ESTIMATION OF GROWING STOCK IN DRY TEMPERATE FORESTS OF SKARDU, BALTISTAN

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ABSTRACT

The growing stock of District Skardu was assessed through a forest inventory in 2016. The average number of trees was estimated at 85 per ha showing very sparse nature of the forests. Kail is the single dominant species (85.26%) in the forests. In co-dominant species, Fir consists of 5.85%, Juniper 3.9% and Spruce 2.09% of the total trees sampled during the inventory. Birch is the only broad-leaved species recorded during the inventory with 2.89% trees. Diameter class distribution shows that the forest is overwhelmingly young and consists of lower dia classes. Most of the trees fall in diameter classes 05-10 cm, 11-20 cm and 21-30 cm. Stand structure is almost entirely young as most of the trees fall in immature (90.61%) and sub-mature (8.96%) development stages. On the other hand, mature tree are almost absent as only 0.43% of the trees are mature. The total growing stock in the forest of Skardu District is estimated at 73,068 m^3 (2,579,327 cft) with an average of 12.99±2.21 m^3/ha (95% CI). The future growing stock for 2026 is estimated at 143,887 m^3 with average of 25.58 m^3/ha. Annual increment was determined for coniferous species based on the growth rate for past 10 years. It was found that the forests of Skardu District would put in about 70,819 m^3 in the next 10 year. This is equal to annual increment of 1.26 m^3/ha. The results of the inventory show that the forests are poorly stocked lacking mature trees. Thus it is imperative to take steps for conservation of the mother trees and regeneration of the forests.

INTRODUCTION

Periodic growing stock assessment is required to know the condition and productivity of the forest and formulate management plan for the forest. For this purpose forest inventory is carried out for obtaining information on the quantity and quality of the forest resource and the main characteristics of the forest area. Forest inventory is aimed at estimating, growing stock, timber, small wood and annual increment in the forest (Husch *et al*., 1982).

Skardu is part of Gilgit-Baltistan lying in Northern part of Pakistan at 35°17′25″N 75°38′40″E. The total area of the district is 270,279 ha, out of which 5,625 ha which constitute 0.28% of the total area of the district (Ali et al., 2017). The district headquarters is Skardu town which is located at 2,500 metres (8,202 feet) height above sea level. The district is surrounded by the district Astore on

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west, Gilgit on north, China on north east, Ganche on east and Indian Occupied Kashmir on south and south east. The landscape consists of valleys, mountains, rivers and plains. Climate of Skardu is dry and moderate during summer with no monsoon rains. Winter is very severe and rainfall along with snow fall occur. December and January are the coldest months when temperature fall below freezing point (Anonymous, 2017). The population of Skardu District is 305,000.

REDD+ Project of Gilgit Baltistan attempted to prepare an Integrated Resource Management Plan for Skardu. The current study was carried out to collect baseline information for this management plan with the objective to estimate total growing stock, timber and small wood in the forests and project these estimates for future 10 years.

MATERIAL AND METHODS

Simple random sampling was carried out in the forest areas of District Skardu. The forest cover in Skardu District was determined and mapped by GB REDD+ Project based on the on-screen digitization of the Google Earth Image. The total forest area of Skardu was estimated at 5,625 ha which constitute 0.28% of the total area of the district.

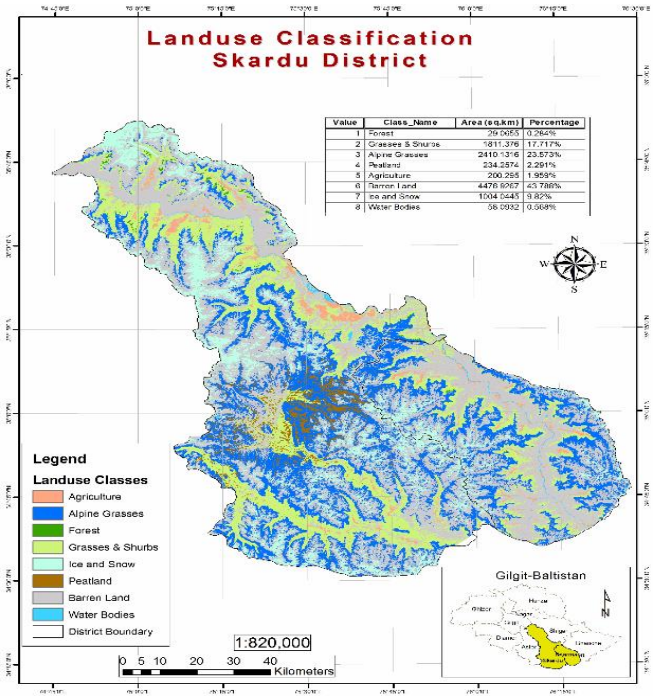

Figure 1. Landuse Map of District Skardu

Sample size for forest inventory was determined using the following formula:

$$N = \frac{(CV)^2 x t^2}{E^2}$$

Where

N= Number of required sample plots
CV= Coefficient of Variation
t= Student t-test value (1.96 at 95% Confidence Level)
E= Allowable Error

It was found that the average growing stock in the area is 12.99 m^3/ ha with a standard deviation of 14.36 m^3/ha. CV was calculated as 110.53% showing large variation in the growing stock in the forest. Based on this data the sample size turned out as given below:

$$N = \frac{(110.53)^2 x 1.96^2}{20^2} = 117$$

Thus a total of 117 plots were required for forest inventory in Skardu with 20% sample error. However 162 sample plots were used for the inventory which is more than the required sample size. Though the sample error is quite high (20%) but still the results of the inventory can be used for assessing the overall condition of the growing stock in the forest.

The sample plots were allocated strata randomly using GIS software. The coordinates of the centers of the sample plots were noted from the geo-referenced map. The coordinates were uploaded onto GPS and navigated in the field accordingly. The distribution of sample plots in the District is shown in the Figure 2.

A team of 3-4 trained foresters conducted inventory in the field. Fixed area circular plots of 17.84 m (0.1 ha area) were laid out in the forests with the help of measuring tape. Slope correction factors were applied to the radius of the plot. In each sample plot, all trees were measured for their girths which were later on converted to DBH. Girth was measured at 1.37 m aboveground on uphill side with a measuring tape.

Data was fed into Excel sheets in proper format. Volume was calculated using the Local Volume Tables and Volume Equations prepared by Pakistan Forest Institute for Gilgit Baltistan (Ali, 2015).

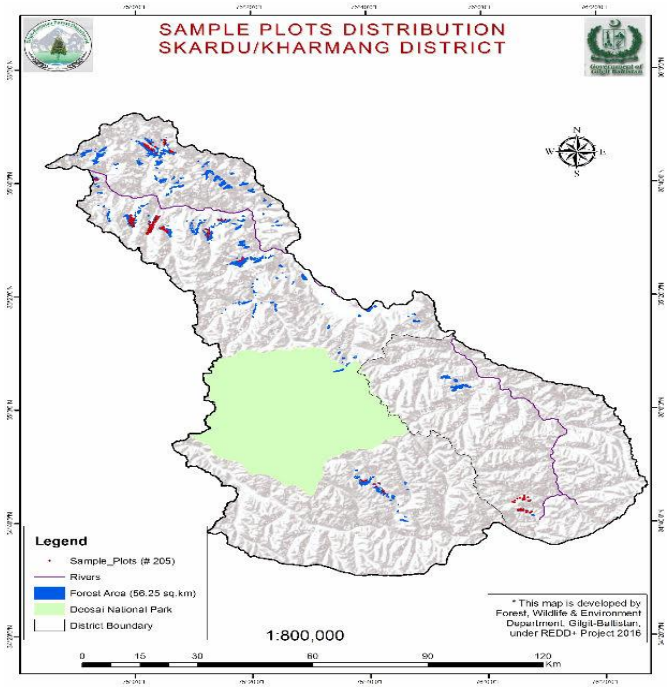

Fig.2. Distribution of Sample Plots in Skardu Forests

RESULTS AND DISCUSSION

Occurrence of tree species

The tree species sampled during inventory consisted of conifers and broadleaved as given in Table 1. The species included Kail, Fir, Juniper, Spruce and Birch. Kail is the single dominant species (85.26%) in the forests. In rest of the species, Fir consists of 5.85%, Juniper 3.9% and Spruce 2.09% of the total trees sampled during the inventory. Birch is the only broad-leaved species recorded during the inventory with 2.89% in terms of trees inventoried.

Table 1. Occurrence of Tree Species

Species	No. of trees sampled	%age
Kail	1180	85.26
Fir	81	5.85
Juniper	54	3.90
Birch	40	2.89
Spruce	29	2.09
Total	1384	100

Growing Stock Composition

About 86% of the growing stock consists of only Kail. Rest of the species contribute little in the total growing stock of the forest as Fir has 5.78%, Spruce 3.88%, Birch 2.57% and Juniper 1.29% share in the total growing stock (Table 2).

Table 2. Growing Stock Composition

Species	Sample Plots Volume (m^3)	%age
Pinus wallichiana (Kail)	181.8	86.47
Abies pindrow (Fir)	12.15	5.78
Picea smithiana (Spruce)	8.17	3.88
Betula utilis (Birch)	5.4	2.57
Juniperous spp. (Juniper)	2.72	1.29
Total	210.24	100

Diameter Class Distribution

Diameter class distribution of the trees sampled during the inventory is shown in Figure 3. It is evident that the forest is overwhelmingly young and consists of lower dia classes. Most of the trees fall in diameter classes 05-10 cm, 11-20 cm and 21-30 cm. Out of total 1384 sample tree, 1322 trees (96%) belonged to these dia classes. On the other hand, only 6 trees occurred in the dia class more than 50 cm.

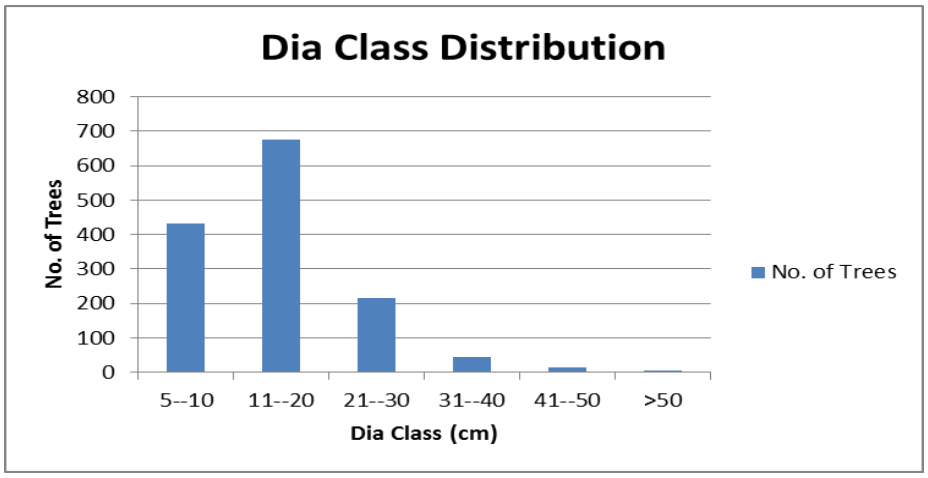

Fig. 3. Diameter class distribution of sample trees

Stand Structure

The dia-class distribution shows that the forest comprises immature trees (Figure 4). Stand structure is almost entirely young as most of the trees fall in immature (90.61%) and sub-mature (8.96%) development stages. On the other hand, mature tree are almost absent as only 0.43% of the trees are mature. Thus the forest is devoid of mature trees and this may cause hindrance in the natural restoration of the forests due to absence of mother trees.

Table 3. Stand Structure

Development Stage	No of trees	%age
Immature (<26 cm)	1254	90.61
Sub-mature (26-50 cm)	124	8.96
Mature (51-75 cm)	6	0.43
Total	1384	100

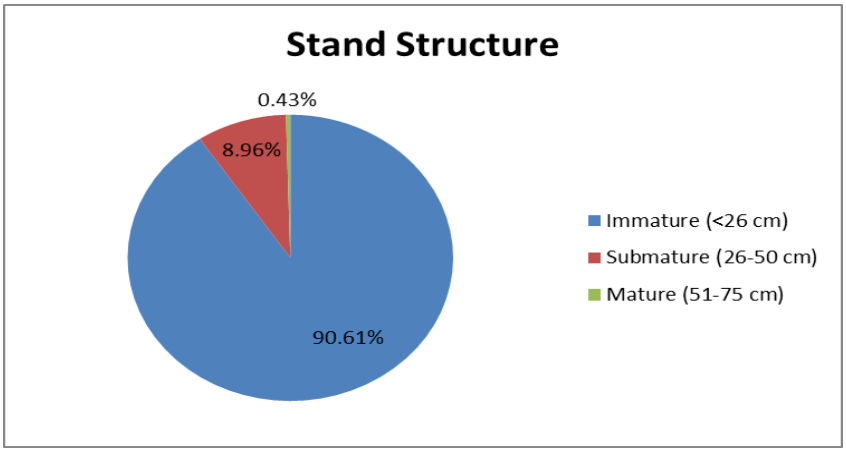

Fig. 4. Stand Structure

Present Growing Stock

The total growing stock in the forest of Skardu District is estimated at 73,068 m^3 (2,579,327 cft) with an average of 12.99±2.21 m^3/ha (95% CI). There is extreme variation in the forest stocking and density. The mean growing stock ranged from 1.17 m^3/ha to 74.73 m^3/ha. In dense coniferous forests and sparse coniferous forests the average growing stocks are 24.73 m^3/ha and 11.00 m^3/ha respectively. In sparse mixed forests, the mean growing stock is 11.17 m^3/ha. This growing stock is significantly lower than the growing stock in the forests of neighboring Astore District which has been reported as 327 m^3/ha (Ali, et al., 2016). This shows that the forests of Skardu District are poorly stocked due to

absence of mature trees and sparse and shrubby nature of the forests. As most of the forests comprise immature and young trees, it can be safely assumed that most of the growing stock consists of small wood with meager timber. The detail of growing stock is given in Table 4.

Table 4. Present Growing Stock

Strata	Area (ha)	Growing Stock (m^3/ha)	Total Growing Stock (m^3)
Dense Conifer		24.73	
Sparse Conifer		11.00	
Sparse Mix		11.17	
Total	5,625	12.99	73,068

Future Growing Stock

Future growing stock was estimated for the area for the next 10 years using growth models of the coniferous species of adjacent Astore District. The future growing stock for 2026 is estimated at 143,887 m^3 with average of 25.58 m^3/ha (Table 5). As most of the forests are young, they put substantial increment and thus the growing stock will become almost double in the next 10 years if natural and anthropogenic disturbances are controlled.

Table 5. Future Growing Stock

Strata	Area (ha)	Growing Stock (m^3/ha)	Total Growing Stock (m^3)
Dense Conifer		55.93	
Sparse Conifer		21.24	
Sparse Mix		13.31	
Total	5,625	25.58	143,887.50

Annual Increment

Annual increment was determined for coniferous species based on the growth rate for past 10 years. It was found that the forests of Skardu District would put in about 70,819 m^3 in the next 10 year. This is equal to annual increment 1.26 m^3/ha. The detail of increment for different strata is tabulated below (Table 6).

Table 6. Annual Increment

Strata	Area (ha)	Total Increment for 10 years (m^3)	Increment (m^3/ha/yr)
Dense Conifer			3.12
Sparse Conifer			1.024
Sparse Mix			0.213
Total	5,625	70,819	1.26

CONCLUSION

The forests of Skardu are poorly-stocked and lacking mature trees. Kail is the single dominant species (85.26%) followed by Fir 5.85%, Juniper 3.9% and Spruce 2.09. Birch is the only broad-leaved species recorded during the inventory with 2.89% trees. Diameter class distribution shows that the forest is overwhelmingly young and consists of lower dia classes. Most of the trees fall in diameter classes 05-10 cm, 11-20 cm and 21-30 cm. Stand structure is almost entirely young as most of the trees fall in immature (90.61%) and sub-mature (8.96%) development stages. On the other hand, mature tree are almost absent as only 0.43% of the trees are mature.

The total growing stock in the forest of Skardu District is estimated at 73,068 m^3 (2,579,327 cft) with an average of about 13 m^3/ha. This is significantly lower than the neighbouring Astore District where growing stock is 327 m^3/ha. The future growing stock for 2026 is estimated at 143,887 m^3 with average of 25.58 m^3/ha. Annual increment was determined for coniferous species based on the growth rate for past 10 years. It was found that the forests of Skardu District would put in about 70,819 m^3 in the next 10 year. This is equal to annual increment of 1.26 m^3/ha. This shows that the forests of Skardu District are poorly stocked due to absence of mature trees and sparse and shrubby nature of the forests. As most of the forests comprise immature and young trees, it can be safely assumed that most of the growing stock consists of small wood with meager timber. Thus it is imperative to take steps for conservation of the mother trees and regeneration of the forests.

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