

Effects of joint forest management on forest conditions in Khyber Pakhtunkhwa, Pakistan

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ABSTRACT

This study measured the effects of joint forest management (JFM) on forest conditions in purposively selected three forest divisions of Khyber Pakhtunkhwa, Pakistan. The technique of experimental (JFM) versus control (non-JFM) group was applied. Assessment was made between JFM forest and nearby similar non-JFM forest located in the same forest-ecological and socio-economic settings. A total of 393 sample plots (234 from JFM forests while 159 from non-JFM forests) were assessed. Results of independent sample t-test revealed significant difference between JFM and non-JFM forests. Average tree density of JFM forests was 276 trees/ha while for non-JFM forests it was 247 trees/ha. Similarly average seedlings density/ha in JFM forests was 3114 as compared to 1987 in non-JFM forests. Data analysis explored that human disturbances were more in non-JFM forests as compared to JFM forests where joint forest management committees played active role in their protection. In JFM forests, forest protection and improvement activities were observed more times as compared to non-JFM forests. So, this can be concluded that JFM has remarkable contribution in protection and improvement of forests in study areas. It is recommended that network of JFMCs should be extended to non-JFM forests for protecting them from further degradation.

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Key words: 'Joint forest management', 'Joint forest management committees', 'forest condition', and 'human disturbance'

Introduction

Pakistan inherited traditional state-owned forest management system which was formulated by British Empire in sub-continent in 1800s. Basic characteristics of that system were: policing attitude of forest field staff, hierarchical top down administration, more emphasize on management and production of timber, lack of lawful access to forest products and non-participation of forest users in the forest management. Traditional centralized forest management system worked effectively, however, after independence in 1947, the rapid increase in population resulted many problems in forest protection and conservation. Against the increased local needs the forest could not be protected whatever force full means employed. Out dated legal and institutional frame work of the whole forestry sector failed to satisfy the growing needs of the local communities in terms of fire wood, construction timber and grazing. Rapid deforestation in the country showed the failure of state owned traditional forest management system in protecting and sustainably managing the forest resources against the increased population, urbanization and uncontrolled grazing pressure (Shahbaz and Ali, 2003).

In response to this, policy makers transformed the centralized state operated forest management to joint forest management (JFM) under the new forest policy of 1999 and forest ordinance 2002 in Khyber Pakhtunkhwa (Shahbaz, 2009). The JFM was started with great zeal in whole Khyber Pakhtunkhwa province of Pakistan for the improvement of physical conditions of natural forests with the active participation of local communities. In Joint forest management approach forest department and local people equitably share the responsibilities, forest benefits and decision making authority according to formal agreements. In light of JFM procedure, various local level institutions such as Village Development Committees (VDCs), Joint Forest Management Committees (JFMCs) and Women Organizations (WOs) were created to govern the natural forest resources of the village. Forest department role was define as to support local communities living in and around the forest to plan for the protection and management of their forest and to share the benefits of forest with them according to prescribed rules and procedures.

It is widely argued that forest areas that are managed by rural communities are likely to have lower levels of forest disturbance and improved forest conditions than areas that are either under exclusive state management or under open access regime (Blomley and Iddi, 2009). Sustainable forest management cannot be achieved without the participation of forest dependent communities (PFAP, 2005). The active involvement of local community is crucial

for addressing environmental, economic and social goals in rural areas since local communities are more or less comparatively advantageous over the government regarding conservation cost, monitoring, implementation and familiarity to local situations (Agrawal and Chhatre, 2006; Dash and Behera, 2015; Rahut et al., 2015). Hence, excluding local community in forest management will be impractical and will certainly result in conflicts between the environment protection office and local people and resource degradation (Andrade and Rhodes, 2012; Lawry et al., 2015), which therefore might badly affect the wellbeing of the people.

One of the major policy objectives for implementing participatory forest management in the world was to improve forest conditions (Agrawal and Chhatre, 2006; Blomley et al., 2008). Therefore, several studies were conducted in different parts of the world for assessing the effects of participatory approaches on forest conditions. Their results showed that participatory approaches had improved the forest conditions in different developing countries (Bardhan, 1993; Behera, 2009; Heltberg, 2001). Some study found the results of participatory forest management by comparing forests with and without participatory management scenarios (Ameha et al., 2014; Gobeze et al., 2009; Tadesse et al., 2017) and discovered that forest under participatory management were better in condition than non-participatory management regime.

Such study literature was dearth in Pakistan and no one evaluated the effects of JFM on forest conditions. In Pakistan different forestry related studies were conducted such as importance of forest protection in poverty reduction (Khan and Khan, 2016) factors that cause deforestation (Ali et al., 2006) economic benefits from forest (Haq et al., 2015; Ali and Rahut, 2018) forest management policies (Shahbaz et al., 2007) and decentralization of forestry sector in Pakistan (Steimann, 2004) but no comparative study has been conducted like the studies of other countries of the world to systematically evaluate the effects of JFM on forest conditions. Therefore, considering this research gap, this study was designed on the objective to study the effects of joint forest management on forest conditions in JFM and non-JFM forests in Khyber Pakhtunkhwa, Pakistan.

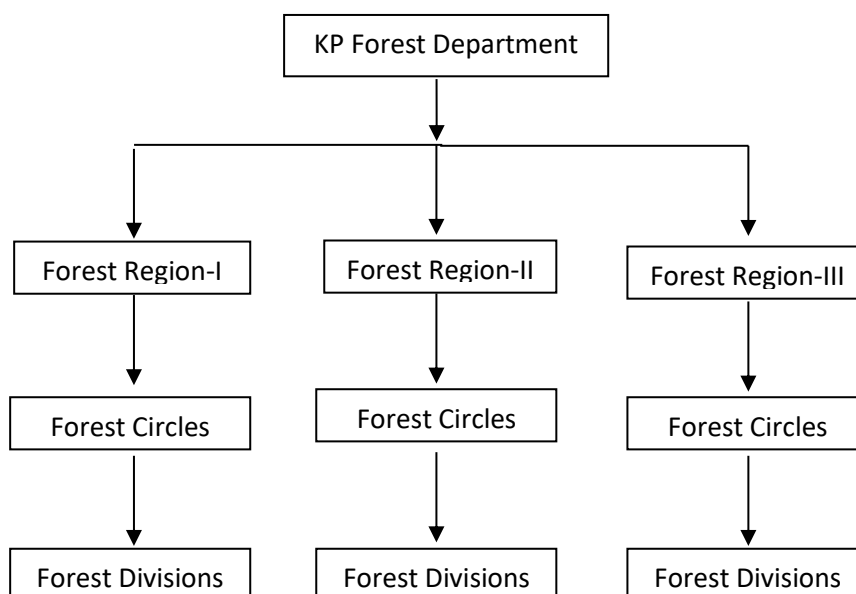
Based on this objective we proposed the hypothesis that there is significant difference between the forest condition of JFM and Non-JFM forests. It is expected that this research will make a valuable contribution to slow and reverse the destruction of dwindling forest resources in Pakistan by positively impacting on policies relating to the sustainable development of forests of Khyber Pakhtunkhwa through the effective participation of

custodian communities in the management process. Furthermore, this study is very timely due to increasing recognition of forests in mitigating climate change.

Materials and Methods

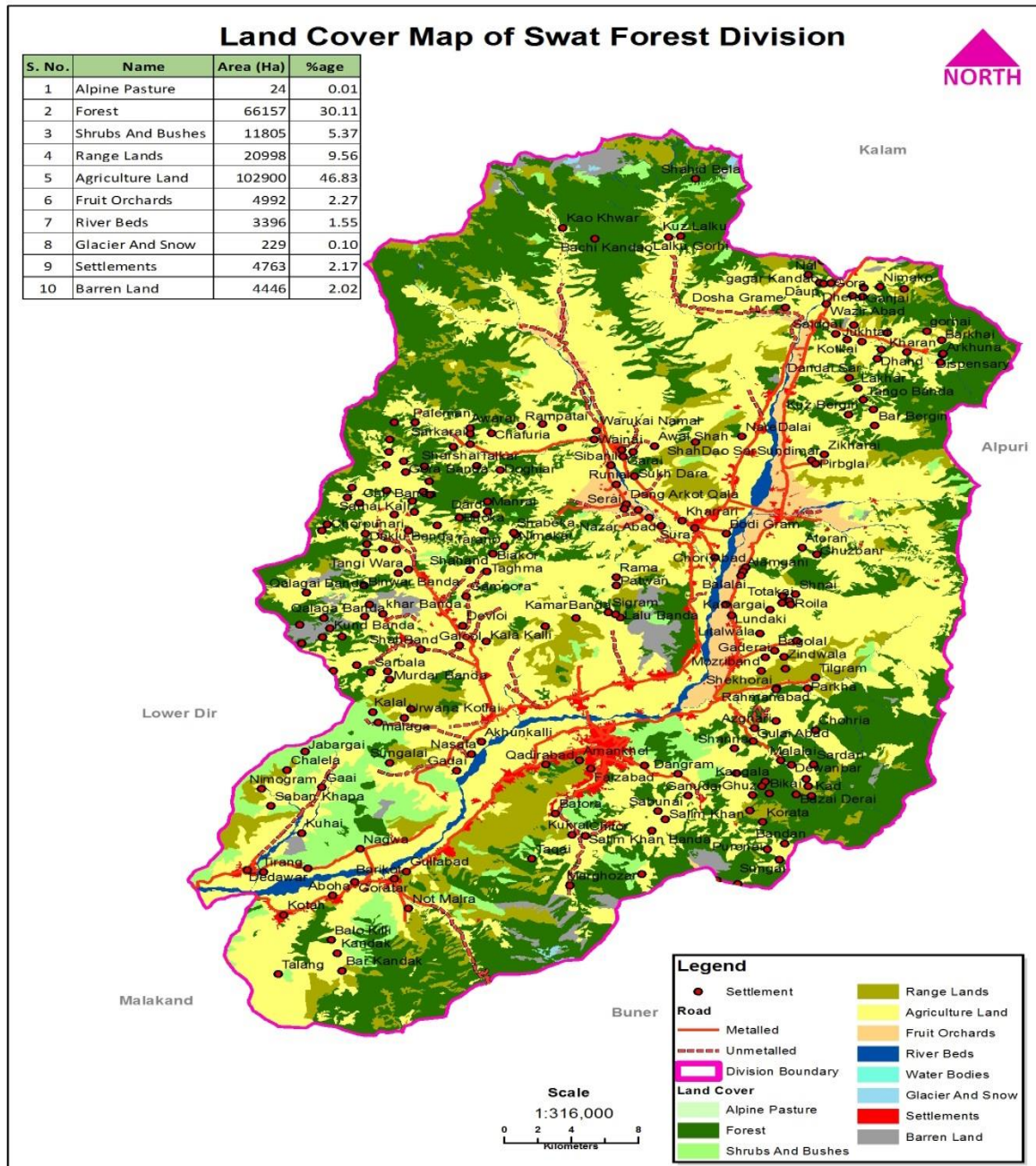
Research plan and study sites

Effects of JFM model were assessed through a comparison between JFM forest and nearby and closely similar non-JFM forest located in the same forest-ecological and socio-economic settings. The method of experimental versus control group was applied. Those forests which were managed by JFM were considered as experimental group while those which were managed by other forest management regime were considered as control group. Study sites selection was done in four stages. In first stage Khyber Pakhtunkhwa province blessed with large area of natural forests than other provinces of Pakistan was purposively chosen. According to Government of Pakistan (2010) statistics forty percent of the total forest area of Pakistan exists in Khyber Pakhtunkhwa province. The Khyber Pakhtunkhwa forest department administers the affairs of forests in whole province and is divided into three regions. These forest regions are as Malakand, Hazara and South. Furthermore, each region is divided into forest circles and further the forest circle divided into forest divisions.



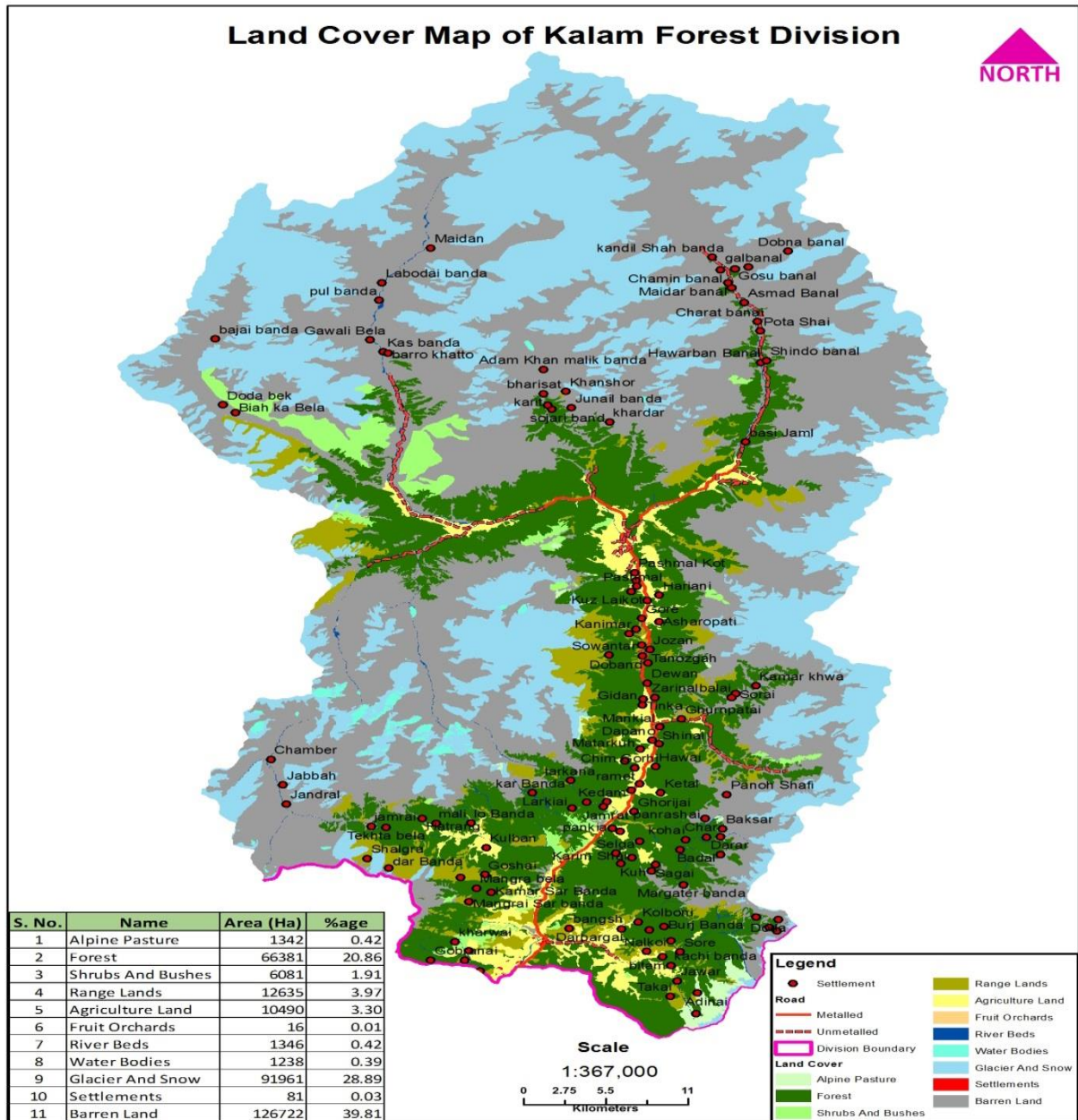
Flow Chart of KP Forest Department

In the second stage, two forest regions Malakand and Hazara were selected purposively because these two regions have maximum forest cover. In third stage Swat and Kalam forest divisions from Malakand forest region and Siran forest division from Hazara forest region were selected purposively. In fourth stage, from each forest division, one JFM forest (experimental group) and nearby one non-JFM its forest (control group) were selected purposively. The study sites are shown in table 2.



Source: GIS Lab. Forestry Planning and Monitoring Circle, Peshawar

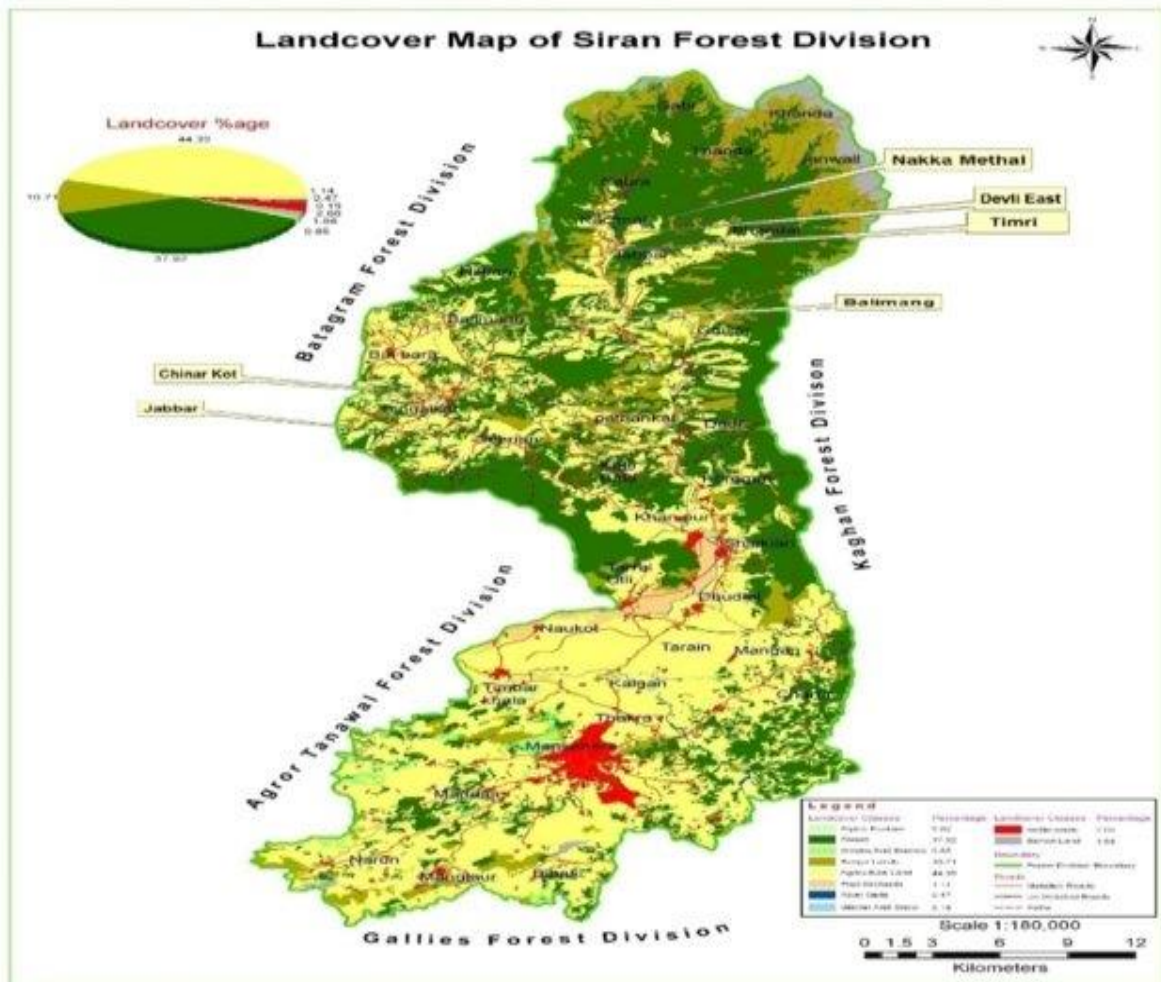
Swat forest division is located between 1475–1800 m above sea level and receives around 1000 mm annual rainfall while Kalam forest division is located between 1475–1800 m above sea level and receives around 1000 mm annual rainfall. Siran forest division is located between 1475–1800 m above sea level and receives around 1000 mm annual rainfall.



Source: GIS Lab. Forestry Planning and Monitoring Circle, Peshawar

These sites were suitable for comparative studies because the pair of selected forest in each forest divisions was in close vicinity and shared comparable climatic and topographic conditions and also has similar forest resource type. A similar criterion has been used by Gobeze et al. (2009); Sitzia et al. (2012); Pandey et al. (2014); Paudel and Sah (2015) who

reported that comparing forests that are in proximity and share similar environmental characteristics provide the ideal conditions for assessing the effects of different management practices on forest structure. Thus we assumed that only management systems were different between the forests.



Source: GIS Lab. Forestry Planning and Monitoring Circle, Peshawar

Indicators design

Forest condition can be described as changes in forest resource, human use or disturbance and forest protection and management activities (Chinangwa et al., 2017). For designing the indicators for forest condition assessment following research studies as Ahrends (2005); Antinori and Rausser (2007); Meshack et al. (2007) and Blomley et al. (2008) were consulted.

Table 1: Indicators for forest condition assessment per plot

S. No.	Indicator	Forest condition aspect
1.	Number of trees in each forest	Biological
2.	Natural regeneration	Biological
3.	Tree stumps	Human disturbance
4.	Evidence of fire, debarked stem, burnt stem and encroachment	Human disturbance
5.	Evidence of fire breakers, marked boundaries and seed sowing	Forest protection and improvement

Note: Trees are defined as all trees with straight stems at least 3 m in length and exceeding 15cm DBH (Doody et al., 2001). Seedlings are defined as plants with height ≤ 1.5 m with DBH < 10 cm (Kelbessa and Soromessa, 2004).

Forest inventory for data collection

Forest inventory was carried out using systematic grid sampling method in each forest. Sample plots were marked on maps prior to the fieldwork and were laid systematically along the grid. In preparation of compartment maps showing sample plots location, GIS Remote Sensing Lab of Forestry Planning and Monitoring Circle Peshawar helped was seek. The intensity of taking the sample plots was 2.5% (Working Plan of Kalam Forest Division, 2015) because variation in study sites was lowest and they were uniform, therefore the sample size was good representative.

Afterward the scale of every sample plot was fastened that was 20 m x 50 m (0.1 ha) which is 1/10th of the area of a hectare (Ronoh et al., 2018). This ensured 10% coverage of the area per hectare for maximum accuracy and precision of the data recorded. Area of each sample plot was 1/10th of the area of a hectare, therefore for conversion of this data into per hectare for data analysis, each sample plot data was multiplied by 10. Natural regeneration data was collected in 10 x 10 meter sub plot (1/100th hectare of the area of a hectare) therefore this data was multiplied by 100 for converting it into per hectare for easy and understandable analysis purpose.

Table 2: Sample plots selected for forest study sites at 2.5% sampling intensity

Site	Forest name	Study group	Forest size (Ha)	Number of sample plots	inaccessibile	Done
1.	Lalku forest	Experimental group	253	63	5	58
	Fazal Baig Garhi forest	Control group	180	45	2	43
2..	Utror forest	Experimental group	300	75	3	72
	Gabral forest	Control group	256	64	-	64
3.	Doga forest	Experimental group	490	122	18	104
	Keri forest	Control group	211	53	1	52
Total			1690	422	29	393

Source: (Siran, Kalam and Swat forest divisions office record, 2018)

Total 393 sample plots were assessed from which 234 were in JFM forests while 159 sample plots were assessed in non-JFM forests. Forest department staff and local people were engaged in this assessment for technical help and also for citing the local names of different seedlings and trees during the data collection in field. Sample plot location was found in field using Garmin 60 GPS, compass, GT sheet map and compartment map. Measuring tape was used for measuring the plot size and other vegetation size in the plot.

Results and Discussions

Forest condition is the combination of three aspects as change in forest resource, human use or disturbance and forest management activities. In this study all the three aspects of forest condition were investigated through already set indicators. Biological indicators of forest growth (e.g. tree density and species richness) take time to respond to management programs therefore, physical indicators of human use or disturbance and forest management activities are included in this study to predict potential effects of the forest management program on forest condition (Chinangwa et al., 2017). Forest condition data was gathered while spending 35 days in field and surveying 393 sample forest plots. For depicting statistically significant difference between the means in two groups (Experimental group and Control group) while analyzing the forest condition data, independent sample t-test was used.

Table 3 results showed significant difference for the variables/indicators (no of trees, natural regeneration, tree stumps, debarked stems, seeds sowing in pits per hectare) between the forests managed under JFM and forests managed under traditional approach ($p < 0.05$).

Table 3: Comparing forest condition indicators between JFM versus non-JFM forests

Aspect	Indicators	JFM	Non-JFM	t-value	p-value
Biological	No of trees/ha	276	247	2.58	0.010
	Natural regeneration/ha	3114	1987	6.60	0.000
Human use	Tree stumps/ha	36	56	-5.09	0.000
	Debarked stems/ha	9	13	-2.32	0.021
	Burnt stem/ha	3	4	-1.43	0.15
	Evidence of fire/ha	0.68	1.07	-1.27	0.20
	Encroachment/ha	0.04	0.19	-1.41	0.16
Forest protection and Improvement	Boundary marking/ha	0.21	0.19	0.17	0.86
	Seed sowing in pits/ha	1.67	0.57	2.12	0.03
	Fire breakers/ha	0.04	0.00	0.82	0.41

Presence of indicator significantly different in forest sample plots under JFM and Non-JFM at 5% level of significance

Biological aspect:

Table 3 showed the significant difference between the tree densities of two forest regimes. The comparison between experimental (JFM) and control group (non-JFM) forests showed that the JFM forests had on average more trees (276 per hectare) than the non-JFM forests (247 per hectare). It can be concluded from these results that local communities involvement effectively protected the mature trees while non- JFM villages do not take measure for the protection of trees as a result their tree density was less as compared to JFM forests. These findings are in line with some other studies in other countries. A study from Malawi reported that forest reserves under participatory forest management had higher tree species abundance or richness than those without participatory forest management (Mtambo and Missanjo, 2015). Ameha et al., (2014) also observed higher number of trees of different species in forests management by community as compared to forests under government management in Ethiopia.

Table 4 results showed the detail of trees in each forest i.e. average tree density per hectare was highest in Lalku forest (323) of Swat forest division followed by Doga forest

(265) of Siran forest division and the lowest in Utror forest (240) of Kalam forest division in JFM forests while in non-JFM forests it was highest in Fazal Baig Garhai forest (286) of Swat forest division followed by Keri forest (267) of Siran forest division and lowest in Gabral forest (190) of Kalam forest division. In study sites under joint forest management (JFM), kail was the dominant specie with the maximum number of stems followed by the deodar and spruce. In forest without JFM, kail was also the specie with highest number of trees followed by chir and blue pine.

Table 4: Number of trees varied considerably among the two forest regimes

Division	JFM Forests		Non JFM Forests	
	Forest name	Average tree density/ha	Forest name	Average tree density/ha
Siran	Doga	265	Keri	267
Swat	Lalku	323	Fazal Baig Garhai	286
Kalam	Utror	240	Gabral	190
All		276	All	247

Source: Field Survey, 2019

Another biological indicator measured by this study was natural regeneration. Natural regeneration is regarded as the natural renewal of forest cover through natural seeding. It is the cheapest and an effective process of rehabilitating depleted forests. Billion trees afforestation project (BTAP) launched by government of Khyber-Pakhtunkhwa in 2014 to 2018 successfully implemented the enclosure scheme in areas where joint forest management committees (JFMCs) were already established. JFM forests were mainly targeted by the said project which could also be a main reason of good condition of JFM forests as compared to non-JFM forests. Table 3 revealed that natural regeneration was significantly higher in JFM forests (3114 seedlings/hectare) as compared to non-JFM forests (1987 seedlings/hectare).

Parallel findings were also reported by Gobeze et al. (2009) in Bonga Forest, Ethiopia, where seedlings density was 5167/ha in PFM forests while in non-PFM forests 3258 seedling/ha were recorded. Alemayhu and Tesfaye, (2019) study results also confirmed that regeneration of the forest under participatory forest management (PFM) management has exhibited advanced number of seedling and sapling than compared to the forest under non-PFM. The average number of seedling and sapling recorded in three PFM forests was 65937

and 20278 per hectare, respectively. Whereas in non-PFM forests 55313 and 18900 seedling and saplings per hectares, respectively. Such results were also reported by Paudel and Sah, (2015) that regeneration was high in community managed forest as compared to government managed forest in Nepal.

Table 5: Natural regeneration in JFM and non-JFM forests

JFM forests	Major species average seedlings/ha	Associated species average seedlings/ha	Total species average seedlings/ha	Non JFM forests	Major species average seedlings/ha	Associated species average seedlings/ha	Total species average seedlings/ha
Doga	4632	184	4816	Keri	3516	74	3590
Lalku	2692	273	2965	F.B. G	1246	167	1413
Utror	1396	165	1561	Gabral	827	132	959
All			3114	All			1987

Source: Field Survey, 2019

Table 5 further explained the natural regeneration status in each forest. Table 5 results showed that doga forest of Siran forest division had the highest potential of natural regeneration (average 4816 seedlings/ha) followed by lalku forest (average 2665 seedlings/ha) in Swat forest division while Utror forest of Kalam forest division had lowest potential (average 1561 seedlings/ha). The table 5 results showed that maximum natural regeneration was observed in moist temperate conifer forest ecological zone (Doga and Keri forests of Siran forest division; Lalku and Fazal Baig Garhai forests of Swat forest division) while in dry temperate conifer forest ecological zone (Utror and Gabral forests of Kalam forest division) there was low natural regeneration. It means the most optimum altitudinal range for natural regeneration is from 4000 to 5500 feet above sea level. During the study, it was observed that the improvement was not confined to just the major species as the associated species had also showed regeneration potential. Major species of doga and keri forests of Siran forest division were kail, fir, spruce, chir (only in keri) and deodar while associated species were kanti and batangi. In lalku and fazal baig garhi forests of Swat forest division major species were fir, spruce, blue pine and chir while associated species were kanar and banjoo. In utror and gabral forests of Kalam forest division major species were deodar, kail, fir and spruce while associated species were mamara, krowch and sperkai.

4.3.3 Human disturbances aspect

Indicators of human disturbance were observed on binary scale (Yes = 1 and No = 0) in both the JFM and non-JFM sample forest plots of study areas. The indicators included tree

stumps per hectare, debarked stems per hectare, burnt stems per hectare, evidence of fire per hectare and encroachment per hectare. Table 3 showed the results of independent sample t-test which revealed significant difference between JFM and non-JFM forests sample plots in terms of tree stumps and debarked stems per hectare. In non-JFM forests, a significantly higher number of tree stumps were recorded in sample plots as compared to tree stumps in JFM forests sample plots. Average tree stumps per hectare in non-JFM forest were 56 while in JFM forest average tree stumps per hectare were 36.

This finding revealed that illegal cutting practices were more in non-JFM forests because of loose control of state forests staff and no implementation of rules and regulations of forest protection from community side. Similarly, in non-JFM forests, a significantly higher number of debarked stems were recorded in sample plots as compared to debarked stems in JFM forests sample plots. Average debarked stems per hectare in non-JFM forests were 13 while in JFM forests average debarked stems per hectare were 9 in number. This revealed significance of involvement of local communities in forest management process.

Similar type of results were explored by other scholars as Lupala, (2009) reported that in Tanzania under PFM Illegal activities and disturbances in Bereku miombo woodland has been reduced. All activities carried out in the woodland were under the supervision of village natural resource committees. According to Bhushan, (2016), JFM reduced the unlawful cutting of trees in India with the active support of forest dependent communities. Patel et al., (2006) reported that average cut stems in JFM forest were 07 while in non-JFM forests the average was 22 cut stems/ha. Similarly Somanathan et al., (2009); Porter-Bolland et al., (2012) and Coleman and Fleischman, (2012) also reported that in developing countries community based forest management approaches are effective against illegal felling of trees practices as compared to state operated forest management approaches. However, these results contradicts the findings of Tekalign et al., (2015) who recorded more tree stumps in forests managed under PFM in Ethiopia which showed weakness of forest user groups to protect the forest.

Regarding the burnt stems, evidence of fire and encroachment indicators of human disturbance aspect, table 3 results showed non-significant difference between JFM and non-JFM forests. However, mean values of these indicators for non-JFM forests were more than JFM forests i.e. average burnt stems per hectare in non-JFM forests were 04 while in JFM forests average burnt stems per hectare were 03 in number, average fire incidents per hectare

in non-JFM forests were 1.07 while in JFM forests average fire incidents per hectare were 0.68 in number, average encroachment evidences per hectare in non-JFM forests were 0.19 while in JFM forests these were 0.04 in number.

These results revealed that overall human disturbance was less in JFM forests. These results explored the importance of community engagement in forest management process. Joint forest management approach organized the local communities in shape of joint forest management committees (JFMCs). Those JFMCs framed out rules and regulations against the illegal use of forest products. Previous studies supported our findings that various participatory forest management approaches (JFM, PFM and CBFM) controlled the human illegal use and disturbance in forests through mutually defined rules and regulations of forest management (Gautam, et al., 2002; Pokharel et al., 2007; Agrawal, and Ostrom, 2008; Iddi, 2010; Niraula et al., 2013; Santika, et al., 2017; Luintel, 2018; Galvin, 2018; Mengist, and Alemu, 2019).

4.3.4 Forest protection and improvement aspect

Forest improvement and management indicators were observed on binary scale, Yes =1 and No =0 in both the JFM and non-JFM forests. These include, boundary marking, sowing of seeds and fire break establishment. Seed sowing indicator showed significant difference between the JFM and non-JFM forests (table 3). Average seed sowing per hectare in JFM forests was 1.67 while in non-JFM forests average seed sowing per hectare was 0.57 in numbers. While boundary marking and fire breakers establishment indicators showed non-significant different between the two forest management regimes. However, mean values of these indicators for JFM forests were more than non-JFM forests i.e. Average boundary marking points per hectare in JFM forests were 0.21 while in non-JFM forests average boundary marking points per hectare were 0.19 in numbers. Similarly, Average fire breakers per hectare in JFM forests were 0.04 while in non-JFM forests these were zero.

These results indicated that engagement of local people in forest management protected the forests and made improvement in its physical condition by sowing of seeds. Same findings were also explored by the authors (Takahashi, and Todo, 2012; Mbwambo, et al., 2012; Prasetyo et al., 2012; Scheba, and Mustalahti, 2015; Newton et al., 2015; Schusser et al., 2015; Blackman et al., 2017; Stickler, et al., 2017; Boedhihartono, 2017; Putraditama, et al., 2019) of different countries that participation of indigenous populations in forest

management process not only protected forest from different anthropogenic disturbances but also made efforts for its physical improvement.

Testing of hypothesis

The hypothesis of this study was that there is a significant difference between the physical conditions of JFM and non-JFM forests. Independent sample t-test results showed the significant differences between the JFM and non-JFM forests in terms of tree density, natural regeneration, tree stumps, debarked stems and seed sowing in pits per hectare ($p < 0.05$; table 3). Therefore, we accept our hypothesis.

Conclusions

On the basis of findings, it is concluded from this study that overall condition of JFM forests was better as compared to non-JFM forests in terms of tree density, natural regeneration, tree stumps, debarked stems and seed sowing in pits per hectare. This revealed that involvement of local communities in shape of JFMCs not only protected forest from illegal human disturbances but also made efforts for forest improvement. While on other side, where communities were not engaged in forest management, overexploitation degraded their forest conditions. Therefore, this study suggests that joint forest management approach has the potential to sustainably manage the forests (Blomley et al., 2008; Phiri et al., 2012).

Recommendations

Based on the study findings it is suggested that network of JFMCs should be extended in entire Khyber-Pakhtunkhwa province to protect non-JFM forests from further degradation.

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