pinaceae as the dominant family representing 6 species.

1. West Himalayan dry temperate deciduous forest : These forests are dominant in the lower elevations of the valley and found along the banks of the river Chenab and its tributary named as Bhotnallah. Nine tree species were recorded in this forest type with *Quercus baloot* as the dominant species having basal area of 45.33 m²/ha, density of 119 trees/ha. The values for Shannon -Weiner Index (H'), Concentration of dominance (Cd) and Evenness (J') were found to be 1.38, 0.41 and 0.26, respectively.

2. Dry broad leaved and coniferous forest : The forest type also named as Neoza pine forest is characterized by the presence of *Pinus gerardiana* and *Quercus baloot* are mostly present at the soils with rock out crops having sunny and dry conditions with steep slopes on north exposure (Champion and Seth, 1968). *Pinus gerardiana* is the most important species of this forest type as seeds of the species are edible and are collected by locals for consumption and sale. A total of 6 tree species were observed in this forest type dominated by *Quercus baloot* with basal area, IVI and tree density of 37.03 m²/ha, 155.39 and 93 trees/ha, respectively, whereas *Pinus gerardiana* was the next dominant species with basal area of 17.7 m²/ha, IVI of 71.29% and tree density of 48 trees/ha. The values for H', Cd and J' were 1.30, 0.35 and 0.24 respectively.

3. Dry deodar forest : The forest type was mainly spread at the middle altitudes above the oak forests. A total of 12 tree species were recorded in this forest type. The forest lies in the whole area and forms a transition zone between the coniferous and deciduous forests. C*edrus deodara* was dominant species with basal area of 60.90 m²/ha, IVI 160.51 and tree density of 95 trees/ha. The corresponding values for H', Cd and J' were 1.73, 0.28 and 0.32.

Table 1 : Phytosociological analysis of trees in dry temperate deciduous forests

S.No	Tree species	Family	B.A (m²/ha)	D (trees/ha)	F (%)	A (trees/ha)	IVI
1	*Quercus baloot*	Fagaceae	45.33	119	90	132.2	170.29
2	*Acer pentapomicum*	Sapindaceae	12.46	60	17	28.3	30.20
3	*Alnus nitida*	Betulaceae	11.49	22	70	31.4	34.44
4	*Aesculus indica*	Sapindaceae	4.73	9	30	30.0	13.09
5	*Ulmus wallichiana*	Ulmaceae	2.66	5	40	12.5	13.36
6	*Juglans regia*	Juglandaceae	2.02	6	30	13.3	9.56
7	*Acer caesium*	Sapindaceae	1.76	8	40	20.0	14.27
8	*Celtis australis*	Cannabaceae	1.51	4	30	13.3	9.60
9	*Prunus armeniaca*	Rosaceae	1.14	3	10	30.0	4.10
			49.90	193	400	317.7	300.00

D: Density; F: frequency; A: Abundance; B.A: Basal area; IVI: Important Value Index.

4. Western mixed coniferous forest : The forest type is prominent at the higher altitudes and conifers are the main components of this forest type. This forest type with a total of 8 tree species was dominated by *Picea simithiana* with basal area of 37.52 m²/ha, IVI 96.96 and tree density of 71 trees/ha followed by *Pinus wallichiana* with basal area of 25.69 m²/ha, IVI 71.44 and density of 63 trees/ha. The value for H', Cd and J' were 1.75, 0.20 and 0.31 respectively for the forest type.

5. Western Himalayan birch/fir forest : The forest type was found at the highest altitude forming a transition zone between the alpine pastures and sub-alpine coniferous forest. The forest type with 5 tree species was dominated by *Betula utilis* with a basal area of 44.30 m²/ha, IVI of 115.54 and tree density of 84 trees per hectare respectively. The corresponding values for H', Cd and J' were 1.36, 0.31 and 0.25 for the forest type.

The above results show the trends that tree diversity and density decreased with increase in altitudes as we move from temperate to sub-alpine regions. A similar trend was also observed by Gairola *et al.* (2008) in subalpine zone of west Himalaya. The low tree density in temperate deciduous and coniferous forests types is due to excessive tree extraction by the locals. It was also observed that the tree density was highest in the western mixed coniferous forests (245 trees/ha) whereas it was lowest in dry temperate deciduous forest (179 trees/ha). The total basal area ranged with 69.14 m²/ha for the sub-alpine birch/fir forests to 42.36 m²/ha for the broad leaved and coniferous forest. The values of tree density

Table 2 : Phytosociological analysis of trees in dry broad leaved and coniferous forests

S.No	Species	Family	B.A (m²/ha)	D (trees/ha)	F (%)	A (trees/ha)	IVI
1	*Quercus baloot*	Fagaceae	37.03	93	100	93	155.39
2	*Pinus gerardiana*	Pinaceae	17.03	48	100	48	71.29
3	*Pinus wallichiana*	Pinaceae	6.43	13	50	26	23.08
4	*Aesculus indica*	Sapindaceae	5.63	9	40	22.5	17.59
5	*Cedrus deodara*	Pinaceae	5.50	12	60	20	24.59
6	*Alnus nitida*	Betulaceae	2.66	4	20	20	8.06
	Total		42.40	179	370	229.5	300.00

D: Density; F: frequency; A: Abundance; B.A: Basal area; IVI: Important Value Index

Table 3 : Phytosociological analysis of trees in dry deodar forests

S.No	Tree species	Family	B.A m²/ha	D (trees/ha)	F %	A (trees/ha)	IVI
1	*Cedrus deodara*	Pinaceae	60.90	95	100	95	160.51
2	*Pinus wallichiana*	Pinaceae	7.59	15	70	21.4	23.79
3	*Picea smithiana*	Pinaceae	4.26	10	40	25	13.91
4	*Quercus baloot*	Fagaceae	12.99	43	70	61.4	40.38
5	*Aesculus indica*	Sapindaceae	4.96	6	20	30	7.82
6	*Corylus cornuta*	Betulaceae	2.87	5	20	25	6.95
7	*Ulmus wallichiana*	Ulmaceae	2.19	6	40	15	11.61
8	*Alnus nitada*	Betulaceae	0.96	2	10	20	3.13
9	*Celtis australis*	Cannabaceae	0.71	2	20	10	5.26
10	*Acer pentapomicum*	Sapindaceae	3.09	6	30	20	9.58
11	*Acer caesium*	Sapindaceae	2.72	6	30	20	9.53
12	*Prunus cornuta*	Rosaceae	3.51	6	20	30	7.53
	Total		63.42	202	470	372.8	300.00

D: Density; RD: F: frequency; A: Abundance; B.A: Basal area; IVI: Important Value Index.

Table 4 : Phytosociological analysis of trees in western mixed coniferous forests

S.No	Tree species	Family	B.A m²/ha	D (trees/ha)	F (%)	A (trees/ha)	IVI
1	*Cedrus deodara*	Pinaceae	19.89	34	50	68.0	41.81
2	*Picea simithiana*	Pinaceae	37.52	71	70	101.4	96.96
3	*Abies pindrow*	Pinaceae	21.66	40	50	80	46.82
4	*Pinus wallichiana*	Pinaceae	25.69	63	80	78.7	71.44
5	*Taxus wallichiana*	Taxaceae	4.57	19	40	47.5	20.22
6	*Betula utilis*	Betulaceae	3.01	7	20	35	9.04
7	*Corylus cornuta*	Betulaceae	2.18	6	20	30	8.49
8	*Acer caesium*	Sapindaceae	1.99	5	10	50	5.22
	Total		54.58	245	340	490.6	300.00

D: Density; F: frequency; A: Abundance; B.A: Basal area; IVI: Important Value Index.

with 199 to 249 trees/ha and basal area of 8.94 to 69.84 m²/ha have been reported by Gairola *et al.* (2008) in western Himalaya and tree density of 470 to 600 trees/ha by Rawat and Chandok (2009) in Pashu Vihar National Park, Uttrakhand. Pandey (2003) has also reported a tree density of 92 to 192 trees/ha and total basal area in the range of 4035.45 to 12662.40 cm²/100m² in mixed oak-coniferous forests of central Himalaya whereas tree density of 70 to 460 trees per hectare has been reported by Saxena and Singh (1982) for the Kumaun Himalayan range. The value of Shannon-Wiener Index ranged between 1.75 for western mixed coniferous forests and 1.30 for dry broad leaved and coniferous forest. Pandey (2003) reported the diversity index values of 2.425, 2.549 and 1.27 for oak forest, oak-chirpine forest and chirpine forest respectively in the central Himalayas.

Disturbance and regeneration status

Tree felling in the area is mainly done for the extraction of timber and collection of fuel wood and fodder. Temperate deciduous forest with oak, *Quercus baloot* as dominant tree species is under heavy pressure of felling and lopping for the collection of fuel wood and fodder for sheep and goats. The incidence of felling as well as lopping in oak forest was found in all the plots (100%). Sharma *et al.* (2008) have also reported the impacts like tree felling and lopping, grazing, fire, encroachment, *etc.* responsible for forest degradation in Birhun watershed of Udhampur district in J&K. The impact decreases with increase in the altitude and the west Himalayan birch/fir forest was found free of felling and lopping impact. However a severe damage was observed on *Betula utilis* for bark extraction which is used by the locals for roofing of their houses because of its slow degradation properties. The impact of fire in the study area was observed to be moderate. The incidence of forest fire is more in coniferous forests due to high accumulation of humus and litter on forest floor, which is usually burnt by the people as they believe that this increases the production of *Morchella* crop in the coming season. The grazing pressure in the area is high as the communities are transhumans and they migrate to alpine pastures for grazing their cattle and sheep. A large scale mortality of seedlings and saplings due to cattle grazing has been reported by Krzic *et al.* (2006). The livestock of nomadic (Gujjar and Bakerwals) and

Table 5 : Phytosociological analysis of trees in West Himalayan birch/fir forests

S.No	Tree species	Family	B.A m²/ha	D (trees/ha)	F %	A (trees/ha)	IVI
1	*Betula utilis*	Betulaceae	44.30	84	100	84.0	115.54
2	*Abies pindrow*	Pinaceae	32.94	43	60	71.6	63.71
3	*Picea simithiana*	Pinaceae	39.94	55	80	68.7	86.98
4	*Taxus wallichiana*	Taxaceae	3.44	11	30	36.6	15.65
5	*Pinus wallichiana*	Pinaceae	11.43	11	30	36.6	18.12
	Total		69.16	204	300	297.5	300.00

D: Density; F: frequency; A: Abundance; B.A: Basal area; IVI: Important Value Index.

Table 6 : Synthetic characters of trees in different forest types

Synthetic characters	TDF	DBCF	DDF	WMCF	WHBF
Shanon-Wiener index (H')	1.38	1.30	1.73	1.75	1.36
Concentration of dominance (Cd)	0.41	0.35	0.28	0.20	0.31
Equitablity or Evenness (J')	0.26	0.24	0.32	0.31	0.25

TDF: Temperate deciduous forest; DBCF: Dry broad leaved and coniferous forest; DDF: Dry deodar forest; WMCF: Western mixed conifer forest; WHBF: West Himalayan birch-fir forest.

Table 7 : Cumulative disturbance scores of five forest types each with 10 plots

S.No	Disturbance indicator	TBLF	DBCF	MDF	WMCF	WHBF	Total scores
1	Tree felling	25	20	22	15	10	92
2	Tree felling	28	19	18	12	16*	93
3	Grazing	21	16	13	10	15	75
4	Fire incidence	16	14	16	16	11	73
5	Litter removal	13	12	20	14	10	69
6	Soil erosion	20	13	16	11	10	70
	Total scores	123	94	105	78	71	471

TBLF: Temperate broad leaved forest; DBCF: Dry broad leaved and coniferous forest; MDF: Moist deodar forest; WMCF: Western mixed conifer forest; WHBF: West Himalayan birch-fir forest.
*shows the impact of bark extraction on *Betula utilis.*

Table 8 : Regeneration status of various forest types in the study area

S.No.	Forest type	Seedlings/ha	Sapling/ha	Adults/ha	Status
1	TDF	361	166	193	Fair
2	DBCF	0	222	179	Poor
3	DDF	416	194	202	Fair
4	WMCF	833	611	245	Good
5	WHBF	583	444	204	Good

TDF: Temperate deciduous forest; DBCF: Dry broad leaved and coniferous forest; DDF: Dry deodar forest; WMCF: Western mixed conifer forest; WHBF: West Himalayan birch-fir forest.

Table 9 : Status of regeneration of different tree species

Good	Fair	Poor	None
Aesculus indica	*Abies pindrow*	*Acer pentapomicum*	*Celtis australis*
Cedrus deodara	*Acer caesium*	*Corylus cornuta*	*Taxus wallichiana*
Picea simithiana	*Alnus nitida*	*Juglans regia*	*Ulmus wallichiana*
Pinus wallichiana	*Betula utilis*	*Pinus gerardiana*	
	Prunus cornuta	*Prunus armeniaca*	
	Quercus baloot		

transhumant populations also cause a considerable damage to the regenerating plants in the area and similar incidents have also been reported by Kiran *et al.* (1999) and Kumar and Hamal (2009) from elsewhere in J&K. The litter is also used as bedding material to be spread in the cattle sheds in order to make the shed dry. The soil erosion is also seen in the forests due to anthropogenic disturbances.

The regeneration status was good in western mixed coniferous forest and birch/fir forest, poor in broadleaf and coniferous forests and fair in temperate deciduous and deodar forests. Among 18 tree species only 4 showed good regeneration status while 5 regenerated poorly and 3 were not regenerating whereas the rest of the species showed fair regeneration. Dhaulkhandi *et al.* (2008) reported 71.4% tree species with good regeneration, 14.3% of the species with poor regeneration and 14.3% species with no regeneration in the Gangotri forest of Uttrakhand. The maximum regenerating species was *Picea simithiana* with 583 seedlings and 334 saplings per hectare in the mixed coniferous forest whereas *Pinus gerardiana* showed least regeneration with 28 saplings per hectare with no seedlings. The decrease in regeneration potential due to increase in the disturbance level has also been reported by Wangada and Ohsawa (2006), Harish (2007) and Sen *et al.* (2008). *Taxus wallichiana* was not regenerating in the area due to its medicinal extraction. Rikhari and Adhikari (1998) have also identified the same reason for its poor number in Himalayas.

उत्तर-पश्चिमी हिमालय की पद्दार घाटी के तुंगीय घटक में वनों का वैविध्य, वितरण तथा पुनर्जनन की स्थिति

सुरेश कुमार तथा संजय शर्मा

सारांश

वर्तमान अध्ययन, उत्तर-पश्चिमी हिमालय की पद्दार घाटी के तुंगीय घटक में पादप-समाजशास्त्रीय विश्लेषण, मानवीय समाधान तथा पांच मुख्य वन किस्मों की पुनर्जनन स्थिति पर आधारित है। पांच वन किस्मों में वृक्ष घनत्व 179 से 245 वृक्ष/हे0 जबकि कुल आधार क्षेत्र 24.7 और 37.7 एम^2/हे. है। पश्चिमी मिश्रित शंकु वृक्षीय वनों में शेनान-वीनर इंडेका ¼एच'½ अधिकतम¼1.75½ पाई गई जबकि शुष्क शीतोष्ण पर्णपाती वनों और देवदार वनों में प्रचुरता तथा समानता 0.41 तथा 0.32 पाई गई। चारे और जलाÅ काष्ठ के लिए स्थानीय बांज ¼*क्वारकस बलोट*½ पर अत्यधिक आश्रितता होने के कारण शुष्क पर्णपाती वनों में अस्तव्यस्तता देखी गई। 18 वृक्ष प्रजातियों के पुनर्जनन परिणाम इस प्रकार रहे :- 4 प्रजातियां उत्तम, 6 प्रजातियां की स्थिति ठीक-ठाक, 5 प्रजातियां कमजोर और 3 प्रजातियों की पुनरूत्पति शून्य रही। मिश्रित शंकुवृक्षीय और विर्क फर वनों में पुनरूत्पति उत्तम, चौड़ी पत्तियों वाले शंकुवृक्षीय वनों में कमजोर तथा शुष्क शीतोष्ण पर्णपाती वनों और देवदार वनों में ठीक-ठाक रही।

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