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RESEARCH ARTICLE

Assessment of deforestation using Diameter size classes distribution of trees in Ganji Valley Himalayan Range of Pakistan

Zarmast Khan[1], Muhammad Akbar[1],Syed M.Ali Rizvi[1], Azfar Hussain[1], Irfan Ali[1], Muhammad Ali[2], Sujjad Hyder[1], Shaukat Ali[1] , Muhammad Essa[3],Naeem Abbas[3] , Jamal Hussain [1]

1. Department of Environmental Science Karakorum International University Gilgit-Baltistan, Pakistan
2. Department of Biological Sciences Karakorum International University Gilgit-Baltistan, Pakistan.
3. Forest and Wildlife Deparment ,Forest complex Jutial Gilgit, Pakistan

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Corresponding Author

Zarmast Khan

Abstract

Forest is one of the most important and valuable God gifted natural resource. Globally it has a great importance in regulating the functions of the nature. Forests are called lungs of the Earth because they remove carbon dioxide from the atmosphere and oxygen is released into it. This study was conducted using Point Centered Quarter method (PCQ) in different stands to investigate the size class structure of forest tree species from Ganji Valley District Skardu Gilgit-Baltistan, Pakistan. Total Six stands were selected from 3345m to 3550m above sea level. The study aims to depict the present status and future trend of the tree species of forest in the study area. Three tree species were observed in the entire forest namely *Pinus wallichiana* A.B Jackson, *Juniperus excels* D.Don and *Betula utilis* M.B. Among them *Pinus wallichiana* A.B Jackson was found the dominant species in all six stands with the mean density 192.35 stems ha^{-1}. while *Juniperus excelsa* D.Don was observed as the 2nd co-dominant species with mean density 57.15 stems ha^{-1}. The size class distribution pattern was observed varied in these stands. Most of the disturbances may be explained in terms of anthropogenic disturbances, i.e., grazing, cutting, sliding, burning and other induced factors. Therefore, this forest is not in a stable condition. If the current anthropogenic as well as some natural disturbances are not monitored by taking some solid actions, then this valuable forest will vanish in few decades in future.

INTRODUCTION

Forest is one of the most and valuable God gifted natural resource. Globally they have great importance in regulating the functions of the nature. Forests are called lungs of the Earth because they remove Carbon Dioxide from the atmosphere for the purpose of photosynthesis and oxygen is released into atmosphere which is the basic need of survival for human beings and animals. Instead of these basic functions forests are the home of other natural resources such as they provide watersheds, habitat to wildlife and so many other natural products. They offer watershed protection, timber and non-timber products, and various recreational options. They prevent soil erosion, help in maintaining the water cycle, and check global warming by using carbon dioxide in photosynthesis (UN FAO, 2014).The numbers of individuals that fall within each tree size class vary considerably in forests (Hitimana et al. 2004, Coomes and Allen 2007). Various factors, such as competition for resources, regeneration patterns, disturbances, and environmental conditions, irregular or seasonal climatic events account for the variation of tree size distributions in forests around the world (Coomes et al, 2003). Thus, tree size distributions have often been used in

assessing the effect of disturbance within forests (Coomes & Allen 2007).It is also used in describing succession pathways and structural development and in predicting future forest stand structure (Feeley et al. 2007).Although tree size distributions vary widely among natural forests they show basic similarities that may suggest general underlying principles. According to FAO (2009) the forest cover of Pakistan is 2% whereas 4% of the country's land is covered by trees, planted in gardens, cities, along rivers, canals and agricultural lands. Ahmed (2009) reported that most of the forest cover is found in Northern Areas of Pakistan. These forests are deteriorating with the passage of time, due to poor management, less research and anthropogenic disturbance.Akbar et al (2013) recorded the varied size class distribution patterns of forest in different stands from three districts of Gilgit-Baltistan namely Gilgit, Skardu and Astore. They concluded that the size class structure of these forests were not satisfactory. Ahmed (1988) presented Population structure of planted tree species of Quetta. While population structure of *Juniperus excelsa* M.B. and Pinus gerardiana Wall.ex Lamb., from Baluchistan was shown by Ahmed et al., (1990) and Ahmed et al., (1991) respectively.

Owiny et al .,(2014) studied the population structure and regeneration status of a medicinal tree species Prunus africana in Uganda.

Though there are number of studies carried out about the forests and over all of Skardu district but no detailed investigations about the forests of Sub-division Roundu was carried out specially the forest of Ganji valley, therefore present work is presented to assess the class size structure of tree species to outline future trends of forest in Ganji valley. This information can be used for conservation and management of forest in that particular area as well as in Gilgit-Baltistan.

Materials and Methods

Methods

Study Area

The area which is selected for the research is Ganji Valley forest. Ganji is a small valley of Sub-Division Roundu District Skardu located between 35.33^0 N latitude to 74.59^0 E longitudes with 3344m to 3550m above sea level.

Data Collection

The study was conducted using Point Centered Quarter method of Cottam and Curtis (1956) applied in different stands of forest. Field studies were carried out from July to December 2014. Six stands were selected in the entire forest for study. Environmental characteristics, i.e., slop angle, geographical coordinate, elevation and aspect, were recorded by GPS. The other apparatus used was, Measuring tape, a cross, four nails, digital camera notepad, pen, and sampling sheets etc.

Statistical Analysis

Density of tree species was calculated following Mueller- Dombois and Ellenberg (1974). In order to assess the general condition and vegetation structure of the forest, we developed a density-diameter histogram. Girth of trees exceeding 10 cm diameter at breast height (dbh, at 1.37 m above the ground) was measured. Fifteen points were taken from each stand in 20-meter intervals.

Diameters at breast height (dbh) of each tree species in a stand were divided into (10cm dbh) fourteen size classes and size structures of coniferous trees are presented using MS Excel 2007. Furthermore, in each stand, size classes were divided into four categories, i.e., small size classes (10 to 30 cm dbh), middle size classes (40 to 60 dbh cm), and large size classes (70 to 90) and above (90 dbh) extra large size classes following Akbar (2013) and Hussain (2011).

Figure: 2. View of sampling tools and techniques during field visits

Identification of Plant

Plants specimens were collected from the studied area and identified with the help of flora of Pakistan (Nasir and Ali, 1972). Highest important value of plant species in the stand was considered as dominant species (Brown & Curtis, 1952). Samples had taken and brought to the botanists of the Karakorum International University for identification.

Results

Environmental Characteristics of sampling sites is presented in Table -1 while size classes distribution of different stands is shown in figure A,B,C,D,E and F where as complete description of stands are given blew.

1. Bado jail stand

This was a mixed stand of the three tree species *Pinus wallichiana* A.B. Jackson, *Juniperus excelsa* M.B., and *Betula utilis* D.Don, situated at 35.33^0 North to 74.59^0 East with 3344m above sea level. The exposure of this stand was West-East and slope angle was 35^0 (Table-1). The density of trees were 307.7 stems ha^{-1} with close canopy. The most overriding tree was *Pinus wallichiana* A.B. Jackson with 200 stems ha^{-1}. *Juniperus excels* was found the co-dominant tree with 76.9 stems ha^{-1} density. While the associated *Betula utilis* D.Don was found with density 30.8 stems ha^{-1}. The distribution of *Pinus wallichiana* A.B. Jackson trees among the four categories of dbh(diameter at breast height) size classes were observed as 23.1% individuals in small classes, 38.5% in middle classes, 25.6% individuals in large classes and only 12.8% individuals in extra large class (Figure-2). This distribution pattern showed slightly dissatisfaction which is because of indiscriminate cutting of different size of trees as prevailed by the cut stems found at the site of sampling. The presence of 12.8% extra large trees showed that this stand is an old stand having the oldest trees among the whole forest which is also reviled from its local name(Bado: means the largest and Jail; means forest in shina; the local language of that area). While the tree distribution pattern of *Juniperus excelsa* M.B., was found that 20% individuals were found in small classes, 53.3% in middle classes, 13.3% in large and 13.3% individuals found in extra large classes. *Juniperus excelsa* M.B., also showed the same level of satisfaction as *Pinus wallichiana* A.B. Jackson showed in order to distribution of trees among the dbh size classes. *Betula utilis* D.Don was observed only in the middle classes and there was not found any tree in other three classes. Therefore; the size class structure of this tree was found unsatisfactory. The gaps in these size classes indicating no regenerations possibility because seedlings were destroyed due to the extensive grazing by livestock.
The overall condition of this stand is prevailed from the above mentioned aspects that the pattern of distribution and regeneration situation of *Pinus wallichiana* A.B. Jackson and *Juniperus excelsa* M.B., are satisfactory to some consideration while *Betula utilis* D.Don, is in extreme condition from all aspects.

2. Takjut jail stand

This stand was located between 35.33^0 N to 74.59^0 E at the height of 3359m above sea level. The exposure was west to East and angle of slope was 45^0 (Table-1). The total stand density of trees in this stand was 237 trees ha^{-1} with a closed canopy. This was also a mixed stand of *Pinus wallichiana* A.B. Jackson, *Juniperus excelsa* M.B., and *Betula utilis* D.Don, tree species. The foremost dominant species was *Pinus wallichiana* A.B. Jackson with the density of 142.2 trees ha^{-1}. The next co-dominant tree was *Juniperus excelsa* M.B., occupying with the density 55.2 stems ha^{-1}. While *Betula utilis* D.Don, was found with density attaining 39.6 trees ha^{-1}. The distribution of *Pinus wallichiana* A.B Jackson among the size class categories was as, 38.9% individuals in small classes, 47.2% in middle, 5.6% in large and 8.3% individuals were found in extra large classes. The distribution of trees in small and middle classes was suitable .While there were some gaps found in large classes (Figure-2). This was due to the removal of large trees in the past. The occurrence of a larger number of trees in extra large classes as compared to large classes was due to the bad shape of these extra large trees. Because of their bad shape these trees had left without cutting in past. The overall distribution pattern was positively skived.
The distribution pattern of *Juniperus excelsa* M.B., trees among Dbh size classes was in an ideal condition as their density in small classes were high and were decreasing in middle and large classes gradually. The individuals in small classes were 50% while middle classes carried 35.7% and large classes attained 14% trees. While extra large dbh trees were not found on this stand. *Betula utilis* D.Don, trees were also distributed in a normal pattern on all size classes. Small classes carried 10% trees, middle classes attained 60% and large classes attained 30% trees. Some gaps were observed on small classes which were disturbed due to over grazing and cutting for the purpose fuel wood.
The overall scenario shows that *Pinus wallichiana* A.B. Jackson and *Juniperus excelsa* M.B., are in a suitable condition on this stand while *Betula utilis* D.Don, is under pressure which can b sustained by the controlling the over grazing and also by reducing the dependency for fuel wood on this trees species.

3. Burbonay stand

This mixed forest of *Pinus wallichiana* A.B. Jackson and *Betula utilis* D.Don, was located between 35.32 N to 74.59 E with facing West-East. This was 3502m above sea level and slop angle was 55^0 (Table-1). The entire stand density was 229.9 trees ha^{-1} with basal area 56.06 m^2 ha^{-1} and 235.35 IVI (Table-2). The canopy of entire stand was

moderate. *Pinus wallichiana* A.B. Jackson was found the dominant species with density 191.1 trees ha^{-1}. The next dominant species observed was *Betula utilis* D.Don, with 38.1 trees ha^{-1}. While *Juniperus excelsa* M.B., was not found in this stand. The distribution of trees in size classes was observed in such a manner that small classes attained 22% trees, middle classes attained 52% trees and large and extra large classes attained 20% and 6% individuals respectively. There were some gaps found in small classes which were caused by destruction of avalanches in spring seasons. The overall pattern of tree distribution was symmetrical in this stand as the number of trees in small and middle classes were smoothly increasing and were decreasing from large to middle classes.
The distribution pattern of *Betula utilis* D.Don was found in such a manner that there were 30% individuals in small classes and 70% in middle classes. While large and extra large classes were not found in this stand which were may be removed in past. Thus, the distribution pattern of trees of this species is approximately moderate in this stand.

4. Pari jail stand

This pure stand of *Pinus wallichiana* A.B. Jackson was located between north latitude 35.33^0 N to East longitude 74.59^0 with the height 3425m above sea level. The slop angle was 25^0 and the stand density was 243.9 trees ha^{-1} with a closed canopy. The distribution pattern of trees in various size classes was found that 36.7% individuals were resided in small classes, 31.7% in middles classes and 15% in large and 16% trees were found in extra large classes. The distribution pattern was ideal and satisfactory because small and middle classes had large number of trees while number of trees was decreasing in large and extra large classes.

5. Khutirung stand

This mixed stand of *Pinus wallichiana* A.B Jackson and *Juniperus excelsa* D.Don was located between the North 35.32^0 N latitude to East 74.59^0 E longitude at 3370m above the sea level. The stand exposure was North-South with the slop angle 35 (Table-1). This stand was also a closed canopy with density 260.4 trees ha^{-1}. The leading dominant tree was *Pinus wallichiana* A.B Jackson attained density 203.9 trees ha^{-1}. While the co-dominant Juniperus excels D.Don was observed with density 53.3 stems ha^{-1}. The size class structure of *Pinus wallichiana* A.B Jackson was found in such a way that there were 44.7% trees scattered in the small classes 29.8% in middle classes, 19.1% in large classes and 6.4% trees were scattered in extra large classes (Figure.4-E). The distribution pattern of wallichiana A.B Jackson was also ideal in this stand that the large number of trees was found in small and middle classes respectively. While these trees showed a decrease in number in large and extra large classes. Thus they showed positive skewness. But some gaps were found in extra large classes which were because of removal of these extra large trees in the past. The distribution pattern of *Juniperus excelsa* D.Don was found that 84.6% trees were found in middle classes. While larger and extra large dbh trees were not found in these two respective large classes (Figure.2-E). This was because of cutting of these large dbh trees for the domestic use as fuel wood, because this stand was located near the residential area of community. This distribution pattern of trees in dbh size classes was not satisfactory due to absence of large dbh trees. But their graph showed a positive skewness.

6. Danoyi jail stand

The mixed stand of *Pinus wallichiana* A.B. Jackson, *Juniperus excelsa* M.B., and *Betula utilis* D.Don, was located between 35.32^0 N to 74.59^0 E at elevation of 3550m above sea level. The slop angle was 25^0 with the North-South exposures (Table-1). The density of entire stand was 237 stems ha^{-1} with approximately open canopy. The first leading dominant tree found in this stand was *Pinus wallichiana* A.B Jackson which was occupied with 173 trees ha^{-1}. The second co- dominant tree was *Juniperus excelsa* M.B., with the density 40 trees ha^{-1}.The next associated *Betula utilis* D.Don, tree species was found with the density 24 trees ha^{-1}. The *Pinus wallichiana* A.B. Jackson trees were concentrated in dbh size classes in such a manner that 34.1% trees were fallen in small size classes, 52.3% in middle size and 6.8% in large classes while 6.8% trees found in extra large classes. Some gapes were found in large classes due to indiscriminate cutting of trees in the past. The distribution pattern of trees was found unsymmetrical and positively skived on the graph shown below. The overall situation is satisfactory to some level.*Betula utilis* D.Don was also scattered in Dbh size classes in such a manner that 50% trees were concentrated in middle classes while other 50% were found in large classes Trees in small and extra large classes were not found in this stand (Fifure.2-F). Thus the distribution pattern of *Juniperus excelsa* M.B., was found unsatisfactory because small size classes were absent due to violent cutting and burning of these classes as the stand was located near the residential area of the community. The *Betula utilis* D.Don, tree species in this stand were concentrated only in middle classes and were not found in other dbh classes. This was also disturbed by the indiscriminate harvesting of *Betula utilis* D.Don, trees on this site due to the same reason mentioned above in case of *Juniperus excelsa* M.B.Thus the overall situation of this stand was not satisfactory and had disturbed due to huge influence of human activities on this site.

These observations reflect the situation that this stand is under pressure by the destruction of human activities in near future if these interruptions are not properly controlled.

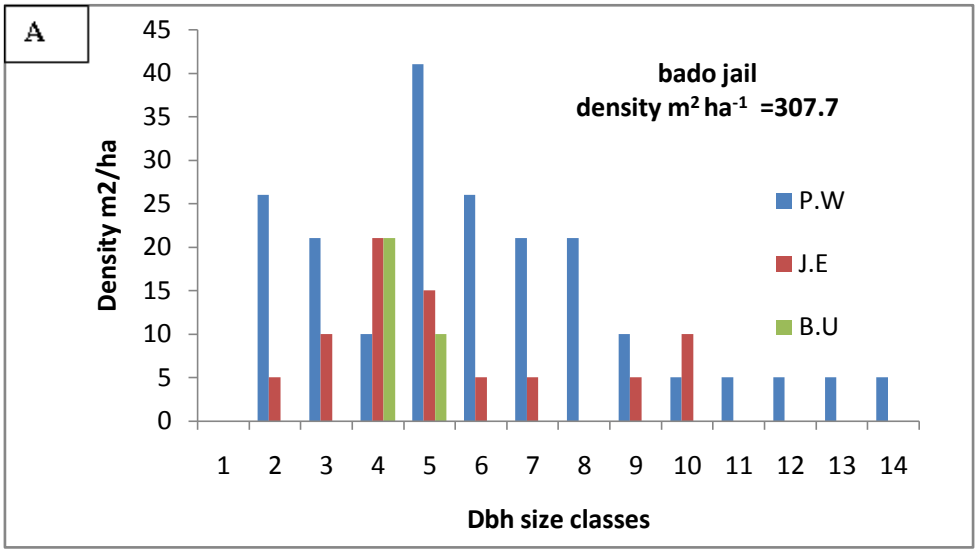
Table: 1 Environmental Characteristics of sampling sites of Ganji Valley of Skardu Districts.

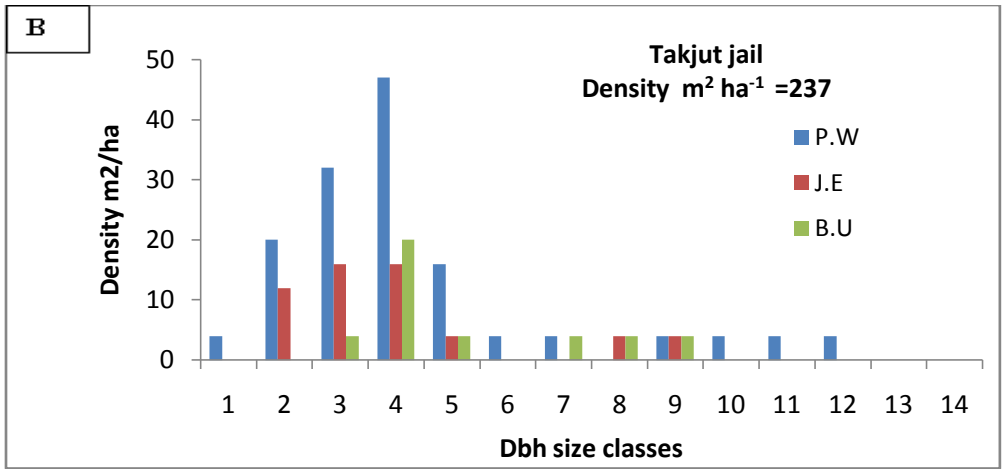
Stn	Main Location and sites	Lat (N)	Long (E)	Ele (M)	Aspect	Slope (^{o})	Canopy
1	Bado jail	35^0 33	74^0 59	3344	WE	35^0	Cls
2	Jail	35^0 33	74^0 59	3359	WE	45^0	Cls
3	Burbonay	35^0 32	74^0 59	3502	WE	55^0	Mdrt
4	Pari Jail	35^0 33	74^0 59	3425	EW	20^0	Cls
5	Khuti rung	35^0 32	74^0 59	3370	NS	35^0	Cls
6	Danuyi jail	35^0 32	74^0 59	3550	NS	25^0	Opn

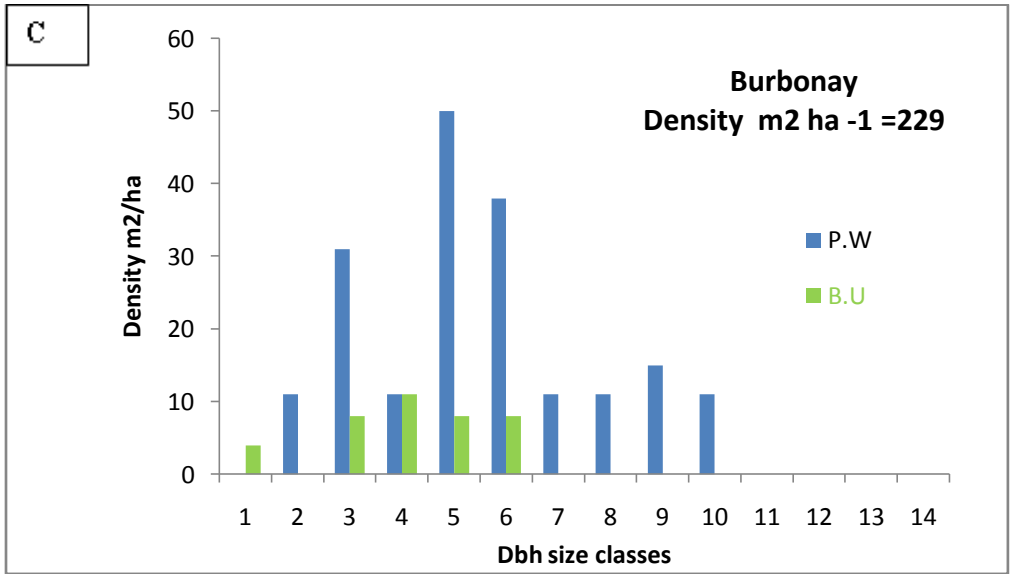
a. The dominant tree species of *Pinus wallichiana*

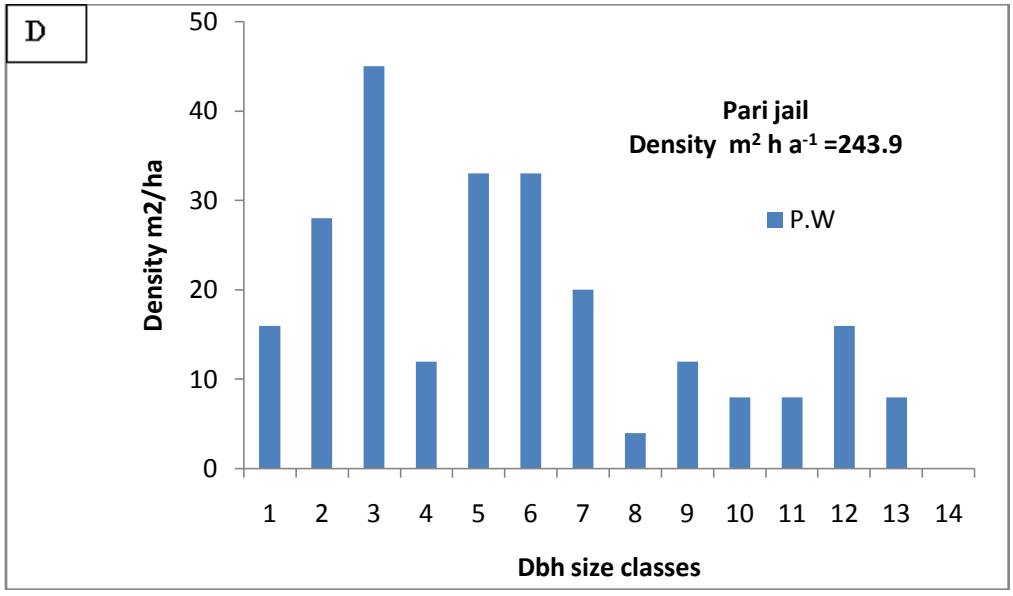
b. *Juniperus excelsa* 2nd co-dominant species.

Figure: 2 images show the leading dominant and 2nd co-dominant tree specie




B
Takjut jail
Density m² ha⁻¹ =237
P.W
J.E
B.U
Density m2/ha
0
10
20
30
40
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Dbh size classes


C
Burbonay
Density m2 ha -1 =229
P.W
B.U
Density m2/ha
0
10
20
30
40
50
60
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Dbh size classes


D
Pari jail
Density m² h a⁻¹ =243.9
P.W
Density m2/ha
0
10
20
30
40
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Dbh size classes

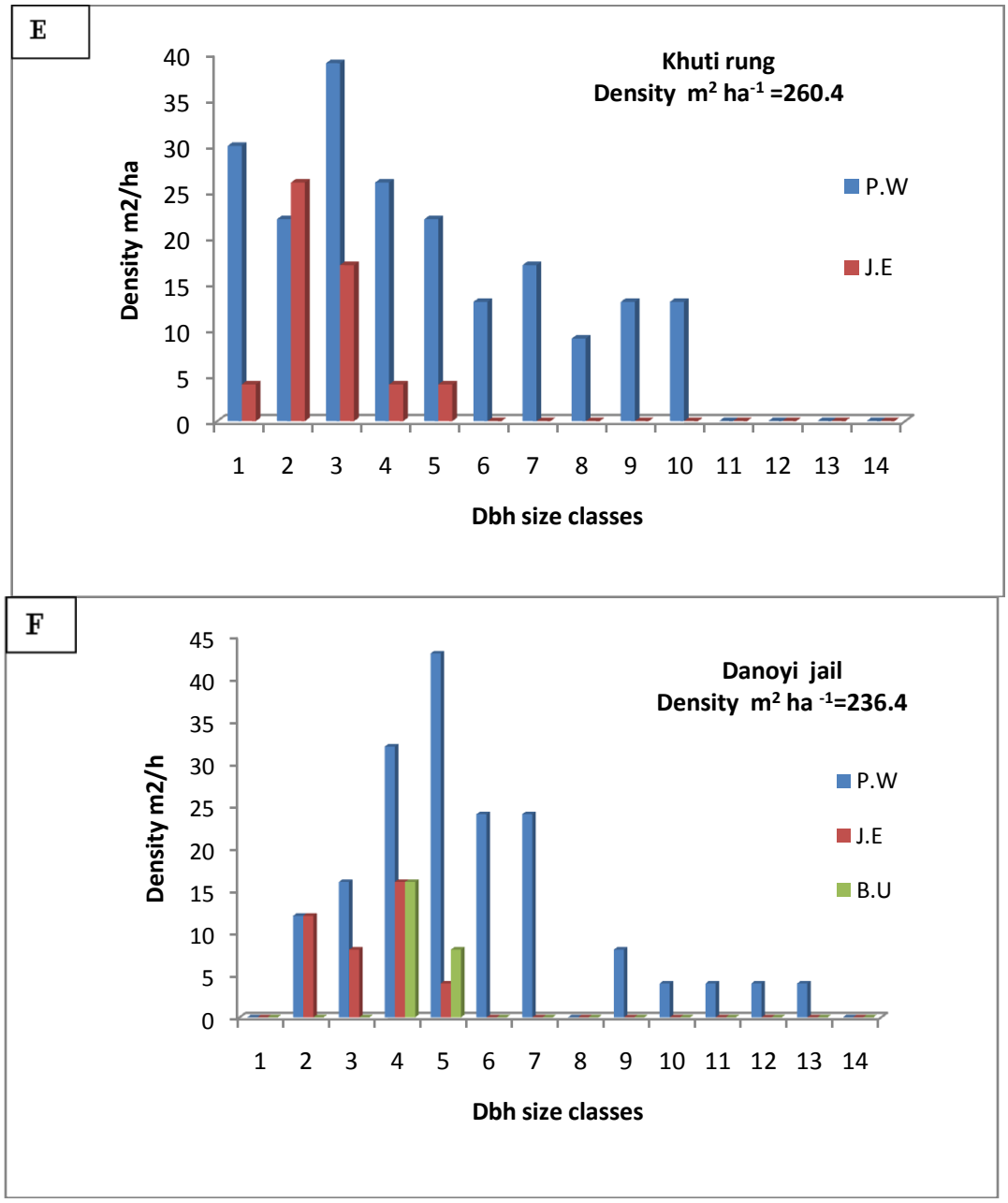


Figure: A,B,C,D,E and F graphs show the size class structure of trees in six stands of Ganji forest

Discussions

Forests and biodiversity is key to all life forms. The richer the diversity of life, the greater the opportunity for medical discoveries, economic development and adaptive responses to such new challenges. Forests serve as a watershed and also provide habitat to millions of animals, birds, insects, and a large biodiversity. Forests have number of economic benefits provide in the form of timber wood, paper and pulp, medicinal plants and provide tourism income and also in so many other forms. Forests are as important from environmental point of view as they control the air pollution; balance the temperature with soil by the process of evopotranspiration (Murniati & Padmanaba, 2009). Tree size distributions have often been used in assessing the effect of disturbance within forests (Coomes & Allen 2007).It is also used in describing succession pathways and structural development and in

predicting future forest stand structure (Feeley et al. 2007).Although tree size distributions vary widely among natural forests they show basic similarities that may suggest general underlying principles.

Present study showed that *Pinus wallichiana* A.B Jackson is present in all 6 stands as the dominant tree while this species was observed as pure stand only in pari jail. *Juniperus excelsa* M.B was found the 2nd co-dominant species in four stands while this was not observed in two stands .This was neither observed as first dominant species in any stand nor observed any pure species in any stand. The associated *Betula utilis* D.Don tree species was also found in four stands and was not observed in two out of six stands. Some of the forest stands showed gaps in earlier size classes with low density. This situation shows livestock overgrazing and cutting of young trees in which it is hard for young seedlings to survive. This situation may be overcome by promoting seedling regeneration in these areas but few other stands also showed gaps in large size classes, indicating extensive cutting. The density of sampled forest stands ranged between 229.2 to 307.7 stems ha-1. Among the stands, *Betula utilis* D.Don occupied with low density as with 24, 30.8 and 38.1 stems ha^{-1} from Danoyi jail, Bado jail and Burbonay respectively, while *Juniperus excelsa* M.B was recorded with 40, 55.2 and 56.5 stems ha-1 from Danoyi jail, Takjut and Khuti rung, respectively. The highest density of *Pinus wallichiana* A.B jackson was recorded from Pari jail stand with 307.7 stems ha-1 as pure form. *Juniperus excelsa* M.B attained the highest value from Bado jail and Khuti rung with 76.9 and 56.5 stems ha-1, whereas *Betula utilis* D.Don occupied the highest density 39.6 and 38.1 stems ha-1 from Khuti rung and Burbonay stands respectively. *Pinus wallichiana* A.B Jackson attended low density from Takjut jail which was 142 stems ha^{-1}.

Among the 6 stands, the highest density was recorded from *Pinus wallichiana* A.B Jackson from pari jail stand with 243.9 stems ha-1 as pure form. Akbar et al (2013) also recorded the highest density of *Pinus wallichiana* A.B Jackson from Ganji forest. Ahmed et al (2006) recorded the densities of *Pinus wallichiana* A.B Jackson 337 stem ha^{-1} and 232 stems ha^{-1} from different climatic zones of Pakistan and Takht-e-Silaiman (Baluchistan), respectively. The present finding was supported to these values mentioned above. Himalayan pine also known as evergreen *Pinus wallichiana* A.B jackson tree which is naturally distributed from Afghanistan to all Himalayan region, including, Pakistan, India, Nepal and Bhutan, having altitude ranging from 1800-3900 meters (Singh & Yadav, 2007). Ahmed and Naqvi (2005) and Ahmed et al (2006) described that *Pinus wallichiana* A.B Jackson may grow in moist temperate as well as in dry temperate. This shows the wide ecological amplitude of this species.

Conclusion

In the light of this study, it is concluded that except one stand the other stands are disturbed, unstable and showing varied size class distribution of trees. Most of the stands have low seedlings, less young trees or they do not show signs of seedling recruitment. Anthropogenic disturbances, i.e., illegal cutting, grazing, and sliding, burning, etc., are most familiar in this area. Present practices are threatening and unsatisfactory for the future of this forest. So, proper regeneration activities, management skills and conservation plan should be introduced and applied immediately to rehabilitate and save this valuable forest.

Recommendations

Some suggestions and recommendations to achieve the rehabilitation and conservation objectives are as below;

1. The illegal cutting of trees of all kind of species should be control by the government with the collaboration of local community.
2. Campaigns for the recruitment of seedlings in open canopy forest areas should be arranged.
3. The grazing of livestock should be managed in accordance to the caring capacity of the available area so that the destruction of seedlings can be avoided.
4. Awareness programs regarding to the social, economical and ecological importance of forest should be organized at community level.
5. The other researchers are suggested to investigate the forest further more to explore the challenges for the future of this forest as well as the importance of this forest for the present and future generation.

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