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Vegetation of highly disturbed conifer forests around Murree, Pakistan

Murree (Pakistan) çevresindeki oldukça bozulmuş iğne yapraklı ormanların vejetasyonu

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Article Info

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Article history

Received: March 23, 2020

Received in revised form: April 12, 2020

Accepted: April 15, 2020

Available online: April 20, 2020



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Keywords:

Phytosociological attributes, forest composition, phytosociology

Anahtar Kelimeler:

Fitososyolojik özellikler, orman kompozisyonu, fitososyoloji

ABSTRACT

This phytosociological investigation is conducted in various disturbed forests around Murree hills. The main purpose of study is to explore community types, associated ground flora and their relation to soil characteristics. Eight community types and two monospecific tree stands have been recognized as follows: *Pinus wallichiana* (pure), *Pinus roxburghii* (pure), *Pinus wallichiana-Quercus baloot*, *Pinus wallichiana-Cedrus deodara*, *Pinus wallichiana-Abies pindrow*, *Pinus wallichiana-Quercus dilatata*, *Quercus dilatata-Cedrus deodara*, *Pinus roxburghii-Pinus wallichiana*, *Pinus roxburghii-Cedrus deodara*, *Pinus roxburghii-Quercus dilatata*. *Pinus wallichiana* dominates monospecifically in 8 stands while *Pinus roxburghii-Pinus wallichiana* community types found at 5 locations. *Pinus wallichiana* formed community type with *Cedrus deodara* and *Abies pindrow* at 4 locations separately. Highest stand density achieved in *Pinus wallichiana-Cedrus deodara* and *Pinus roxburghii-Quercus dilatata* community i.e. 128 trees/h. Highest basal area (48.06 (m²/ha) recorded from *Pinus wallichiana* (pure) stands. *Pinus wallichiana-Pinus roxburghii* communities correlated significantly ($p < 0.05$) with tree density. Range of DO, pH, Temperature, Conductivity, Salinity, ORP and chemical parameters in each community type has also shown and discussed.

ÖZ

Bu fitososyolojik araştırma, Murree tepeleri çevresindeki çeşitli bozulmuş ormanlarda yapılmıştır. Çalışmanın temel amacı topluluk türlerini, ilişkili zemin florasını ve toprak özellikleri ile ilişkilerini araştırmaktır. Sekiz bitki topluluğu ve iki monospesifik meşcere tanımlanmıştır: *Pinus wallichiana* (saf), *Pinus roxburghii* (saf), *Pinus wallichiana-Quercus baloot*, *Pinus wallichiana-Cedrus deodara*, *Pinus wallichiana-Abies pindrow*, *Pinus wallichiana-Quercus dilatata*, *Quercus dilatata-Cedrus deodara*, *Pinus roxburghii-Pinus wallichiana*, *Pinus roxburghii-Cedrus deodara*, *Pinus roxburghii-Quercus dilatata*. *Pinus wallichiana* 8 standda monospesifik olarak baskınken, 5 yerde bulunan *Pinus roxburghii-Pinus wallichiana* topluluk türleri. *Pinus wallichiana*, *Cedrus deodara* ve *Abies* ile 4 yerde ayrı ayrı topluluk oluşturmuştur. *Pinus wallichiana-Cedrus deodara* ve *Pinus roxburghii-Quercus dilatata* topluluğunda, yani 128 ağaç/saatte elde edilen en yüksek meşcere yoğunluğu olarak gözlenmiştir. *Pinus wallichiana* (saf) meşcerelerinden kaydedilen en yüksek bazal alan (48.06 (m²/ha) olarak kaydedilmiştir. *Pinus wallichiana-Pinus roxburghii* toplulukları ağaç yoğunluğu ile anlamlı bir şekilde korelasyon göstermiştir ($p < 0.05$). DO, PH, Sıcaklık, İletkenlik, Tuzluluk, ORP her topluluk türündeki kimyasal parametreler de gösterilmiş ve tartışılmıştır.

Citation:

To cite this article: Khan A, Ahmed M, Ahmed F, Saeed R, Siddiqui F (2020). Vegetation of highly disturbed conifer forests around Murree, Pakistan. *Turk J Biod* 3(2): 43-53. <https://doi.org/10.38059/biodiversity.708154>.

1. INTRODUCTION

Vegetative groups or communities characterize forests and their types. The grouping of vegetation, species diversity defined the nature and absorbance capability of forests. The emphasized work on different plant species

living together by forming an association with each other was firstly explained by European workers during which they introduced the term "Phytosociology" to quantify the plant species in a particular manner. The precise description on the structure of the community can develop a system to classify plant communities explained

by Oosting (1956). To analyze the behavior and future trend of plant community, the kind of vegetation, their composition and structure, mode of association among the species and most importantly their destruction are found to be the stronger units in community study (Shimwell, 1971; Muller-Dumbois & Ellenberg, 1974). An appropriate study of community in an area could produce a system of classification of the vegetation types.

By following the basic strategies, recent ecologists have figured out various problems in their targeted area and have involved methods due to the changes in the environment and adapted by the plants. The evolutionary features are the response of the plants in the changing environment. According to Thorpe et al. (2008) competition in living organisms is the main point of research on which ecological changes are dependent. The species found in the forests face a greater level of

competition that can be examined by the indications of their basal area at stand level (m^2/h) or by recording the number of individuals with their diameters and height at individual level suggested by Ogden et al. (1987). Stand level properties can sketch out the forest condition as it can summarize the community interaction, their prevailing direction, dominance and diversity. In the recent time, population and competition are the major factors which have created destruction in the forests. Alterations in the growth of forest ultimately results to change the climatic schedule throughout the world as well as changes in forests dynamics. The forests would face the emigration of species or destruction of trees due to the fast growing population needs. This paper has the summary of stands and their Phytosociological attributes to define the current condition of disturbed forest of Murree which would be helpful to understand the present vegetation status of the forest.

In Pakistan, community description of various forests has presented by various workers i.e. Ahmed (1988), Ahmed et al. (1990a, b, 1991, 2010), Ahmed & Naqvi (2005), Hussain & Badshah (1998), Wahab et al. (2008), Siddiqui et al. (2009), Khan et al. (2010a, b). However these descriptions were based on least disturbed forests and no work was carried out in highly disturbed forests. This was necessary to see the extent of change in forest floristic composition, quantitative values and communities for future research and management/conservational purpose. Therefore, bearing these points in mind description of communities from highly disturbed areas around Murree is presented.

2. MATERIALS AND METHODS

This study was conducted in Murree forests of Pakistan. Murree was selected for the study because of being famous hill station in Pakistan. It is located in the Himalayan foothills at 2286 meters above sea level (Figure 1). The forest comprised of sub-tropical to temperate zone that receives 70.4inch as an average rainfall per year. Murree bear a mild average temperature up to 12°C annually, hottest month is June (21°C) while coolest and driest month is January (3°C). 30 different sites were targeted to sample the vegetation around Galyat in Murree which specifically focused the disturbance in the area. Quadrature method (Cottam & Curtis, 1956) was applied for the sampling in the study sites by making 1 hectare (100X100m) rectangular plot. Understory vegetation was also recorded by making 10 circular plots (1.5m radius) within each 1 hectare plot. Relative and absolute Density. ha^{-1} and Basal area ($m^2.ha^{-1}$) were calculated of the recorded tree species by following Ahmed & Shaukat (2012) while the understory species were estimated by using relative frequency following Braun-Blanquet (1965) and Ahmed & Shaukat (2012) phytosociological evaluation methods. Organic matter was calculated following Nelson & Sommers (1996) method. Soil nutrients and related parameters (DO, ORP, TDS, Temperature, Salinity, Conductivity, pH) were examined by using Kjeldahl (1883) and Flame photometer, Portable Multiparameter Model Sension, TM 105 UK, following Nazim (2011). Environmental estimations were taken by GPS. Understory abundance classes were determined by following Braun-Blanquet (1965) with modification of Ahmed (1986).

3. RESULTS AND DISCUSSION

Study area and sites were presented in Figure 1. The study was conducted on the disturbed areas in the forest for the analysis of existing communities under disturbed condition. Four dominant conifer species were found i.e. *Pinus wallichiana* (P.W), *Pinus roxburghii* (P.R), *Cedrus deodara* (C.D) and *Abies pindrow* (A.P). For this purpose, Phytosociological investigations were made and as a result of which eight communities and two monospecific vegetative groups were produced, details of phytosociological evaluation were given in Figure 2. The communities recognized in the study area (Figure 1), its range of elevation, density, basal area and aspect are presented in Table 1. In addition, this table also indicated the range of relative frequencies of pine seedlings only.

Table 2 showed soil characteristics of the communities. Out of thirty stands, eight communities and two monospecific stands were recorded on the basis of two first leading dominant species, obtaining higher importance value and similar floristic composition. Eight community types and two monospecific tree stands have been recognized on the basis of floristic composition and highest density/basal area values as follows: *Pinus*

wallichiana (pure), *Pinus roxburghii* (pure), *Pinus wallichiana-Quercus baloot*, *Pinus wallichiana-Cedrus deodara*, *Pinus wallichiana-Abies pindrow*, *Pinus wallichiana-Quercus dilatata*, *Quercus dilatata-Cedrus deodara*, *Pinus roxburghii-Pinus wallichiana*, *Pinus roxburghii-Cedrus deodara*, *Pinus roxburghii-Quercus dilatata*.



Figure 1. Study area and sampled sites in Murree, Pakistan.

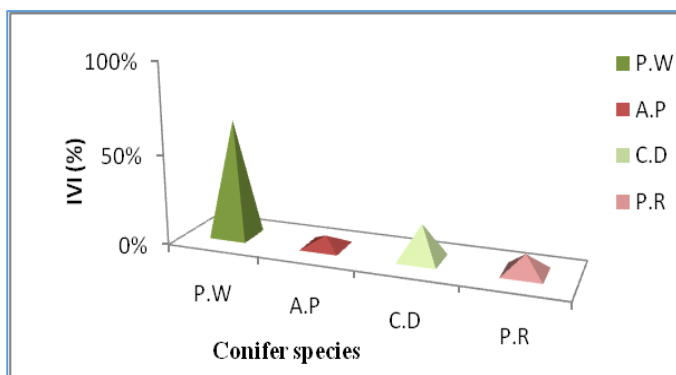


Figure 2. Phytosociological status of pine species in disturbed forests. P.W = *Pinus wallichiana*, A.P = *Abies pindrow*, C.D = *Cedrus deodara*, P.R = *Pinus roxburghii*.

Pinus wallichiana (monospecific)

These monospecific stands lie under moist temperate areas of Pakistan, however this species also found in dry

temperate areas due to wide ecological amplitude (Ahmed et al., 2010). *Pinus wallichiana* appeared in pure form in 7 stands from 30 stands. The species found to be more persistent in most of the areas of the forest in Murree even in the highly disturbed condition. Pure stands found on seven different locations i.e. Nathiagali behind chairlift, Kaseri Town-Murree road-Ptriata, Kaseri town-Murree road-Ptriata, Kondla-Changla gali, Bhurban, Bhurban, Bansra gali. The elevation range started from 1699 to 2628 meters. The stand density ranged from 70 to 106 trees per hectare while the basal area per hectare ranges from 14.84 to 48.06 m²/hec⁻¹. Siddiqui (2011) reported 135 to 429 hec⁻¹ density with the basal area 69 to 78 m²/hec⁻¹ of *Pinus wallichiana* trees in the same elevation range of Murree from least disturbed sites, this showed a clear difference in the decreased values of standing trees in present area due to disturbance. *Pinus wallichiana* is considered to be a pioneer species in various aspects hence its distribution is vast at different

altitudes (Chaudhri, 1960). Ahmed et al., (2006) reported pure stands of *Pinus wallichiana* from Nalter at 2770m elevation with higher density and basal area. Wahab (2011) observed *Pinus wallichiana* pure stands at 1875m elevation in Dir District. He calculated 43 stems.ha⁻¹ density from the forest in this locality. *Pinus wallichiana* populated forests were also been reported by various workers (Ahmed et al., 1989, 1990a, b, 1991, 2006, 2009; Wahab et al., 2008 and Siddiqui et al., 2009) at similar elevations, in other areas of Pakistan.

These monospecific stands were comprised of most abundant *Pinus wallichiana* seedlings throughout all the stands. Seedlings of *Quercus incana* were frequently found in this community. Seedlings of *Quercus dilatata*, *Populus ciliata*, *Urtica dioica*, *Aqualegia vulgaris*, *Paeonia emodi* and *Myrsine africana* were occasionally found in this form. Seedlings of *Aesculus indica* were rarely found in these stands. Among herbs and bushes, *Berberis lycium*, *Cornus macrophylla*, *Argemone mexicana*, *Frageria vesca*, *Rosa moschata*, *Cannabis sativa*, *Rumex nepalensis*, seedlings of *Juglans regia*, *Populus nigra*, *Ficus palmata*, *Narcissum poeticus*, *Cassia glauca*, *Olea feruginea*, *Diospyros lotus*, *Viola odorata* were rarely found plant species. *Hedera nepalensis*, *Thymus serpyllum*, *Rubus ellipticus*, *Rosa webbiana*, *Rosa brunonii*, *Ulmus wallichiana*, *Aristida cyantha*, *Pyrus pashia*, *Pyrus spp*, *Prunus deomestica*, *Prunus cornuta*, *Cupressus sempervirens*, *Campanula tenuissima*, *Magnolia champaca* and *Symphyotrichum dumosum* were also the understory herbs and shrubs which were found with low number in the area. Results from soil analysis showed a wide range in its parameters like pH, TDS, Conductivity, Salinity, ORP (7.37 to 8.00, 151 to 364mg/L, 0.18 to 0.44 µ/cm, 0.14 to 0.24%, 15.7 to 68.6mV respectively), with highest range of TDS among all communities. Ranges of OM%, WHC%, N, P, K and Na concentrations were 5.8 to 8.56%, 20 to 51%, 0.14 to 1.21%, 0.21 to 0.46mg/g, 1.42 to 2.43mg/g, 0.54 to 1.42mg/g respectively. Soil texture was sandy clay. Concentration of Sodium and Water holding capacity of this form were found to be highest as compared to other communities.

***Pinus roxburghii* (monospecific)**

This species considered as indicator of subtropical condition of forest, occupying comparatively lowest elevational limit (Ahmed et al., 2006). *Pinus roxburghii*

occurred in pure form at 2 stands (18 and 30) at the locations of P.A.F. Base and T-Base respectively. Species in pure condition found more stable with a density range of 103-104 plants per hectare with the basal area of 20.25 to 37.53m²/hec⁻¹. The elevation range was 1787-1789 meters. The species found more tolerant in the highly precipitated environment with human and animal interference. Anthropogenic disturbance also found in the area due to dumping of garbage, lower elevation cutting branches and being a tourist place the area possessed different kinds of litter in the soil which act as shelter for insects and animals. From different Himalayan regions Ahmed et al., (2006) reported 732 trees hec⁻¹ and 31m²hec⁻¹ basal area in pure *Pinus roxburghii* forest indicating healthy growth rate of this pine species in pure form but in present study area, the density is very low with poor basal area. Forests comprised of pure *Pinus roxburghii* were also cited by Wahab (2011) in lower Dir at the elevation ranged from 1230 to 1622m. The species showed density range from 46 to 155 ha⁻¹.

The community consisted of abundant *Quercus incana* while seedlings of *Pinus roxburghii*, *Quercus dilatata*, *Populus ciliata*, *Urtica dioica* and *Paeonia emodi* were frequently found. Seedlings of *Quercus Baloot* and *Aesculus indicus* were occasionally found. Other understory species in these forests were *Cannabis sativa*, *Aqualegia vesca* and *Myrsine africana*. *Berberis lycium*, *Cornus macrophylla*, *Frageria vesca*, *Rannunculus acris*, *Rosa moschata*, *Juglans regia*, *Populus nigra*, *Ficus palmate*, *Pyrus pashia*, *Punica granatum*, *Prunus deomestica*, *Pyrus spp*, *Narcissum poeticus*, *Cassia glauca*, *Olea feruginea*, *Diospyros lotus* and *Magnolia champaca* with rarely occurrence. *Magnolia champaca*, *Pyrus pashia*, *Prunus deomestica*, *Pyrus spp* and *Cornus macrophylla* were found to be threatened in the area because of very poor frequency. From many previous studies it was evident that monospecific stands of *Pinus roxburghii* possess thick understory vegetation as mentioned by Wahab (2011); Siddiqui (2011) and Khan (2011). Wahab (2011) quoted 34 understory species from *Pinus roxburghii* forests in which *Rumex dentatus*, *Punica granatum*, *Indigofera spp*, *Dodonea viscosa*, *Rannunculus spp*, *Oxalis corniculata*, *Mentha spp*. were commonly found. Table 2 showed the range of soil parameters analyzed. Phosphorus concentration was the highest in this form. Silty clay and sandy clay combined formed the texture of the soil in its stands.

***Pinus wallichiana* – *Quercus baloot* community type**

Pinus wallichiana - *Quercus baloot* community found in 3 stands at different locations of Lowertopa facing the North-South aspect. The density ranges from 67 to 98 plants per hectare at the elevation from 1956 to 2155m. The basal area of this community ranged from 5.32 to 34 m²hec⁻¹. Ahmed et al., (2006) recorded *Pinus wallichiana* - *Quercus incana* community at 1970 to 2250m elevation from Lowertopa, Murree Hills and Jhika gali. There previous study showed dominance of *Pinus wallichiana* with 63% density and 88% basal area in association with *Quercus incana*. While present study showed the co dominant position of *Quercus baloot* in the disturbed area at the same elevation with presence of *Quercus incana* seedlings which confirmed the presence of this species in past but now it get eliminated due to continuous disturbance activities in this area. Seedlings of *Pinus wallichiana* were most abundantly distributed in these stands. No other species were present in the abundant form in the community while shrubs like *Rosa brunonii* and *Berberis lycium* were present frequently in the community. *Cornus macrophylla*, *Argemone mexicana* and *Echinophus nivens* and seedlings of *Populus ciliata* were occasional. Seedlings of *Quercus incana*, *Quercus dilatata*, *Quercus baloot*, *Aesculus indica* while *Hedra helpensis*, *Thymus serpyllum*, *Rubus ellipticus*, *Indigofera hebeptela*, *Plantago asiatica*, *Rosa webbiana*, *Acer ceasium*, *Berberis kunawerensis*, *Campanula tenuissima*, *Cannabis sativa*, *Frageria vesca* were rare. Seedlings of *Cedrus deodara* were very few showed the signs of previous existence of this pine in this area but it seems to be eliminated from the area similarly seedlings of *Acer ceasium* seems to be the emigrant in the area to replace pine species.

This community showed very small range in some of its soil parameters like pH and Conductivity *i.e.* 7.43 to 7.65 and 0.32 to 0.92 μ /cm respectively while TDS, Salinity and ORP showed higher ranges *i.e.* 145 to 343mg/L, 0.14 to 0.43% and -25.9 to 34.7mV respectively as shown in Table.2. Furthermore, the community attained highest values of Conductivity, ORP and Salinity among other communities.

***Pinus wallichiana* – *Cedrus deodara* community type**

Cedrus deodara considered as a dry temperate species but due to wide ecological amplitude also found in moist temperate areas (Ahmed et al., 2006). *Pinus wallichiana* and *Cedrus deodara* formed the community in the higher

elevations at four (stand 4,5,9,11,12) different locations. In 9, 11 and 12 stands which were at the location of New Murree, Changla gali and Seherbagla respectively. *Pinus wallichiana* was in the leading position where as in stand number 4 and 5 was co-dominant. In stand number 12, *Abies pindrow* was also present at 3rd position with a lower density and basal area. The elevation range of this community was from 2129 to 2464 meters. Density range starts from 65 to 128 plants per hectare and basal area estimated from 17.05 to 43.53 m²hec⁻¹. Ahmed et al., (2010) designated *Pinus wallichiana* and *Cedrus deodara* communities from 22 stands from 1950 to 2700 m elevated areas of moist temperate zones of Pakistan. They recorded 40 to 276 trees hec⁻¹ while in our study area, this community was present in very few stands due to the increasing use of deodara timber for various purposes and it is now replaced by different angiosperms. In addition, it is considered as a dry temperate species. Siddiqui (2011) reported that in this community, *Cedrus deodara* trees attained 52 to 362 hec⁻¹ density while basal area 15 to 100 m²hec⁻¹. In some communities *Pinus wallichiana* trees were 36 to 228 hec⁻¹ and basal area 4 to 37 m²/hec⁻¹. This study was conducted from Kumrat and other nearby areas at 1900 to 2730m elevation. Wahab (2011) recorded 40 to 276 ha⁻¹ trees from *Pinus wallichiana*-*Cedrus deodara* community at 1990 to 2310 meters elevation from Dir. It was a *Pinus wallichiana* dominated forest while in Kumrat area deodar was dominated. Wahab et al., (2008) found this community in Afghanistan (North eastern zone) where *Cedrus deodara* was in abundance with the density ranged from 15 to 394 ha⁻¹. Communities often show similar Phytosociological attributes with some differences in their absolute values stated by Ahmed et al., (2006). This community was also observed by Ahmed et al., (2010), from different locations in moist temperate aspects of Himalayan ranges showing wide ecological amplitude. In our study area, *Pinus wallichiana* and *Cedrus deodara* seedlings showed dominance over other associated angiospermic tree seedlings. Besides trees, *Rannunculus acris* was also present in abundance to cover the ground flora. *Sophora mollis*, *Urtica dioica* and *Crotalaria juncea* were frequently appeared in the stands of this community. Occasionally present flora was comprised of *Indigofera helpense* and *Rumex nepalensis*. Seedlings of *Quercus incana*, *Prunus granatum*, *Quercus dilatata*, *Acer ceasium*, *Populus ciliata*, *Populus nigra*, *Pyrus pashia*, *Pyrus* spp. were also rarely present. Other rarely present plant species were *Rosa brunonii*, *Rubus ellipticus*, *Cornus*

macrophylla, *Rosa webbiana*, *Campanula tenuisima*, *Frageria vesca*, *Ulmus wallichiana*, *Cannabis sativa*, *Rannunculus acris*, *Salix australis*, *Viola odorata*, *Adiantum*, *Aqualegia vulgaris* and *Ficus auriculata*.

This community possessed higher values in some soil parameters like TDS range started from 106 to 222mg/L, Conductivity ranged from 0.23 to 0.48 μcm , ORP ranged from -7.8 to 49.7mV, OM% ranged from 5.6 to 8.9%, WHC% ranged from 24 to 45%, Potassium ranged from 0.42 to 2.08mg/g, Phosphorus ranged from 0.26 to 0.54mg/g. The other parameters showed relatively lower ranges.

***Pinus wallichiana* – *Abies pindrow* community type**

Pinus wallichiana - *Abies pindrow* community also comprised of four stands with a diverse range of elevation from 2072 to 2672 meters. This shows that both species together can produce better vegetation as density per hectare of the community ranges from 68 to 113 per plants per hectare and the basal area constituted by these plants was 19.58 to 33.38m².hec⁻¹. This community was located at Ayubia dairy farm, Changla gali, Sunny bank and Bansra gali respectively. These areas included in moist temperate areas of Pakistan, but both species may grow in dry temperate areas and in timber line due to wide ecological amplitude Ahmed et al., (2006). This community occupied the highest elevation of the study area. Stand number 22 was dominated by *Abies pindrow* while in other stands it is in 2nd dominant position. This community was the abundantly observed by Siddiqui (2011) in his study area at the elevation from 2350 to 2800m. *Abies pindrow* usually occurred in leading position at higher and cooler elevation while *Pinus wallichiana* distributed relatively lower elevation. Siddiqui (2011) observed *Cedrus deodara*, *Taxus wallichiana* and *Juglans regia* as third dominant species at different locations showing a diverse range of association between them. This community also exhibit strong association in dry temperate zones of Gilgit as observed by Ahmed & Naqvi (2005). From moist temperate zones, the community type was reported in Dunga gali, Murree Hills, Ayubia and Miandam (2295–2350m elevation). In present study the community was observed only in four stands with a poor value of density and basal area while Siddiqui (2011) recorded greater number of sites presenting this community from least disturbed areas of Murree and higher elevation (2350 to 2800m) with the density range from 260 to 289 trees hec⁻¹ and basal area 12 to 108m²hec⁻¹.

The understory cover showed seedlings of *Pinus wallichiana* as most abundantly in the localities while no other species occupied the abundant class. Seedlings of *Abies pindrow* were frequently present. *Quercus dilatata*, *Berberis lycium*, *Frageria vesca*, *Rosa moschata*, *Juglans regia* and *Myrsine africana* were occasionally found species. Species found rarely were *Quercus incana*, *Aesculus indica*, *Indigofera helpense*, *Cornus macrophylla*, *Argemone mexicana*, *Acer ceasium*, *Ulmus wallichiana*, *Rumex nepalensis*, *Cannabis sativa*, *Populus nigra*, *Sophora mollis*, *Rannunculus acris*, *Paeonia emodi*, *Populus ciliata*, *Punica granata*, *Salix australis*, *Urtica dioica*, *Aqualegia vulgaris*, *Narcissum poeticus*, *Olea feruginea*, *Diospyros lotus*, *Rubus* spp. *Imperata cylindrica*, *Echinops nivens*, *Betula utilis*, *Ficus palmata*, *Pyrus pashia*, *Prunus deomestica* and *Pyrus* spp. Siddiqui (2011) explored forty six understory species from this community found in Changla gali and other moist temperate locations while in current study most of those species were depleted most probably due to over grazing of livestock present. These species include *Chrysopogon aciculatus*, *Duchesnea indica*, *Asplenium filix*, *Andropogon lancifolius* and many herbs and grasses. This absence of different herbs and grasses exposes the soil leaving it barren and allows the erosion.

Soil parameters nutrients were distributed within average limits in this community ranged values.

***Pinus wallichiana* – *Quercus dilatata* community type**

Besides other pine species *Pinus wallichiana* also found in association with angiospermic trees in the stand number 19 at the location of P.A.F. base. *Quercus dilatata* is a well-known species of moist temperate forests and at this location it was found to be as a 2nd dominant species at the elevation of 1839 meters. The density of the community was 99 trees per hectare while 27 were pine seedlings. The basal area was 25.63 m²hec⁻¹. It is a new community combination as previously *Quercus incana* was observed at different sites in association with other pine species. Siddiqui (2011) observed *Quercus incana* species as third dominant species in *Pinus wallichiana* and *Pyrus pashia* community at Ghora gali (2100 m elevation). This association was not previously observed in the region. *Pinus wallichiana* plants were in abundance but the angiosperms seem to be more likely adaptive in the destructive situation of the forests. Seedlings of *Pinus wallichiana* covered the area found in most abundance while *Quercus dilatata* were in abundance with *Myrsine africana* plants. *Berberis lycium*, *Frageria vesca*, *Rosa*

moschata, *Juglans regia*, *Aqualegia vulgaris*, *Narcissus poeticus*, *Olea feruginea* were occasional in the area. Seedlings of *Aesculus indica*, *Populus nigra*, *Punica granatum*, *Diospyros lotus*, *Rubus* spp. were the rare species. This community was recorded from only one location.

Single stand community showed basic pH (8.14), high values of TDS (242 mg/L), Conductivity (0.53 μ /cm) and Salinity (0.23%) whereas ORP was negligible i.e. -2mV. OM and M.W.H.C was considerably higher i.e. 9.08% and 48% respectively. Among NPK ratio, the concentration of K was highest i.e. 2.56 mg/g while N, P and Na were in 1.24%, 0.35 mg/g and 1.31% concentrations respectively (Table 2).

***Quercus dilatata* – *Cedrus deodara* community type**

More *Cedrus deodara* may be eliminated from this site hence angiosperm become leading dominated. Stand number 8 constituted another new combination of an angiospermic tree species associated with the older pine tree species in the area. The stand was cited at Koozah gali. This site is well known for the tourism, which is the main cause of the disturbance in the area. *Quercus dilatata* became dominant in this stand with 98 plants per hectare and 39.37 m²hec⁻¹ basal area. The location of the stand was on the third highest elevation i.e. 2460 meters. *Quercus baloot* found dominant in Chitral and Drosh areas in association with *Pinus gerardiana* and *Cedrus deodara* observed by Champion et al., (1965), Beg (1974) Beg & Khan (1984) occupying higher density and basal area i.e. 166 to 351hec⁻¹ and 12.51 to 30.13m²hec⁻¹. This community type i.e. pine with broad leaf angiosperm was also observed in Barai (Dir District) at the 2144 meters elevation showing 103 density.ha⁻¹ where *Cedrus deodara* was dominant reported by Wahab (2011) while in current study *Quercus baloot* was dominant. In various studies, association of *Cedrus deodara* with broad leaf angiosperms was reported and *Quercus baloot* was the mostly found angiosperm with pine species at different moist temperate locations claimed by Wahab (2011), Khan et al., (2010).

Pinus wallichiana seedlings were found in most abundance showing presence of this species in the past while *Quercus incana* seedlings were in abundance. *Quercus dilatata* seedlings were frequently found with *Myrsine africana*, *Berberis lycium*, *Frageria vesca*, *Rosa moschata*, *Juglans regia*, *Aqualegia vescum* and *Narcissum poeticus* which were occasionally occurring

species on the forest ground. *Aesculus indicus*, *Cornus macrophylla*, *Argemone mexicana*, *Populus nigra*, *Populus ciliata*, *Punica granatum*, *Diospyros lotus*, *Rubus* spp. were rarely occurred in the community. Soil was basic in this community and parameters were given in Table 2.

***Pinus roxburghii* – *Pinus wallichiana* community type**

Another community was observed at 5 different locations of lower elevations. According to Ahmed et al., (2006), these indicated the transition (ecotone) between subtropical to moist temperate zone. The community occurred at 1636-1919 meters elevation in the forest. *Pinus roxburghii* dominates in 13, 14, 17 and 25 stands with co-dominated *Pinus wallichiana*. The community consists density range from 87 to 113 trees per hectare which is a reasonable density range compared to other communities in his area. The basal area recorded in the range was 16.25-29.53m²hec⁻¹. From Ghora gali, this community type was recorded by Siddiqui et al., (2009) and Ahmed et al., (2009). The community observed only at lower elevation with higher density of *Pinus roxburghii* species and relatively lower density and co dominant *Pinus wallichiana* trees. Malik and Hussain (2007) also found *Pinus wallichiana* and broad leaf *Ficus palmata* dominated forests with co dominant pines like *Pinus roxburghii* and *Picea smithiana* from Azad Jammu Kashmir (moist temperate forest in Pir Chinasi Hills) at different locations. Both species found better adapted in the extremely destructive environment and occurred as best tolerant in the study area. Similar combination explored by Siddiqui (2011) and Iqbal et al., (2017 and 2020) in the form of *Pinus wallichiana* and *Picea smithiana* community in Shogran, Naran and Shangla District respectively. *Picea smithiana* is a species of temperate areas but in this study *Pinus wallichiana* showed wide ecological amplitude.

Ground flora of this community was dominated by the seedlings of *Pinus wallichiana* in most abundant form while *Pinus roxburghii* showed its presence in the abundance form. The other associated seedlings of *Quercus dilatata* and *Quercus incana* were also occurred frequently with *Urtica dioica*, *Cannabis sativa*, *Populus ciliata*, *Aqualegia vescum*, *Narcissum poeticus* and *Platanus orientalis* which were occasionally occurring species. *Acer ceasium*, *Berberis lycium*, *Argemone mexicana*, *Frageria vesca*, *Rannunculus nepalensis*, *Rosa moschata*, *Juglans regia*, *Populus nigra*, *Ficus palmata*, *Punica granatum*, *Viola odorata*, *Cassia glauca*, *Myrsine*

africana, *Olea feruginea* and *Diospyros lotus* were found rarely. Some other species like *Cornus macrophylla*, *Pyrus pashia*, *Prunus deomestica*, *Pyrus* spp., *Magnolia champaca* and *Symphyotrichum dumosum* were extremely rare and may be towards extinction from the community.

Sandy clay soil was found in this community. The community presented highest basic range of pH (7.71 to 8.27), Organic matter (6.8 to 7.76%) and M.W.H.C (28 to 43%) in the whole study area which indicated the old growth of forest containing higher level of litter and organic matter. ORP range was found to be highest in this stand *i.e.* from 45.2 to 58.8mV. Sodium concentration ranged (0.64 to 1.23mg/g) comparatively higher in this community.

***Pinus roxburghii* – *Cedrus deodara* community type**

It was reported that at this place *Pinus roxburghii* and *Cedrus deodara* trees were planted by Forest Department about 100 years ago (Personnel Communication). *Pinus roxburghii* appeared to form community with *Cedrus deodara* one stands which is at Ghora gali. The species show capability to grow on higher elevation of 1638 meters. The precipitation rate was higher in the area; hence the area was absolutely moist. That is most probably why the density and basal area level of this single stand was higher than other communities, despite heavy human interference for tourism. This area was protected by Forest Department. Density of the trees was 116ha⁻¹ with 28.81m²ha⁻¹.

Ground flora of this community showed missing of most abundant and abundant classes which was an indication of very strong herbivorey condition. Seedlings of *Pinus roxburghii*, *Quercus dilatata*, *Quercus baloot*, *Quercus incana* and *Aesculus indica* were present frequently in the community which is an indication of regeneration of species in future in this area. The frequently occurring species were *Fragaria vesca*, *Cannabis sativa*, *Rosa moschata*, *Juglans regia*, *Populus ciliate*, *Urtica dioica*, *Aqualegia vulgaris*, *Narcissus poeticus*, *Olea feruginea*, *Diospyros lotus*. Some rarely occurring species were also recorded which were *Cornus microphylla*, *Populus nigra*, *Punica granatum* and *Magnolia champaca*. *Deodar* seedlings were rarely present in the area. Sandy clay with basic pH soil present in this community, other parameters were averagely found as given in Table 2.

***Pinus roxburghii* – *Quercus dilatata* community type**

In the stand 29 which is located at T-Base-Dewal Road near Kashmir point, *Pinus roxburghii* was forming community with an angiosperm species *Quercus dilatata*. This community gave a considerable density and basal area 128 plants per hectare and 37.53m²hec⁻¹ respectively. Basal area indicated small sized trees in this community. The community present at the elevation of 1858 meters. Ahmed et al., (2006) provided a record of 732 trees hec⁻¹ of *Pinus roxburghii* in association with broad leaf angiosperm trees with 31m²hec⁻¹ basal area from Himalayan forests. In this community most abundance and abundance classes were absent showing a poor condition of ground flora may be due to over grazing by the livestock which were present in nearby villages. Seedlings of *Pinus roxburghii*, *Quercus dilatata*, *Quercus baloot*, *Quercus incana* and *Aesculus indica* were present frequently with *Platanus orientalis* and *Myrsine africana*, *Populus ciliata*. The frequently occurring species were *Fragaria vesca*, *Cannabis sativa*, *Rosa moschata*, *Juglans regia*, *Populus ciliate*, *Urtica dioica*, *Aqualegia vulgaris*, *Narcissus poeticus*, *Olea feruginea*, *Diospyros lotus*. Some rarely occurring species were also recorded which were *Cornus microphylla*, *Populus nigra*, *Punica granatum* and *Magnolia champaca*.

This community comprised of only one stand with Sandy clay soil. Table 3 showed the details of soil analysis of this community. In this stand, basic pH (7.57) seen, high values of TDS (253 mg/L) and ORP (59 mV), N (1.2%), K (2.46 mg/g) were estimated while OM (7.8%), M.W.H.C (32%), P (0.35 mg/g) and Na (0.85 mg/g) were moderately present in the soil. The concentration of Conductivity (0.12 µ/cm) and Salinity (0.12%) were lower.

Present study showed that above mentioned communities were also found in nearby least disturbed forest stands or in other forests of Pakistan, but due to anthropogenic disturbances the quantitative values of these associated and dominant tree species were considerably low. It was also indicated that ground flora was in poor condition and many herbs, shrubs and other plants were recorded in extremely less in number showing possible future extinction. Soil condition was also poor as compared to least disturbed sites. It has been suggested that proper forest management system was not induced there would be biodiversity, infrastructure and human lost in future.

Correlation between tree density and basal area, tree density and seedling density and basal area and seedling density nearly in all communities were not significantly related except tree density versus basal area of community no.8, this may be due to the higher disturbed nature of the communities (Table 3).

Among the above defined communities, two communities (*Pinus wallichiana* and *Quercus dilatata* community and *Pinus roxburghii* and *Quercus dilatata* community were entirely a new combination that showed a high tolerance level of conifers with associated species tree species to establish sustainability under disturbed conditions. Another community of *Cedrus deodara*-*Pinus roxburghii* community was a protected forest that presented this completely rare combination as both the species are known for inhabiting entirely different altitudes. Ground flora of the identified communities showed few herbs and shrubs with some mosses,

pteridophytes but no climber was observed from studied sites, which gave an indication of worst degradation of the ecosystem specifically from moist temperate areas. As moist temperate areas have seen to be rich in climber species that often cover tree crown. Most probably logging in these forests have brought the canopies open that would be incompatible for the growth and development of climbers. Climbers need low light in the initial stages of their life and after getting maturity, they could absorb high intensity of sunlight that could be possible by reaching tree crown. In current case, open floor of the forest do not let the climbers to survive as high intensity of light reached the forest floor. Soil conditions were not estimated to be the conditions of moist temperate soil as they have sandy and silty combination at greater percentage while chemical composition was calculated to be more towards salinity. Former studies (Siddiqui, 2011) quoted soil samples from these regions to be basic in nature.

Table 1. Characteristics of communities recorded in the study area.

S. No.	Community	Stands in community	ER (meters)	Aspect Range	SD (trees/ha) Range	BA (m ² /ha) Range	RF of pine seedlings
1	<i>Pinus wallichiana</i> (pure)	6,15,16,21,23,24,26.	1619-1974	South facing	70 – 106	14.84 – 48.06	40 - 100%
2	<i>Pinus roxburghii</i> (pure)	18,30.	1574-1576	North facing	103 – 104	20.25 – 37.53	80 - 60%
3	<i>Pinus wallichiana</i> - <i>Quercus baloot</i>	1,2,3.	1834-1975	North & South	67 – 98	24.96 – 33.93	100%
4	<i>Pinus wallichiana</i> - <i>Cedrus deodara</i>	4,5,9,11,12.	1977-2337	North & South	65 – 128	17.05 – 43.53	80 - 100%
5	<i>Pinus wallichiana</i> - <i>Abies pindrow</i>	7,10,20,22.	1845-2435	North facing	68 – 113	19.58 – 33.38	20 - 100%
6	<i>Pinus wallichiana</i> - <i>Quercus dilatata</i>	19.	1839	South facing	99	25.63	80 - 100%
7	<i>Quercus dilatata</i> - <i>Cedrus deodara</i>	8.	2358	North facing	98	39.37	100%
8	<i>Pinus roxburghii</i> - <i>Pinus wallichiana</i>	13,14,17,25,27.	1468-1840	South & North	87 – 113	16.25 – 29.53	60 - 100%
9	<i>Pinus roxburghii</i> - <i>Cedrus deodara</i>	28.	1472	South facing	116	28.81	60%
10	<i>Pinus roxburghii</i> - <i>Quercus dilatata</i>	29.	1568	South facing	128	37.53	60%

Note: ER= elevation range, SD= stand density, BA= basal area, RF= relative frequency

Table 2. Showing soil physical and chemical characteristics summarized on community basis: values are given as ranges.

Community	pH	TDS mg/ltr	Cond μ/cm	Sal %	ORP mV	OM %	WHC %	N %	P mg/g	K mg/g	Na mg/g
<i>P.W</i> pure	7.37-8.00	151-364	0.18-0.44	0.14-0.24	15.7-68.6	5.8-8.56	20-51	0.14-1.21	0.21-0.46	1.42-2.43	0.54-1.42
<i>P.R</i> Pure	7.48-7.51	167-229	0.36-0.50	0.16-0.22	50.9-63.7	6.94-8.57	28-42	0.18-1.2	0.26-0.56	1.74-2.3	0.69-1.12
<i>P.W</i> ↔ <i>Q.B</i>	7.43-7.65	145-343	0.32-0.92	0.14-0.43	-25.9-34.7	5.58-7.07	27-47	0.11-0.15	0.23-0.26	0.4-0.45	0.1-0.16
<i>P.W</i> ↔ <i>C.D</i>	6.96-7.85	106-222	0.23-0.48	0.1-0.21	-7.8-49.7	5.6-8.9	24-45	0.13-0.17	0.26-0.54	0.42-2.08	0.1-0.85
<i>P.W</i> ↔ <i>A.P</i>	7.34-7.98	121-204	0.36-0.61	0.06-0.19	-12.5-50.9	6-8.58	21-43	0.16-1.1	0.26-0.35	1.68-2.32	0.76-1.12
<i>P.W</i> ↔ <i>Q.D</i>	8.14	242	0.53	0.23	-2	9.08	48	1.24	0.35	2.56	1.31
<i>Q.D</i> ↔ <i>C.D</i>	7.52	157	0.34	0.15	29.6	7.7	41	1.15	0.26	2.28	0.92
<i>P.R</i> ↔ <i>P.W</i>	7.71-8.27	121-202	0.34-0.85	0.06-0.19	45.2-58.8	6.8-7.76	28-43	0.16-1.24	0.26-0.54	1.42-2.5	0.64-1.23
<i>P.R</i> ↔ <i>C.D</i>	7.72	128	0.18	0.15	60	7.55	33	0.19	0.35	1.26	0.64
<i>P.R</i> ↔ <i>Q.D</i>	7.57	253	0.12	0.12	59	7.8	32	1.2	0.35	2.46	0.85

Note: *P.W* = *Pinus wallichiana*, *P.R* = *Pinus roxburghii*, *C.D* = *Cedrus deodara*, *A.P* = *Abies pindrow*, *Q.B* = *Quercus baloot*, *Q.I* = *Quercus dilatata*, *A.C* = *Aesculus indicum*, ↔ = chances of dominance of either species in the community, this might be due to disturbed condition in the area.

Table 3. Showing community correlations among Tree density, basal area and seedling density.

	Correlations	R ² - value	P – value
Community 1	T.D v/s B.A	0.027	Non- Significant
	T.D v/s S.D	0.081	Non- Significant
	B.A v/s S.D	0.205	Non- Significant
Community 4	T.D v/s B.A	0.634	Non- Significant
	T.D v/s S.D	0.029	Non- Significant
	B.A v/s S.D	0.402	Non- Significant
Community 5	T.D v/s B.A	0.390	Non- Significant
	T.D v/s S.D	0.097	Non- Significant
	B.A v/s S.D	0.266	Non- Significant
Community 8	T.D v/s B.A	0.863	Significant
	T.D v/s S.D	0.223	Non- Significant
	B.A v/s S.D	0.092	Non- Significant

Note: T.D = Tree density, B.A = Basal area and S.D = Seedling density.

Among the above defined communities, two communities (*Pinus wallichiana* and *Quercus dilatata* community and *Pinus roxburghii* and *Quercus dilatata* community) were entirely a new combination that showed a high tolerance level of conifers with associated species tree species to establish sustainability under disturbed conditions. Another community of *Cedrus deodara*-*Pinus roxburghii* community was a protected forest that presented this completely rare combination as both the species are known for inhabiting entirely different altitudes. Ground flora of the identified communities showed few herbs and shrubs with some mosses, pteridophytes but no climber was observed from studied sites, which gave an indication of worst degradation of the ecosystem specifically from moist temperate areas. As moist temperate areas have been seen to be rich in climber species that often cover tree crown. Most probably logging in these forests has brought the canopies open that would be incompatible for the growth and development of climbers. Climbers need low light in the initial stages of their life and after getting maturity, they could absorb high intensity of sunlight that could be possible by reaching tree crown. In current case, open floor of the forest does not let the climbers to survive as high intensity of light reached the forest floor. Soil conditions were not estimated to be the conditions of moist temperate soil as they have sandy and silty combination at greater percentage while chemical composition was calculated to be more towards salinity. Former studies (Siddiqui, 2011) quoted soil samples from these regions to be basic in nature.

In addition, seedling numbers were also considerably low as compared to least disturbed nearby stands. It was anticipated due to less ground cover most of the seeds

flooded away during rain and seedlings crushed by the grazing animals, therefore hard to survive. This might be the main reason for low number of seedlings in disturbed areas. No correlation among community density, basal area and seedling density give additional support to the opinion. The overall condition of these forests was expected to be declined in future if the human interference and logging persisted in the area.

4. CONCLUSION

Current study evaluated a comprehensive detail about vegetation type and forest present cover status of disturbed forests in Muree. Under the light of predescribed findings, it is strongly recommended to implement conservation strategies in the forest as there are various species including conifers in vulnerable condition. Due to loss of trees the understory species are depleting due to lack of shelter for the seedlings. The survived seedlings are endangered because of presence of grazing. Therefore, serious attention is needed for conservation of vegetation and biodiversity.

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