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PREDICTING THE PRESENT GROWING STOCK FOR THE NEXT TEN YEARS KEEPING IN VIEW THE DEPENDENCY OF LOCAL COMMUNITY IN KARAKER FOREST SWAT

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Abstract: Accurate, precise and updated knowledge about forest growing stock facilitates forest manager in the in the context of timber-oriented forest management. In this study, the present growing stock parameters (2014) were measured and predicted for the next ten years (2024) by keeping into consideration the annual demands of the local community. For the measurement of growing stock, a study test site namely Barikot planning unit located in the Karaker forest of district Swat of Kyber Pakhtunkhwa (KPK), Pakistan was selected. A systematic sampling approach was adopted by covering 2.5% of the test site area for the measurement of growing stock. The dependency of the local community on forest resources was assessed with 25% sample intensity in the Karaker village with the help of a questionnaire. The results show that average present tree density, basal area and volume at 2014 was 18 trees hac^{-1}, 1.3 m^2, and 15.19 m^3 respectively. After applying movement ratio formula for the prediction of growing stock for the next ten years (2024) the average present tree density, basal area, and volume were decreased to 14 trees hac^{-1}, 1.2 m^2 and 13 m^3 due to annual local demand of the community. Similarly, the average tree density 31 trees hac^{-1}, basal area 2.71 m^2 hac^{-1} of the regeneration at 2014 will be decreased to 23 trees hac^{-1} and 25 m^3 at 2024, respectively. The findings of the study indicated that forest resources of Karaker forest are notably declining due to the ever increasing demands of local population and hence need protection and conservation. The present study will be useful for the planning and scientific management of forest growing stock of the study area on a sustainable basis.

Keywords: Forest inventory; growing stock; movement ratio; socioeconomic; subtropical chir pine forest.

Introduction

Form ancient time, people get benefited and prospered from earth plenty resources. The population is on high growth rate, but resources are not. Forest provides goods and services like timber, food products (Honey, berries, Mushroom etc.) and forage. A forest also gives socioeconomic benefits, such as employment, products, sites protection of cultural value (FAO, 2006). It provides, the growing stock .i.e. the productive part and the growth. Growing stock may be defined as volume taken over bark of forest trees (living) above 30 cm in diameter at breast height. It

estimated the stem from ground or stump height up to maximum diameter of 1cm, and includes branches (diameter of 5 cm). While commercial growing stock means that under current market conditions with a diameter of 5 cm at Diameter at breast height (dbh) or above stem or branches are considered. (FAO, 2010). For sustainability, however, progressive activities must balance ecological and socioeconomic factors. Forests are unique for balancing the socioeconomic, ecological challenges because their renewability (*The Guardian*, 2011). Forests also play important role in carbon sequestration, storing 289 tons of carbon in their standing biomass (FAO, 2010a).Total forested area of the world is about four billion hectares (ha), which is 31 percent of the earth surface. This forest estate supports a US$224 billion global market for timber and timber products (FAO, 2012) and produces a wide variety of other social, cultural and environmental benefits and services that are important for human well being and survival. Forests play a key role in a sustainable and prosperous future (FAO, 2010). The growing stock, in forest resources management is important parameter. The Growing stock characteristics are tree parameters i.e. tree height, age, volume, forest structure, composition, density and bark included of forest. For assessing the above ground biomass the growing stock is a major predictor (Hame *et al.,* 1992).And also play central role for estimating the compartments(Jenkins *et al.,* 2003) or biomass above the ground (Somogyi *et al*., 2008), which is the basic forest mating the net carbon dioxide exchange between the atmosphere and land surface. Forest volume of growing stock is useful in terrestrial modeling models (Beer *et al.,* 2006), but also for inversely estimating parameters of biosphere models (Carvalhais *et al.,* 2010; Williams *et al.,* 2005). Forest growing stock is obtained by measuring diameter at breast height at sample plots through intensive measurements. Kindermann *et al.,* (2008).

The Ministerial Conference on the Protection of Forests in Europe defined sustainability criteria which cover all aspects of forests i.e. economic, ecological and social, and all related indicators that can be used for sustainability assessment to measure the state of forests For example, the volume of the growing stock, tree species composition and volume of standing clearly in this category, provided that models exist for such predictions. One of the indicators directly demands that “forest management planning enhances sustainable management and use of forests” (MCPFE 2002). A number of forest growth and yield prediction models have been developed to predict forest growing parameters (Fontes *et al*., 2010). Many countries developed Growth Yield Models that predict the total carbon content of the tree stock from variables measured or predicted with GYMs (Lehtonen et al. 2004, Eriksson et al. 2007; Calama et al. 2008), In Spain a special network of Permanent Inventory Plots (PIP). Data from these plots have been used for growth and yield modeling purposes providing detailed and representative data for future predictions, these measurements are useful for model development and predictions are made on the basis of these plots to the whole forest. (Pettersson and Melin 2010). The most common method used to predict forest variables with ALS data is the area based approach, which converts 3D point clouds into metrics useful as independent variables in predicting forest characteristics (Næsset, 2002; Næsset et al., 2004). In tactical forestry planning, information about all stands within the management region is

required (Duvemo *et al.,* 2014). Accurate information of the current state of the forest resource is important for planning silviculture measures (Barth, 2008). The main reasons for using subjective field inventory methods is because they are cheap and fast, and method of objective field inventory is costly expensive to measure all stands (Holmgren, 2004). Commonly for forest variables predictions linear regression analysis is used. (Maltamo *et al.,* 2006a). Other scientific methods like ALS, but field plots give better accuracy than most other inventory methods that predicting stand variables and (Holmgren, 2003; Eid *et al.,* 2004). Objective field inventories are costly component of remote sensing predictions (Means et al., 2000; Næsset, 2007). Growth estimation via "movement ratios" was measured diameter class intervals and also increment, giving the correct example correctly predicts that 30, 50 and 20% of trees move 0, 1 and 2 classes, but the movement ratio approach predicted 6, 94 and 0% respectively (Husch *et al.,* 1982). The purpose of the present study was to assess the forest resources to get sustainability. Before any decision the accurate measurement of growing stock is necessary.

Materials and Methods

Swat forest range covers 97,339 ha. It is divide into the following planning units, which are small units comprising of a major valley or continuation of sub valleys or small valleys, within a planning area. Planning units are: Barikot PU, Marghuzar PU, Charbagh PU, Miandam PU. Barikot planning unit comprises the Barikot valley which is the southernmost valley of Swat forest range its central town is Barikot. The study was conducted in Karaker valley which lies in Barikot planning unit. The forest was Chir pine forest and it is protected forest and lies in the Barikot valley. The Karaker forest provide main route to Buner from Barikot. It lies in the subtropical sub humid zone. Most of the area receives rainfall 625-800 mm in summer monsoon. Area above 1500 m receives snow but it melts rapidly up to 2000 m elevation. The Karaker forest is partly managed by the local community and the elevated top forest is managed by forest department, total area taken for research study was 957 hectares and the overall management responsibility is however with swat Forest department, government of KPK, There was scientific management tools in the form of working plan have been made for the period of 2000 to 2014. (Forest Resource management plan Swat 2002-2014). There were Approximately 300 houses living in the Karaker forest and they have dependency upon the forest resources. The study area fall in the southernmost part of the Swat (Figure. 1). Growing stock data was collected from three different working circles, Compartment (C. No.37) from conservation working circle, three Compartments (C.No.34,35,36) from community use working circle, two Compartments (C.No.38,39) from tourism working circle of the study area. The present density (No. of trees.hac^{-1}) was estimated from diameter classes (12-64 cm). Forest tree density of Chir pine (tree.ha−1) was estimated in Karaker forest whose management was our prime objective in comparison to 192 tree.ha−1of a standard forest. Similar study was conducted about present number of trees against each mid diameter class and estimated that there are 160 trees of Chir Pine (*Pinus roxburghii)* tree.ha−1in the Ghoragali Forest Sub Division (Nizami 2003).

The relationship between average tree density and diameter was statistically analyzed by

linear regression and correlation, and found negative correlation with value of co-efficient of determination (R^2) equals to R^2=.723 and r = -.850 (Correlation is significant at the 0.01 level). Abdul Raqeeb *et al.*,(2014) studied the density of the temperate forest in which the density of two species, Deodar average 26 tree.ha−1, Chalgoza 4 trees.ha−1, they plot the tree density (No. of trees.ha−1) against the diameter by allometric equations and linear quadratic relationship. The density of trees.ha−1 was maximum that the forest is in the mature stage (Hussain, 1984; Fatime and Hussain, 1984). Chandra *et al*., (2010) found thatupper west Himalayan is dominated by *Abies pindrow* forest and *Cedrus deodara* (moist) forest had maximum total density as compared to other forest types in the Himalayan region of Pakistan and India. They calculated the total tree density of 507 and 447 trees.ha−1 in two types of forest.

Sample and data collection

For measurement of growing stock systematic sampling techniques with 2.5% sample intensity was used for Karaker forest.. For the assessment of growing stock the circular plot size (r=17.84 m) used and (r= 5m) was used in the same circular plot for regeneration. Sample plot Size was taken $1/10^{th}$ of the hectare. Plot to plot distance was (204 m) calculated. For growing stock data collection a total 240 sample plots were taken systematically of 957 hectare in study area From each plot growing stock parameters i.e. tree diameter (cm),tree height (m) , tree age (yr) and Mean annual increment (cm) estimated of those trees having diameter 12 cm and above at breast height (dbh; at 4.5 ft from ground). Diameter tape, Measuring tape, Pressler borer, Spegial Reliscope, GPS instruments were used for field inventory. For volume estimation formula [Volume (m^3) = $\pi D^2/4 * Ht * FF$] was used. All the relevant information of the forest resources was taken through questionnaire with 25% sample intensity in the study area. A total of 75 houses out of 300 were communicated randomly in Karaker forest. Present and future stand table were prepared by using the “Stand Projection Table Method” of Davis (1966). Data was statistically analyzed by correlation and linear regression through Excel 2007, and SPSS 16 version.

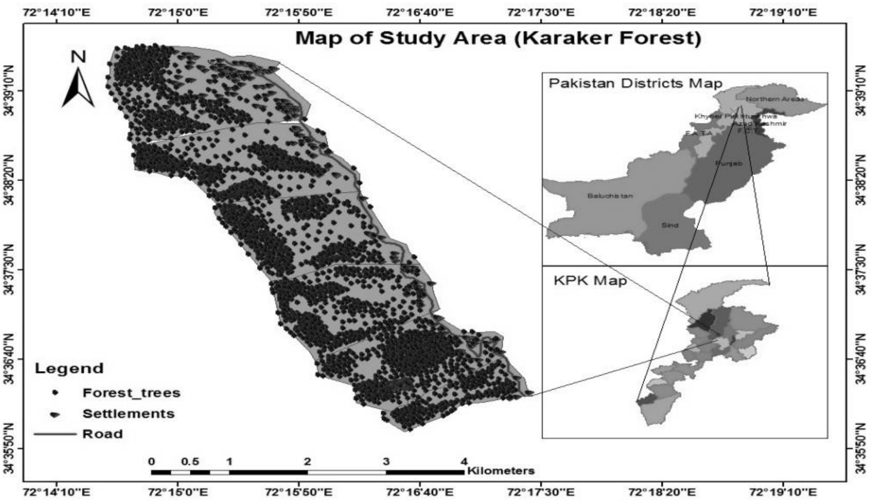

Fig.1. Map the study area of Karaker forest.

Results and Discussion

Analysis of Growing Stock

Forests have two important productive sites, one is the growing stock and the other is site quality. The analysis of the growing stock is very important it show the potential productivity of the area.

Density of Present Growing Stock of Chir pine

The present growing stock data was estimated for Chir pine forest in 240 sample plots , in which 190 sample plots lied in forested area, and 50 sample plots were blank and agriculture land of six.

The present density (No. of trees·hac⁻¹) in different diameter classes (12-64cm) were calculated average18 tree·hac⁻¹and average (6) seedlings/plot in the six compartments. The total average numbers of tree were counted for each diameter classes (12-64 cm). Total average numbers of trees were 1314 (Table.1). Maximum number of average trees (880) was present in diameter classes of 12-28 cm. The forest tree growth was in the pole stage. Numbers of trees (434) were present in diameter class of 30-64 cm given (figure.2). Similar study was conducted and found that the maximum dbh was 200 cm and the maximum height was 36 m for the diameter distribution, highest proportion (41%) of tree. ha−1 belong to the (20-29 cm) while only 1% were found to greater than 100 cm, because the growth of the forest was mostly in the pole stage (Andekunl, 2007).

Table 1 Average present number of trees in various diameter classes (12-64 cm)

DBH (cm)	**P # of trees**	**DHH (cm)**	**P # of trees**	**DBH (cm)**	***P # of trees***
12	153	30	36	48	30
14	132	32	32	50	32
16	112	34	26	52	31
18	93	36	22	54	28
20	67	38	26	56	22
22	132	40	28	58	12
24	66	42	30	60	10
26	73	44	31	62	3
28	52	46	32	64	3
Total (12-28cm)	**880**	**Total (30-64cm)**	**263**	**+ 434**	**171**

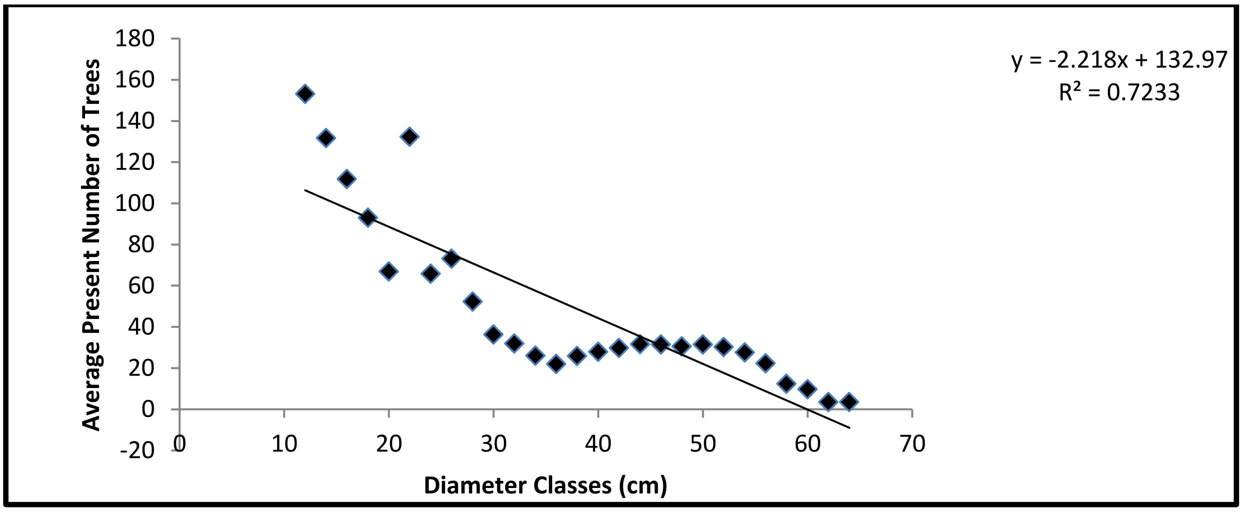

Fig.2. Relationship between diameter Classes (cm) and Average Present number of trees of *pinus roxberghii* (Chir).

Present basal area of chir pine

Present Basal area of Chir pine (*Pinus roxburghii*) crop was 1.30m^2.ha−1 calculated in diameter range 12-64cm.The total average Basal Area of the above six compartment was 95 m^2.The basal increases with increase in diameter classes (Table.2). The present study gave low average basal area 25.5m^2 in the diameter classes ranges from (12-28 cm) and calculated high basal area 69.6 m^2 in the diameter classes ranges from (30-64cm). The relationship between average present basal area (ha−1) and their diameter classes was statistically analyzed by linear regression and correlation relationship and it was found R^2= 0.110and r = .332 (Correlation is significant at the .091 level (Figure. 3), the positive sign show that with the increase of one variable the other variable also increases(Figure 2). To compare the present study Matti Maltamo, (1997) studied the pine forest and the results obtained were overestimates for Norway spruce and underestimates for Scots pine. The models for these parameters were derived using regression analysis, and found the relationship between the basal area and median diameter for pine was 18 m^2.ha−1 and 32 cm, for spruce 12 m^2.ha−1 and 25 cm, and for broadleaves 4 m^2.ha−1 and 18 cm. For the entire growing stock, the basal area median diameter was 29 cm. The results in comparison with the present study showed that the basal area of the higher diameter classes were maximum, calculated the relationship of the pine spruce, and broad leaved with different diameter classes and their growth rate.

Another similar study was conducted about the basal area variation of sample plots, were separated to diameter classes by 4 cm width, and calculated mean basal area 58.71 m^2.ha−1 for 26 plots, and found variation in basal area, the data analysis show significant correlation between diameter classes and basal area (Ramazan and Ozcelik 2008). Alkan Günlü1(2014) calculated Stand volume, basal area and dominant height ranged from 47.24 m^3.ha−1 to 873.66 m^3.ha−1, 5.34 m^2.ha−1 to 76.46 m^2.ha−1 and

7.26 m to 32.65m , respectively. The mean stand volume was 445.03 $m^3.ha^{-1}$(standard deviation=173.29), the mean basal area was 41.98 $m^2.ha^{-1}$ (standard deviation=14.95) and the mean dominant height was 21.01 m (standard deviation=5.00. The study was to find the relationship of tree parameters by using different regression models and prove that prediction of stand parameters better in Artvin-Genya Mountain forest areas.

Table 2 Relationship between diameter classes and present basal area

DBH (cm)	P. Basal area (m^2)	DHH (cm)	P. Basal area (m^2)	DBH (cm)	P. Basal area (m^2)
12	1.73	30	2.62	48	5.6
14	2.02	32	2.62	50	6.33
16	2.24	34	2.4	52	6.55
18	2.36	36	2.27	54	6.43
20	2.09	38	2.97	56	5.58
22	5.02	40	3.62	58	3.33
24	2.97	42	4.19	60	2.75
26	3.88	44	4.89	62	1.05
28	3.22	46	5.33	64	1.12
Total (12-28cm)	**25.5**	**Total (30-64cm)**	**30.9**	**+ 69.6**	**38.7**

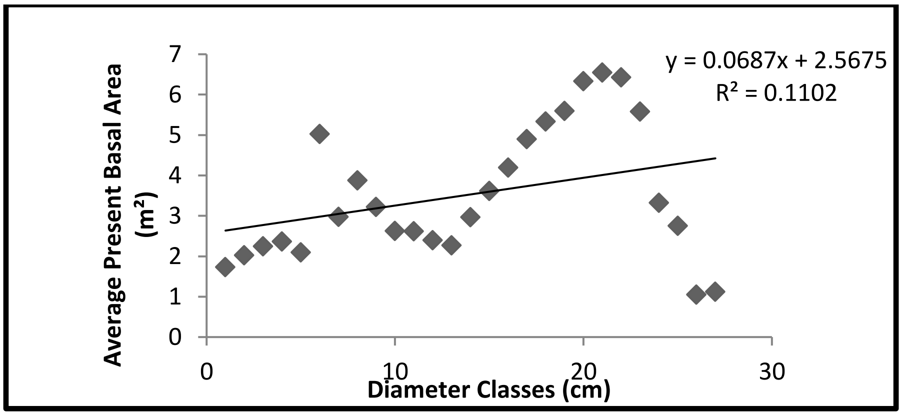

Fig.3. Relationship between diameters Classes (cm) and Average Present basal area trees of *Pinus roxburghii* (Chir)

Present volume of chir pine forest

Average present volume 15.19 $m^3.ha^{-1}$of Chir Pine (*Pinus roxburghii)* was estimated in the Karaker forest. The total average volume of the total study area was 1104 m^3. In the diameter range (12-64 cm) the volume of the initial diameter classes ranges (12-28 cm) was 273 m^3 and 831 m^3 in the diameter classes ranges from (30-64 cm) (Table. 3). The volume was calculated less in the lower diameter classes as compared to higher diameter classes because the volume depends on the diameter and height of the forest crop. The linear regression and significant correlation relationship was found R^2= .101 and r = .319 (Figure.4).

Martinez Pastur, (2008) calculated that variation in stand growth ranges from 1 and 20 $m^3.ha^{-1}.yr^{-1}$. The study was to calculate the growth rate upto 20 years. During the last twenty years the growth value were calculated to suit the model, considering total volume increment/basal area ratio as an independent variable. In relation to site quality and stand age, stand growth model gives a ratio between volume increment and basal area.

Similarly Milan Saniga, (2014) studied three different sites (Bokey, (Bujanov) Kasivarova) the highest long-term mean stem density (151ha^{-1}) was reflected the most differentiated structure and the basal area and growing stock were the lowest stand (site)1.4 $m^2.ha^{-1}$ and 22 $m^3.ha^{-1}$, respectively. In the past the forest (Bujanov) severely affected maximum basal area was calculated 20% (2.1 $m^2.ha^{-1}$) and the Mean basal area was higher by and that of growing stock by 83% (49 m^3. ha^{-1}) as compared with the Boky reserve. The dead wood volume was higher by three times in the site (Kasivarova) with human impacts as compared to the old growth forest in Boky. He concluded that the human impacts on natural reserves showed uniform stand structure, as estimated significantly by higher stem basal area and lower stem density and growing stock.

Martinez Pastur (2006) in Tierra del Fuego, In a low site quality it is possible to calculate low *TVI* (1.1 m^3/ha/year), and maximum (20.0 m^2/ha/year) in a good site quality and young dense stands. The study concluded that good site quality gave maximum volume per ha as compared to low site quality.

Table 4 Diameter classes and presents Volume of the study area

DBH (cm)	P. Volume (m^3)	DHH (cm)	P. Volume (m^3)	DBH (cm)	P. Volume (m^3)
12	13.5	30	35.6	48	64.5
14	17.5	32	37.3	50	101.1
16	20.5	34	35.4	52	54.5
18	22.5	36	35.1	54	57.5
20	21.5	38	40.8	56	46.7
22	54.3	40	36.3	58	31.8
24	34.1	42	65.08	60	54.7
26	47.6	44	57.8	62	8.81
28	41.6	46	58.8	64	9.17
Total	**273**	**Total**	**402**	**+**	**428**

(12-28cm)	**(30-64cm)**	**831**

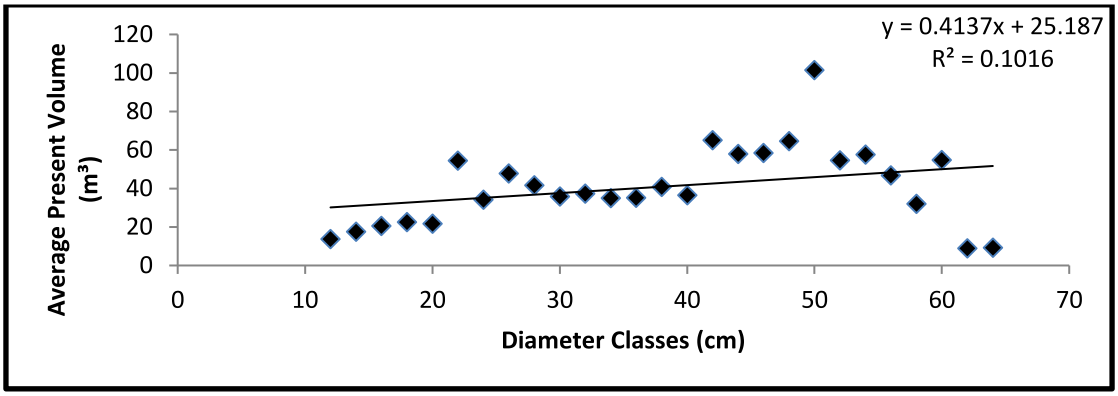

Fig.4. Relationship between diameters Classes (cm) and Average Present volume trees of *pinus roxberghii* (Chir).

Future prediction of trees density after ten (10) years

The average future numbers of trees were 31 trees.hac^{-1} by using stand projection model for Karaker Forest. The total average future numbers of trees was estimated (2260) for the next ten years (2024) in the study area of karaker forest in the diameter classes of (12-64 cm) in Table. 4.Stand projection table showed that within the various diameter classes the shifting of the number of trees due to different conditions of the MR%(movement ratio formula) results. Projection Table Method given by Davis (1960) was adopted. Movement ratio (%) was estimated for each diameter class and found the average future Number of trees (2260) in the next ten years (2024) for Karaker forest. The relationship between average future number of trees and their diameter classes was statistically analyzedR^2= .714 and r = -.845 (Correlation is significant at the .000 level) in (Figure.5).

Mehtatalo, (2007) selected data set of 213 plots and only two were taken in the Scots pine stands. He predicted stand parameters (density, volume, height) and found various results, three observations were taken to predict tree density (true density 668 and predicted 799), (true density 1336 and pred 1365),(true 707 and pred 953) and in the diameter upto (35 cm), height upto (20 m).This study considered stand description in Sots pine stands. It was assumed that it is known prior to prediction that these forests are pure pine stands (pine proportion of volume over 90%).

Simerda L. (2011), summarized the main characteristics of a mixed stand during 80-year. The initial main stand was mostly composed of conifers. And also broad leaved in less numbers as compared to conifers in 1928. Due to various operations the tree density of conifers decreases and broad leaved increases upto 2008.

Table 5 Diameter classes and Future number of trees

DBH (cm)	F # of trees	DHH (cm)	F # of trees	DBH (cm)	F # of trees
12		30	106	48	61
14		32	76	50	65
16	159	34	47	52	63
18	252	36	40	54	60
20	209	38	49	56	48
22	238	40	48	58	31
24	149	42	60	60	22
26	194	44	62	62	9
28	141	46	63	64	8
Total (12-28cm)	**1342**	**Total (30-64cm)**	**551**	**+ 918**	**367**

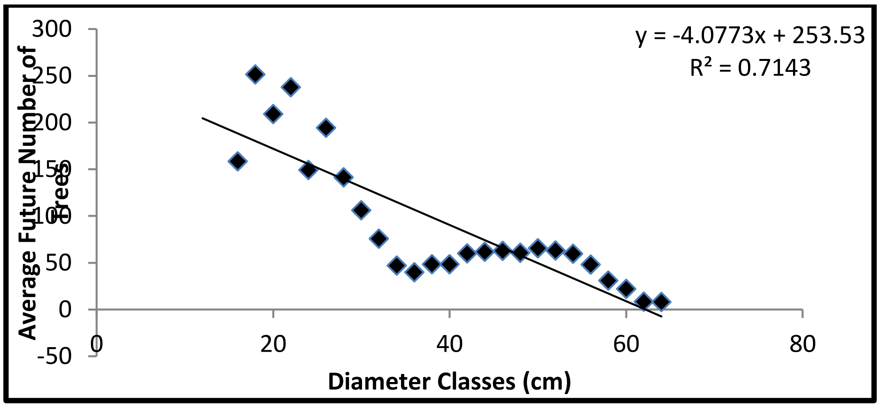

Fig.5. Relationship between diameters Classes (cm) and Average future number of trees of *pinus roxburghii* (Chir).

Future basal area

Future Basal area of Chir pine forest was calculated 2.71 m².hac⁻¹ of trees having diameter classes range (12-64 cm) at breast height. The total average future Basal area was calculated 197.7 m².Upto the diameter range (12-28 cm) the basal area was calculated 50.9 m², and 146.7 m² was calculated of the diameter range of (30-64 cm) shown in(Table.5).The relationship between average future basal area and their diameter classes was statistically analyzed by line arregression and correlationR^2= .040 and r = .201 (Correlation is significant at the .335 level) in (Figure. 6), Hannu and Hokka (1997) calculated basal area growth for the following two growth periods (1-5, 6-10 yrs) was predicted. Bias (with a constant correction term) was estimated for both periods and was expressed as a function of the initial diameter. The average bias in the test data was positive for the first period and negative for the second period (5.766 and -4.216 cm2/5yrs with standard errors of 0.324 and 0.299, respectively).Models for birch and

spruce were used in a similar manner to predict growth in the test data. The average bias in basal area growth for birch was 1.79 cm2/5 yrs (s.e. 0.361), and -2.72 cm2/5 yrs (s.e. 0.385) for spruce. When expressed as a function of tree diameter, the birch model produced both under- and overestimates of growth.

Caldwell M. K. (2013), study was conducted to forecast the basal area, four primary species (lodge pole pine, Engelmann spruce, subalpine fir and quaking aspen) were present under conditions, (controle, pine mountain beetle and fire) in stands in 2010: this study discusses the variability of basal area under the following three conditions. Dominated by lodge pole pine, mid basal area 27.1m². ha−1. Mountain pine beetle conditions were based on the measurement of field data. Lodge pole pine tree basal area and tree density had much difference, ranging as maximum 1400 tree.ha−1 and 34.1m². ha−1 in spite of beetle mortility. The median tree basal area and tree density of dead lodge pole was 550 tree.ha−1 and 21.2m².ha−1, respectively. Minimum numbers (up to around 590 to 3410 tree. ha−1) of subalpine fir and Engelmann spruce were calculated 14 and 13 out of 97 plots, respectively. Aspen pine calculated in 13 out of 97 plots in 2010–2019, but the relative sapling density was maximum (around 2700–18 500 tree. ha−1;) in the sample plots. In the control site the lodge pole median tree density gradually become low and increased in basal area gradually in the period of 200 year. In the mountain pine beetle scenario, the density of lodge pole pine increased up to 2110, after that it declined; the basal area gradually increased at a rapid rate over time. Density of Lodge pole pine tree was significantly low in the case of mountain pine beetle as compared to the control site upto 2060, but counted similar later on; basal area calculated remain low until 2110. Relative to the pre-outbreak conditions (i.e., 2010 in the control site), in 2090 the tree density and basal area of lodge pole pine backed to pre-outbreak levels.

Table 6 Diameter classes and Future Basal Area

DBH (cm)	F. Basal area	DHH (cm)	F. Basal area	DBH (cm)	F. Basal area
12		30	7.68	48	124.7
14		32	6.24	50	239.8
16	3.18	34	4.32	52	106.8
18	6.4	36	4.14	54	114.9
20	6.57	38	5.59	56	102.2
22	9.64	40	6.25	58	75.3

24	6.75	42	8.46	60	124.9
26	10.31	44	9.59	62	21.4
28	8.70	46	10.62	64	20.9
Total (12-28cm)	**51.55**	**Total (30-64cm)**	**62.89**	**+ 993.79**	**930.9**

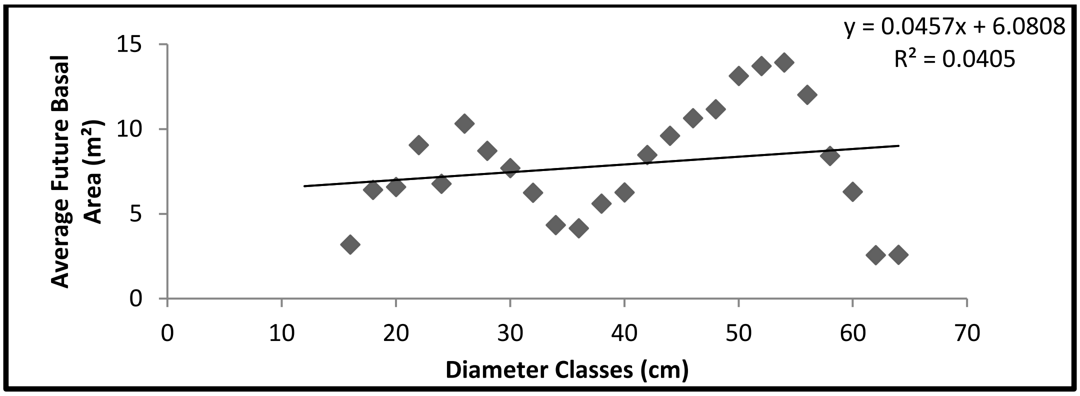

Fig.6. Relationship between diameters Classes (cm) and Average Future basal area trees of *pinus roxberghii* (Chir).

Expected future volume of the growing stock

Calculations for expected future volume and found that there was30 m³.ha−1 expected future volume of Chir Pine (*Pinus roxburghii)*per hectare in the Karaker forest. Maximum volume was 1711.8 in diameter range (30-64 cm). The minimum was 509.3 m³ in lower diameter classes (12-28 cm) in (Table.6), (Figure. 7). Total expected future volume 2223 m³ in the different diameter classes. The data is statistically analyzed in which the average number of trees in each diameter class was 82.34 ±0.574 while the other values of Standard Deviation, Correlation and t-test statistic were 48.89 (P <0.123), 0.383 (P = 0..049) and -4.4823 (P = 0.0000408847) respectively. Nizami (2003) find out the number of existing tree in Sub-Division of Ghoragali Forest Murree with an average number of trees was 10557 ± 4.046 and Standard Deviation value was 7659 (P <0.005), they applied Stand Projection Table (MR %) for future number of trees.

Marko Debeljak (2014), Predictions of growing stock for the decade 2010–2020 suggest that Slovenian forests will continue to accumulate their growing stock (private owned forests to 327 m^3/ha and state owned forests to 343 m^3/ha in 2020). The presented data mining approach that was here applied to the growing stock can also be used for investigating other ecological indicators.

Table 7 Diameter classes and future volume

DBH (cm)	F. Volume (m³)	DHH (cm)	F. Volume (m³)	DBH (cm)	F. Volume (m³)
12		30	93.9	48	124.7

14		32	86.9	50	239.8
16	29	34	64.1	52	106.8
18	55.8	36	40.8	54	114.9
20	60.6	38	72.9	56	102.2
22	85.7	40	70.8	58	75.3
24	69.9	42	116.7	60	124.9
26	108.7	44	115.9	62	21.4
28	99.6	46	118.9	64	20.9
Total (12-28cm)	**509.3**	**Total (30-64cm)**	**780.9**	**+ 1711.8**	**930.9**

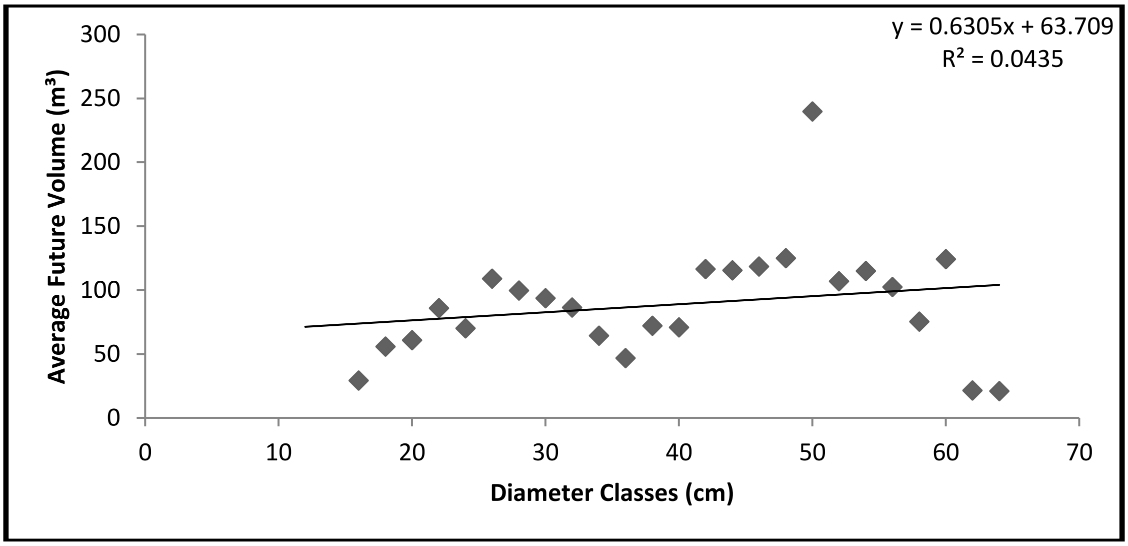

Fig.7. Relationship between diameters Classes (cm) and Average future volume trees of *pinus roxberghii* (Chir).

Local Community Demand for Timber and Fuel Wood.

Present demand of timber (trees) of local community from Karaker Barikot forest.

Data analysis revealed that 100% perception was that, the 300 houses have rights to get 6 m³ of standing volume per capita from the Karaker forest on the basis of new houses construction (4%) and annual repair (2%) of houses. The present demand in year was 353 trees of diameter 18cm from present total number of trees. The total number of trees demand for fuel was 737, which was deducted from diameter classes 12, 14, 16 cm. The total present fir damage was 90 trees in six compartment of the study area were calculated. The average volume of the above diameter classes was (.3m³/tree) calculated and deducted. At 4% construction rate (N=12) new houses were added to 300 houses per year, and 2 % (N=6) were repaired annually, the total number of tree (353) were calculated for present demand year. The total

average present number of trees were (1314)18 trees·hac^{-1}, but due to total timber, fuel wood and fire damage deduction it remains (1034) 14 trees·hac^{-1}. The total present timber requirement was 108m^3 for the present year on the above conditions.

Future demand of trees (Volume, Timber) of local community from Karaker Barikot Forest

Data analysis revealed that at 2.7% rate of the population increase the number of people were calculated for next 10 years 420 (N= 3429) houses, and 120 new houses were calculated. At 4% new houses construction and with the growth of 2% repair, the total timber for future was 1080 m^3 on the basis of (6m^3) calculated for next ten years. The total requirements of trees for future were estimated and the trees will drop from 30trees·hac^{-1} to 23 trees·hac^{-1}.

Present Fuel Wood Requirements of the local community

A total of 70% of the population (210 Hs) of the local community were depended on the forest for their fuel wood requirement. Average 20 kg wood was used per capita for cooking; 7200 kg of fuel wood was calculated for 210 houses. One (1) kg of wood is equal to .00042m^3. Total fuel wood demand was 1512000kg (635m^3) for the present year and the rest 30% population was depended on other sources of energy.

Similar study was conducted and found that the community dependency and importance of Bankariya was high on forest resources. In Bankariya 13 respondents i.e. 31 percent respondent said that forest resources are very important, 54 percent perception was that forest resources uplift the socio economic conditions, while 15 percent perception were opposed. The survey showed that the Bankariya community was dependency on forest resources for the uplifting the socio economic conditions. (Gautam, R. 2014).

Future Fuel Wood Demand

The future demand of fuel wood was calculated, for 70 % of the 480 houses, and found that future fuel wood demand 2419200kg (1060m^3) calculated at 4% new houses construction (figure.9).

Present Fire damage trees in the Karaker Barikot forest

Data analysis revealed that 60% of the population perceptions about forest fire damage trees were average 15 per compartment. In six compartment of the study area estimated fire damage was 90trees in 957 ha area of diameter 12-20 cm (Figure. 8). Total averages volume loss was 10.5 m^3 per year in summer. Comparative study results found that in fire prone forest, total growing stock, increment, and distribution of biomass is influenced by fire frequency and intensity (Joshi, *et al.*, 2008).The growing stock in north-western site was high (62.54tree.ha-1and 49.93tree. ha-1) as compared to the south-western forest (9.47 tree.ha-1 and 38.54 tree. ha-1) respectively. Tree biomass decreases in south-western aspects more Community because fire frequency was every year as compared to northern site.

Future Fire damage trees in Karaker Barikot forest

Future number of tree were calculated and it was found that about 900 trees in lower diameter classes (16-22) will be damage in the next ten year and estimated 100 m^3

(Figure. 9), volume will be lost from the Karaker Barikot forest.

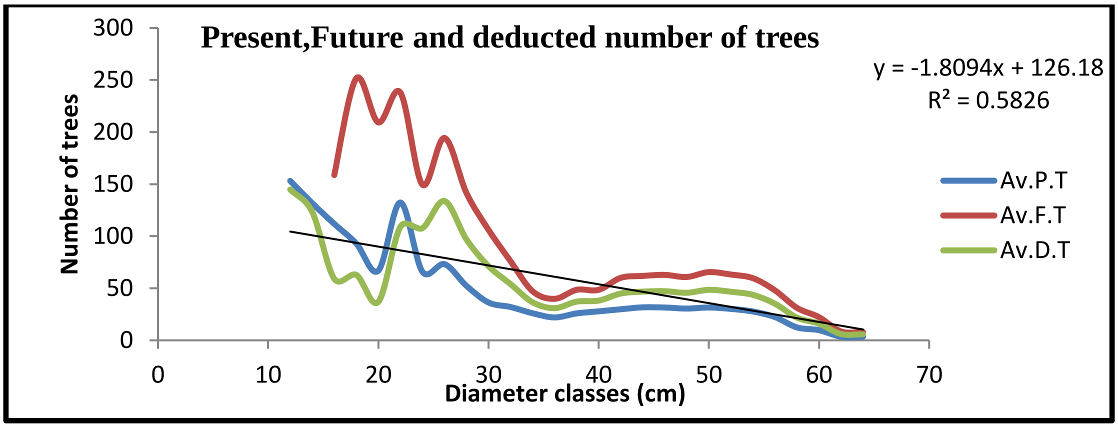

Fig.8. Show relationship between Diameter classes and number of trees

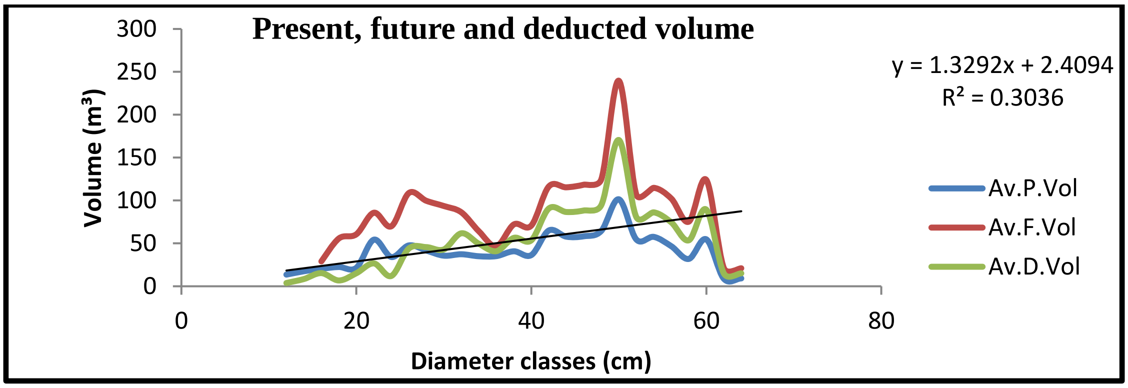

Fig.9. Show relationship between Diameter classes and number of trees

Role of Local Community in Management of the Forest Resources

Protection of forest resources by share holders (inhabitants)

Survey revealed that 70% of respondents stated that the inhabitants in the forest have positive impacts in the management of forest resources up to some extent. Small part of the forest was given to the local forest villagers to protect it from being damaged. The role of local community (forest villagers) was satisfactory in controlling the forest resources, they used it wisely. According to an old (Jalander) inhabitant in the compartment no 39, two trees can replace the vegetation quickly of the entire compartment, it was observed that the site has great potential but it need attention.

Stall feeding as compared to open grazing of the some forest villagers

According to survey report 20% respondents said that Some forest villagers avoid to graze livestock inside the forest or bring the grasses either from the forest, sometimes they cut and store the grasses for the next coming season or either their livestock were depended on their agriculture fodder, as compared to the open grazing in the forest. It was best approach towards sustainability, because the damage to the forest resources as compared to open grazing of live stock in the forest was less.

Artificial Regeneration

According to the survey 90% of the people have great interest to regenerate the blank area inside the forest, they have about 30 hectares blank area and they want to regenerate it but there was no availability of seedlings, according to Sanuber (Temporary supervisor of regeneration workers 2010 of Karaker forest) said that if forest department provide seedlings we will plant it without any charge from department, and he also stated that we have best potential sites for regeneration. Unfortunately there was no technical or material input from forest department.

Similar study was conducted that people of Khwrba (Indonesia) were not only not dependent on forest resources for their food. They have also a contribution to protect local biodiversity; the depended community also has contribution in the management of forest resources. (Lawrence and Sheil 2004). They were interested to have their access to forest resources and protect them from outsiders.

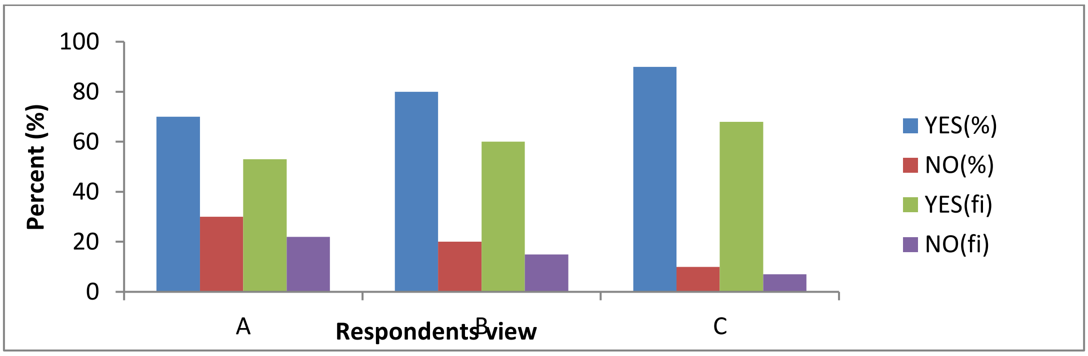

Fig.9. Respondents view in management of the forest

Conclusion

It is concluded from the present growing stock that 18 trees·hac⁻¹ drop to 14 trees·hac⁻¹ due to timber, fuel wood requirement of 70% of population. Similarly the future trees will be reduce to 23 trees·hac⁻¹ from 30 trees·hac⁻¹ in the next ten years (2024). The present and future volume will be reduced. Use of forest resources according to rules of the forest management plan, the forest can support the various demands of present and future the local community if the conditions remain the same.

Recommendations

Keeping in view the spirits of the national forest policy, the objectives of forest

management to maintenance and improvement of the imbalance structure of forest growing stock. Felling should be done within the limits of demand in case of community use working circle to ensure the forest sustainability. Provision of artificial regeneration should be made to cover the blanks and failure areas.

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Appendix 1 Average number of growing stock parameters

S.No	DBH (cm)	P.B.A (m^2)	F.B.A (m^2)	P.Vol (m^3)	F.Vol (m^3)	P.No of trees	F.No of trees	Increment (cm) in last 10 years	Height (m)	Age (years)	Future Age (yrs)
1	12	1.73		13.5		153		5.4	8	13	26
2	14	2.02		17.5		132		5.2	9	15	30
3	16	2.24	3.18	20.5	29	112	159	5.1	10	18	36
4	18	2.36	6.4	22.5	55.8	93	252	4.9	10	19	38
5	20	2.09	6.57	21.5	60.6	67	209	4.7	11	21	42
6	22	5.02	9.64	54.3	85.7	132	238	4.5	11	19	38
7	24	2.97	6.75	34.1	69.9	66	149	4.4	12	24	48
8	26	3.88	10.31	47.6	108.7	73	194	4.3	13	28	56
9	28	3.22	8.70	41.6	99.6	52	141	4.1	14	30	60
10	30	2.62	7.68	35.6	93.9	36	106	4	14	31	62
11	32	2.62	6.24	37.3	86.9	32	76	3.9	15	34	68
12	34	2.4	4.32	35.4	64.1	26	47	3.8	15	35	70
13	36	2.27	4.14	35.1	40.8	22	40	3.7	16	37	74
14	38	2.97	5.59	40.8	72.9	26	49	3.6	17	39	78
15	40	3.62	6.25	36.3	70.8	28	48	3.4	17	42	84
16	42	4.19	8.46	65.08	116.7	30	60	3.3	18	44	88
17	44	4.89	9.59	57.8	115.9	31	62	3.2	18	47	94
18	46	5.33	10.62	58.8	118.9	32	63	3	19	49	98
19	48	5.6	11.16	64.5	124.7	30	61	2.9	19	52	104
20	50	6.33	13.11	101.1	239.8	32	65	2.8	20	54	108
21	52	6.55	13.71	54.5	106.8	31	63	2.7	21	58	116
22	54	6.43	13.91	57.5	114.9	28	60	2.6	21	61	122
23	56	5.58	12.01	46.7	102.2	22	48	2.5	22	62	124
24	58	3.33	8.41	31.8	75.3	12	31	2.3	23	65	130
25	60	2.75	6.28	54.7	124.9	10	22	2.2	20	68	136
26	62	1.05	2.56	8.81	21.4	3	9	2.2	8	70	140
27	64	1.12	2.57	9.17	20.9	3	8	2.1	9	74	148
Total		**95.18**	**198**	**1104**	**2223**	**1314**	**2260**				
Avg/ha		**1.30**	**2.71**	**15**	**30**	**18**	**31**				