Participatory Forest Management Plan, (PFMP)

Coniferous Forests of Punjab

2022 – 2031

Community Members Kotli Sattian
&
Forestry, Wildlife and Fisheries Department
Government of Punjab

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Credentials

Writing and Data Analysis
Dr. Sardar Fida Hussain
Hammad Gilani
Sajid Hussain

Data Collection Team
Community members of surrounding Villages
Sardar Fida Hussain
Tariq Mehmood Raja
Ammad Saleem SDFO Lehtrar
Saif Ali Khan SDFO Kotli Sattian

Peer Review
Saqib Mehmood CF Rawalpindi North
Frans Werter, Consultant

Technical Assistance
Helvetas Swiss Intercooperation Pakistan
Forestry, Wildlife and Fisheries Department, Punjab

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Endorsement

1. **Chairman, Community Members Kotli Sattian**

2. **REDD+ Focal Person, Punjab Forest Department**

Disclaimer:
This Participatory Forest Management Plan is not a funding commitment from Forest, Wildlife & Fisheries Department Punjab. It is a proposal to be considered for future implementation of REDD+ Programme if funds are committed by the Punjab government and/or any other donor(s). The success of this plan is contingent to the commitment of all stakeholders involved in the implementation of this plan. Benefit Sharing Mechanism and institutional setup for implementation of REDD+ approved by the Government of Punjab will form the basis for implementing this Plan. Information on these aspects are suggestive and not binding on the Forest, Wildlife & Fisheries Department Punjab and any other stakeholders mentioned in this document.

وضاحت

پنجاب کا محکمہ جنگلات، جنگلی حیات و ماہی گیری اس منصوبے کے لیے مالی وسائل فراہم کرنے کا پابند نہیں ہوگا۔ اس منصوبہ پر عمل درآمد کرنے کے لیے مالی اور انتظامی سفارشات دی گئی ہیں۔ تاہم ان پر عمل پنجاب کے محکمہ جنگلات، جنگلی حیات و ماہی گیری کے بنائے گئے انتظامی و مالی رہنما اصولوں کے تحت ہوگا۔

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Acronyms

AGB	Above Ground Carbon
BGB	Below Ground Carbon
FD	Forest Department
BURs	Biennial Update Reports
CERs	Certified Emission Reduction
TFCC	Task Force on Climate Change
Corg	Organic Carbon
FPIC	Free, Prior, Informed Consent
FCPF	Forest Carbon Partnership Facility
FD	Forest Department
GHGEs	Green House Gas Emissions
GIS	Geographical Information System
GoP	Government of Pakistan
IPCC	Intergovernmental Panel on Climate Change
MoCC	Ministry of Climate Change
PES	Payment for Ecosystem Services
PFMP	Participatory Forest Management Plan
R-PP	Readiness Preparation Project
REDD+	Reducing Emissions from Deforestation and Forest Degradation
tCO_2-eq	Tonnes Carbon dioxide (Carbon credit)
UNFCCC	UN Framework Convention on Climate Change

Executive Summary

Forest located in Kotli Sattian Punjab is one of the sites selected by the Forest, Wildlife and Fisheries Department (FD) in consultation with key stakeholders as a pilot site to demonstrate implementation of REDD+. This is part of a larger project being implemented by the Ministry of Climate Change, Government of Pakistan, and the Provincial Forest departments in which a total of 15 Participatory Forest Management Plans are being developed for REDD+ implementation in all six entities of Pakistan.

The Government of Pakistan has joined global efforts to address deforestation and forest degradation to mitigate climate change and its impact by initiating REDD+ activities. REDD+ has three phases; i. readiness, ii. demonstration through implementation, and iii. result-based payments. The first two phases when combined are known as the REDD+ Readiness Phase. Pakistan has made substantial progress in meeting REDD+ readiness requirements. Pakistan has developed a National REDD+ Strategy in 2021. Whereas the Punjab Forests, Wildlife and Fisheries department has developed a Subnational / Provincial REDD+ Action Plan. This action plan is a decentralised framework for Punjab to proceed with REDD+ implementation. Preparation of Participatory Forest Management Plans is an important step to implement this action plan by integrating and implementing REDD+ activities in forest management in various socio-ecological systems.

The local stakeholders were engaged in preparation of this Participatory Forest Management Plan. The plan will guide the implementation of REDD+ by projecting business as usual and reduced emission scenarios derived from detailed participatory assessment of socio-economic circumstances, ecological condition, and challenges (drivers), and assessment of the forest resource which have been described in this plan. The plan also presents stakeholders' analysis with their roles and obligations, use rights of forest dependent communities, conflict resolution and benefit-sharing mechanisms. This information is crucial for determining inclusive activities and successful implementation of REDD+.

The analysis of forest cover revealed that since 2010 the Kotli Sattian Forest is decreasing at a small rate of -0.23 hectares per year, causing 12 tonnes CO_2 eq emissions annually. Enhancing the forest resource base by 10%, will require 6 ha of forest cover to be added annually, which will increase the forest cover to 5,188.5 ha instead of 5,183.4 ha in the business-as-usual scenario by the year 2031. The activities included in this PFMP if properly implemented, will further enhance this trend through collaborative forest management efforts of the stakeholders. This plan has proposed distribution of carbon and non-carbon benefits accrued by the implementation of plan according to which 80% benefits will go to the Government, and 20% will go to the customary right holders and users. These benefits will only be distributed if the targets are achieved. The plan therefore provides scenarios to reduce or increase benefits so that the stakeholders can enjoy results-based payment and benefits. The success of this plan, therefore, is contingent to the commitment of all the stakeholders involved. A specific and definitive distribution of benefits in case of REDD+ programme is yet to be developed by the government, which will form basis for sharing of benefits in the case of private forests. This proposed ratio will be finalized or confirmed only after finalizing Punjab's benefit sharing mechanism.

The initial period of this plan will be 10 years; however, the plan will be a living document and open for annual reviews. A budget forecast to implement activities mentioned is also provided in this plan. The major focus of the plan will be on enhancing forest cover by reforestation and regeneration of forest blanks and reducing the demand for fuel wood from the forest through promotion of energy efficiency and alternate sources of energy.

The implementation of activities described in the plan will be guided by annual operational plans to be developed by the provincial FD in consultation with the relevant stakeholders. The plan will be implemented by village and district committees to be notified by the provincial FD in consultation with the relevant stakeholders.

خلاصہ

پنجاب کے کوٹلی ستیاں میں واقع جنگل محکمۂ جنگلات، جنگلی حیات اور فشریز کی جانب سے منتخب کردہ اُن تین مقامات میں سے ایک ہے جہاں ایک پائلٹ سائٹ کے طور پر اہم شراکت داروں سے مشاورت کے ساتھ ریڈ پلس کے نفاذ کا عملی مظاہرہ کیا جائے گا۔ یہ ایک بڑے منصوبے کا حصہ ہے جو وزارتِ موسمیاتی تبدیلی، حکومتِ پاکستان اور صوبائی محکمۂ جنگلات کے ذریعے لاگو کیا جا رہا ہے جس میں پاکستان کے تمام چھ علاقوں میں ریڈ پلس پر عمل درآمد کی غرض سے مجموعی طور پر جنگلات کے شراکتی انتظام کے لیے پندرہ منصوبے بنائے جا رہے ہیں۔

حکومتِ پاکستان نے جنگلات کی کٹائی اور تنزلی سے نمٹنے اور موسمیاتی تبدیلی کے اثرات کم کرنے کے لیے ریڈ پلس سرگرمیوں کا آغاز کر کے عالمی کوششوں میں شمولیت اختیار کی ہے۔ ریڈ پلس کے تین مراحل ہیں۔ (i) تیاری (ii) عمل درآمد کے ذریعے مظاہرہ، اور (iii) نتائج پر مبنی ادائیگیاں۔ پہلے دو مراحل کو مشترکہ طور پر ریڈ پلس کی تیاری کا مرحلہ کہا جاتا ہے۔ پاکستان نے ریڈ پلس کی تیاری کی ضروریات کو پورا کرنے کے لیے خاطر خواہ پیش رفت کی ہے۔ پاکستان نے 2021ء میں ایک قومی ریڈ پلس حکمتِ عملی تیار کی ہے۔ جب کہ پنجاب کے جنگلات، جنگلی حیات اور فشریز کے محکمے نے صوبائی سطح پر ایک جامع ریڈ پلس ایکشن پلان تیار کیا ہے۔ پنجاب میں ریڈ پلس پر عمل درآمد کو آگے بڑھانے کے لیے یہ ایکشن پلان ایک صوبائی فریم ورک ہے۔ مختلف سماجی ماحولیاتی نظاموں میں جنگل کے انتظام کے لیے ریڈ پلس سرگرمیوں کو مربوط اور لاگو کر کے جنگلات کے شراکتی انتظام کے منصوبوں کی تیاری اس ایکشن پلان پر عمل درآمد کے لیے ایک اہم قدم ہے۔

مقامی فریقین نے جنگلات کے شراکتی انتظام کے منصوبے کی تیاری میں حصہ لیا۔ ریڈ پلس پر عمل درآمد میں رہنمائی کے لیے اس منصوبے کے تحت دو مختلف منظرناموں یعنی موجودہ حالات اور اخراج میں کمی کا اندازہ لگایا جائے گا۔ اس مقصد کے لیے سماجی اقتصادی حالات کے تفصیلی شراکتی تجزیے، ماحولیاتی صورتِ حال اور چیلنجز اور منصوبے میں واضح کردہ جنگلاتی وسائل کا جائزہ لیا جائے گا۔ یہ منصوبہ فریقین کے کردار اور ذمّے داریوں کے ساتھ اُن کے تجزیے، جنگلات پر انحصار کرنے والی لوگو کے حقوق کے استعمال، تنازعات کے حل اور مشترک فوائد کے حصول کا طریقۂ کار بھی پیش کرتا ہے۔ ریڈ پلس پر کامیاب عمل درآمد اور شراکتی سرگرمیوں کی تفصیلات کا تعیّن کرنے کے لیے یہ معلومات ضروری ہیں۔

جنگل کے رقبے کے تجزیے سے پتا چلتا ہے کہ 2010ء کے بعد سے اس جنگل میں 0.23 ہیکٹر سالانہ کی معمولی شرح سے کمی ہو رہی ہے۔ جس سے سالانہ 12 ٹن کاربن ڈائی آکسائڈ کا اخراج عمل میں آ رہا ہے۔ جنگل کے رقبے کو بڑھانے کے لئے 6 ہیکٹر یعنی 10 فی صد سالانہ کے حساب سے اضافے کی ضرورت ہوگی۔ جنگلات کے شراکتی انتظام کا اس منصوبے میں شامل اقدامات کے عملی اطلاق سے نہ صرف ان نقصانات میں کمی آئیگی بلکہ فریقین کے مشترکہ جنگلات کے انتظامی اقدامات سے جنگلات کے وسائل میں مزید اضافہ ہوگا۔

مجوزہ منصوبے کے مطابق اس منصوبے پر عمل درآمد سے حاصل ہونے والے کاربن اور نان کاربن محصولات میں سے 80 فی صد حکومت کو حاصل ہوں گے، جبکہ 20 فی صد جنگل کے استعمال کے حقوق رکھنے والے صارفین کو ملیں گے۔ یہ فوائد صرف اہداف حاصل ہونے کی صورت میں تقسیم کیے جائیں گے اس لیے یہ منصوبہ فوائد میں کمی یا اضافے کا منظرنامہ پیش کرتا ہے تاکہ فریقین نتائج پر مبنی ادائیگی اور فوائد سے مستفید ہو سکیں۔ لہٰذا اِس منصوبے کی کامیابی اس میں شامل تمام فریقین کے عزم پر منحصر ہے۔

حکومت کی طرف سے ریڈ پلس پروگرام کے معاملے میں فوائد کی ایک مخصوص اور قطعی تقسیم فی الحال تیار نہیں ہوئی ہے جو جنگلات کے سلسلے میں فوائد کے اشتراک کی بنیاد بنائے گی۔ مشترک فوائد پر مبنی پنجاب کے طریقۂ کار کے طے ہونے کے بعد ہی اس مجوزہ تناسب کو حتمی شکل دی جائے گی یا اس کی تصدیق کی جائے گی۔

اس منصوبے کی ابتدائی مدّت دس سال ہوگی تاہم یہ منصوبہ ایک زندہ دستاویز ہوگا اور سالانہ جائزے کے لیے پیش ہوگا۔ اس منصوبے میں مذکورہ سرگرمیوں پر عمل درآمد کے لیے رہنمائی متعلقہ فریقین کی مشاورت سے صوبائی محکمۂ جنگلات کی طرف سے تیار کیے جانے والے سالانہ آپریشنل منصوبوں کی مدد سے کی جائے گی۔ اس منصوبے کو گاؤں اور ضلعی کمیٹیوں کے ذریعے لاگو کیا جائے گا اور اس کے بارے میں متعلقہ فریقین کی مشاورت سے صوبائی محکمۂ جنگلات کے ذریعے مطلع کیا جائے گا۔

1. Introduction

1.1 The Context of PFMP

Pakistan has been implementing REDD+ activities since 2010 to mitigate climate change through reduced carbon emissions from the forestry sector. The Government of Pakistan (GoP), Ministry of Climate Change (MOCC) is implementing a REED+ readiness programme funded by the Forest Carbon Partnership Facility (FCPF) of the World Bank. This Participatory Forest Management Plan (PFMP) is to demonstrate integration and implementation of REDD+ activities in forest management in various socio-ecological systems

The Participatory Forest Management Plans (PFMPs) translate REDD+ concepts and processes at practical level considering complex socio-economic conditions, burden of rights and concessions, as well as obligations in the forest. This is the reason that in addition to forest stock assessment, the preparation of PFMPs for REDD+ sites require a detailed assessment of the roles and rights of stakeholders in forest management and revenues so that trade-offs become clearer for redressal and communities are not deprived of their legitimate access to forest for their livelihoods. The core thrust of PFMPs in REDD+ perspective is to find contextually relevant options to address drivers of deforestation and forest degradation to mitigate global climate change. REDD+ also provides mechanisms for the enhancement, measurement, and trade of carbon.

This PFMP provides information including description of the site, GIS supported forest stock assessment, socio-economic situation, analysis of stakeholders with their interests and influences, emissions reduction scenarios, future interventions with estimated budget and implementation mechanism and key challenges for implementation. The activities that will maintain forest as carbon pool have been exclusively explained in this plan giving a lead and support role to stakeholders, as well as the expected outputs. It is expected that the implementation of the PFMP will enable the stakeholders of Coniferous Forests of the Punjab to trade carbon credits in the national and international market in foreseeable future like any other product, by increasing and maintaining the carbon stock sequestered in the forest. The PFMP will thus act as a road map for implementation, monitoring, reporting and verification of resources improvement, and distribution of benefits among stakeholders.

A budget forecast to implement activities mentioned in PFMPs is also provided. Introduction of biomass pelleting/ briquetting plants and introduction of energy efficient stoves, geysers and heaters will reduce the burden on forest and also reduce fire hazards. Similarly, solarisation of houses as alternate source of energy will not only benefit the target population but will act as a role model for other communities.

1.2 Objectives of PFMP

The specific objectives of this plan are as under:

1. To promote sustainable Forest management in Coniferous Forests of Punjab.
2. To protect, improve forest health and enhance Carbon stocks in Coniferous Forests of Punjab while addressing drivers of deforestation and forest degradation
3. To enable the local Forest community and Forest Department staff to manage forests jointly and efficiently for multiple uses.

1.3 Methodology

A multi-disciplinary team consisting of two Participatory Forest Management experts, a sociologist, a GIS specialist, two Range Forest Officers, two Forest Guards and three community representatives (nominated by the community) collected data for preparation of the management plan. The overall methodology for preparation of the plan has been guided by PFMP Manual (version 1.0, 2021) for practitioners prepared under Forest Carbon Partnership Facility (FCPF) of the Ministry of Climate Change (MOCC), Islamabad. A multi-layered methodology was adapted for the preparation of PFMP, which includes the following steps:

i. Selection of site in light of the REDD+ guidelines and procedure. Coniferous Forests of Kotli Sattian, Patriata and Murree was one of the two selected sites for preparation of PFMP.
ii. Participatory data collection. Local community of PFMP sites participated in providing socio-economic data and sharing details on forest-community interaction., They also participated in collecting forest resource assessment data. They also participated in identifying forest management activities and implementation mechanism. Under the Free Prior Informed Consent (FPIC), the community was briefed on relevant concepts, causes and effects of activities. They participated in identifying drivers of deforestation and forest degradation and demand of timber and firewood. The solutions to problems and demands of community were translated into interventions in prioritised order and listed. The exercise was conducted through PRA using spot observations, Focused Group discussion, mapping, semi structure interviews, transect walk and ranking.
iii. Participator Forest Inventory was conducted to collect data from 9 sample plots selected in the PFMP. The location of sample plots is provided in following map (**Figure 1**). The sample plots were chosen through stratified random sampling among each forest stratum. The soil, topography, water availability, and status of vegetation vary spatially within a land-use category and the overall area proposed for the site. Trees, biomass stock, and growth rate are not distributed uniformly in a site. Therefore, a sampling design is followed for locating the sample plots in each of the selected forest strata. The location of sampling plots could determine the biomass stock or growth rate estimates. Based on forest type and forest density, three forest stratum (>70%, 40%-70%, 10%-40% tree canopy cover) were formed to carry out the systematic stratified sample on the map.
iv. Sample points were nested circular plots of 17.64 m, 5.64 m, and 0.56 m radius. All living trees and standing dead woods with DBH above 5cm, and stumps were measured from the full plot of 17.84 meters (~1000 m^2). Fallen trees and stumps, dead wood with diameter above 5cm were also recorded from the plot. The plot included two subplots; 5.64 meters (~100 m^2) for collecting data of seedlings and shrubs and 0.56-meter plots (~1 m^2) for data on litter, leaves, grasses, etc. From a plot of 5.64 m, all seedlings were counted, and shrubs were cut down and fresh weight of the sample was recorded. This sample was clipped and collected in the bags to find out oven dried biomass in the lab. The above-ground non-tree biomass including leaves, litter, grasses, etc. collected from 0.56 m radius sub-plot and weighed. Soil organic carbon values were taken from the national forest inventory, carried out in 2018. The data from these samples was analysed for estimation of carbon stock. The coordinates of each sample plot were noted, and fixed-point photos were taken during the inventory
v. Data analysis and development of PFMP: The data were analysed, GIS map prepared and put together in the form of PFMP with a 10-year perspective including an annual forestry operational plan. The plan was reviewed individually, jointly and sent to experts for peer review.
vi. The plan was sent for endorsement by the Punjab Forest Department and relevant community.

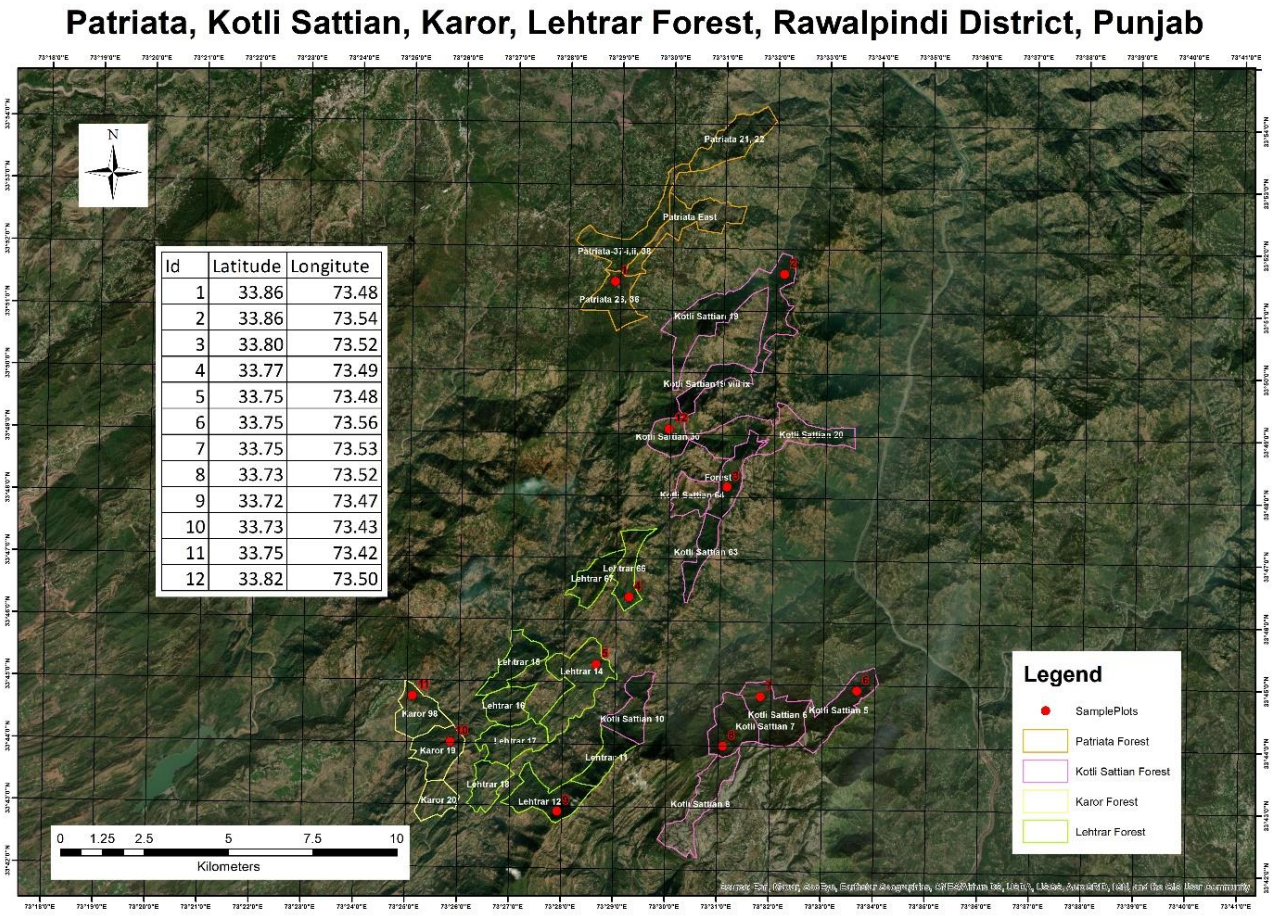


Figure 1. Location of sample plot

1.4 Policy Alignment

The objectives of this local PFMP are aligned with the following provincial, national, and global policies/strategies/commitments related to REDD+.

Global Commitment: To reduce current global 23% carbon emission contributed from AFOLU sector (IPCC 6th Assessment Report, 2021, p245).

National Policies/commitments: Pakistan's report on intended Nationally Determined Contributions seeks 20% reduction of the current national GHG emissions (GOP, 2017). Pakistan intends to set a cumulative ambitious aim of conditional and voluntary contributions of overall 50% reduction of its projected emissions by 2030, with a 15% drop below business as usual from the country's own resources, and an additional 35% drop below business as usual subject to international financial support (NDC, GOP 2021)

National forest policy 2015 also emphasise on enhancing role and contribution of forests in reducing carbon emissions and enhancing forest carbon pool,

The National Climate Change Policy 2012 under Section 4.4 on Forestry Sector states that the climate change is likely to have multi-faceted adverse effects on the ecosystem as a whole, particularly on the already vulnerable forestry sector in Pakistan. Mitigations in the forestry sector entail restoration of

Pakistan's forests through sustainable forest management, with particular focus on how these are affected by climate change. This will not only benefit state forests but forests dependent communities and the whole society in general. The impacts of climate change will be decreased productivity, changes in species composition, reduced forest area, unfavourable conditions for biodiversity, higher flood risks and the like, as portrayed in the Planning Commission Task Force on Climate Change (TFCC) Report (GoP, 2008).

Provincial Policies/commitments:

The goal set under provincial forest policy 2019 is to develop, maintain and maximize forest resources in a scientific, environmentally sustainable, ecologically stable, economically viable and socially acceptable manner. The climate change policy of province of the Punjab acknowledges the role of forests in mitigation and adaption and most particularly to improve resilience of communities and their livelihoods in future scenarios of changes in local climate. The activities mentioned in this PFMP to manage coniferous forests of the Punjab align well with the actions suggested in the climate change policy of the province for managing forest and pastures.

2. Participatory Forest Management Planning

The data and information gathered during PFMP survey through, participatory planning with communities were analysed, results compiled, and interventions identified **(Annex 1, data)**.
The results are presented in this chapter.

2.1 Ecological

2.1.1 Site description

The coniferous forests dealt with in this Management plan comprises of the forests situated in the civil tehsils of Kahuta, Kotli Sattian, and Murree of Rawalpindi District. The forests lie around central coordinates of 33.7822º North latitude and 73.5075º East longitude. Elevation has a gradient starting from 723 m above sea level and culminating at 2207 m at Patriata top, mean elevation is thus 1365 m. Total area included in management plan is 5188.5 hectare. The forest selected for the pilot sites REDD+ implementation consist of two forest types namely Subtropical Chir Pine Forest, where *Pinus roxburghii* is the dominant species with *Quercus incana* as major associate and moist temperate forests dominated *by Pinus wallichiana* along with *Abies pindrow* and *Quercus dilitata* as major associates.

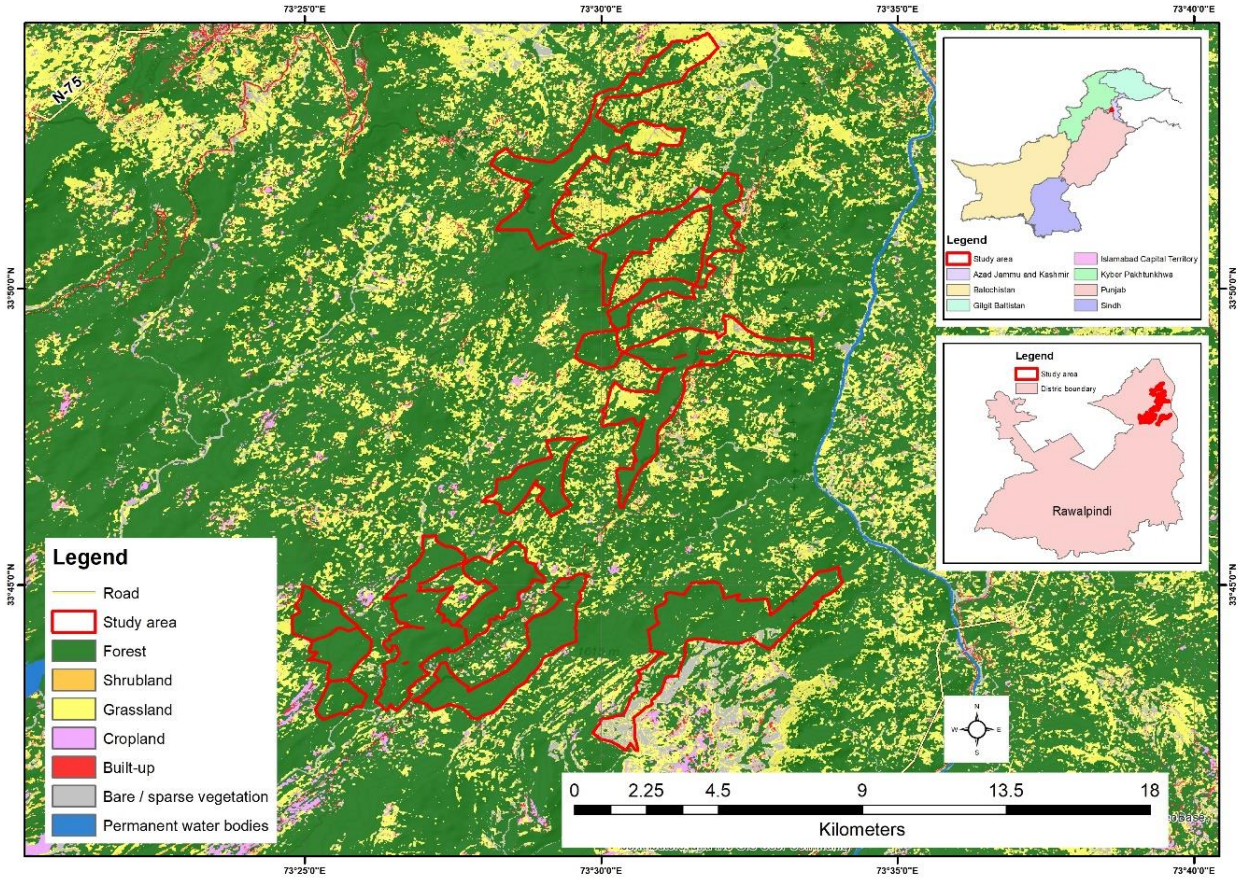


Figure 2. Location and Land Cover map of Kotli Sattian, Patriata and Murree Forest, Punjab

2.1.2 Physical Features and Topography

The area included in study area lies in the mountainous tract of the sub-Himalayan range. Its elevation ranges from 723 m to 2202 m with a mean elevation of 2361.03 m, with a steady rise from south to north. Major part of the area comprises of a series of mountain ridges with narrow intervening valleys.

There is great altitudinal variation within a short distance giving rise to very steep slopes and even bluffs. At some places torrential seasonal streams have cut deep gorges through the rock strata. The major portion of forest consists of steep hills where physical features of the area exhibit a rich variety of plateau, glaciers, valleys, ravines, torrents, streams, plains, and all possible types of topographies that looks continental in dimension and covered with natural vegetation.

2.1.3 Geology, Rocks, and Soils

Geologically, the forests are composed of tertiary sandstone, limestone, and alluvial deposits. More than three forth of the area comprising mountain slopes has soils derived from local weathering of bedrocks resulting in mixed presidium and colluviums. These sandstones belong to the Sirmar and Siwalik series of the sub-Himalayans system. The alluvial deposits chiefly occur in the lower portions of the Kahuta Tehsil, where most of the forests are on the pebble ridges. Large, isolated boulders in many places seem to paint a glacial epoch in the region.

The rock formation is composed of red and purple sandstone and shale. The plains were formed during quaternary period. They are composed of alluvial and gravel caps. The clay shows five distinct layers. The lowest layer consists of coarse pebbles within sand or clay. Stratum is that of alluvium deposit by older system of Soan basin over the pebble bed. During this period, the Soan was the mighty river bigger than the present-day Indus. The next upper layer consists of the alluvium deposit of the present river system. At the top is the layer of silt or clay called loess. At the bottom is the gravelly conglomerate and loose gravel cap deposit. Pebble beds, pebble deposit and pebble ridges form a conspicuous feature of landscape. The greater part of the area consists of hills, with some rough, rolling plains extending from the foot of outer Himalayas towards the salt range. The continuity of the rough rolling plains is also broken by ravines. The rocks exposed in the area ranges in age from upper Cretaceous (70 to 100 million years old) to early Pleistocene (1 million-year-old). The rocks are sedimentary in origin and comprise sandstone, shale, limestone, marble, and conglomerate.

The river Jhelum is the main contributors of the Mangla dam. A newly constructed hydropower project at Karot is also fed by river Jhelum thus enhancing the importance of this important watershed. The river Jhelum flows throughout the lofty, mountains and precipitous rocks. It is interrupted by numerous rapid, which render it incapable of navigation. The river Soan takes its rise from within a few kilometres of the Murree hill station. Its watershed is comprised of three parallel hill spurs of Murree hills. Eastern side of Murree spur, western side of Chrihan spur give rise to Soan tributary and western side of Puphundi spur and eastern side of Chrihan spur give rise to Khad tributary, which join each other at village Chhaka a few kilometres above Simly dam.

2.1.4 Climate

The climate of the area is not uniform; there are large climatic variations mainly because of altitudinal differences. The variations are well reflected in soil and vegetation. The tract can be divided into three climatic zones. There is wide variation between various parts of the Forest. Most of the area has severe winter and mild summer. The average rain fall is 1142 mm. The coldest month is January when the mean maximum temperature is 17.7 ^{o}C and minimum 2.6 ^{o}C. From February to May temperature rises at the rate of 5.06 ^{o}C per month. The highest temperature is recorded in the month of June when it may rise to 40 ^{o}C. There are two distinct zones with respect to climate namely:

2.1.5 Existing Land Use Pattern and vegetation

The sharp variations in physiographic features and climatic conditions have produced highly varying vegetation types. Following vegetation types have been identified on the basis of climax tree species in the area (Champion *et al.*, 1965).

Moist temperate zone
This zone is comprised of high mountainous region in the north. Its elevation is above 1500 m. The average annual precipitation varies from 1500 to 1700 mm. Almost 67 percent of this precipitation occur in summer as rain and remaining 33 percent precipitation occur partly as rain and partly as snow in winter. The mean temperature during November to March remains below 10 ^{o}C. In this zone summer is pleasant but winter is severe. There are large differences in summer and winter temperatures (Champion *et al.*, 1965).

Sub-humid subtropical zone
This zone is comprised of low hilly terrains where elevation varies from 600 to 1500 m above mean sea level. The average annual precipitation varies from 1000 to 1750 mm (Champion *et al.*, 1965).

Moist temperate zone
This zone occupies steep and very steep mountain slopes occurring between 1800 to 2200 meters above mean sea level. It is characterized by severe cold winter and mild to cool summer. The precipitation varies from 1500 to 1750 mm per annum. The *Pinus wallichiana* trees occur in pure stands and are the principal species of this zone. Some *Cedrus deodara* and *Abies pindrow* trees are also found on higher elevations. Few broad leave trees species like *Quercus incana*, *Quercus dilatata*, *Cedrela serrata, Prunus padus*, *Acer spp.*, *Aesculus indica, Cornus macrophylla (kander), Juglans regia* (walnut), *Populus Spp, Pyrus pashia* (batangi), *Salix spp.* and *Machilus duthiei (batti)* are also found mixed with the principal species. Some *Pinus roxburghii* (Chir) trees are also found on warmer aspects and on lower elevations of the zone. The gradual conversion of Chir forest into Kail forest has been noticed at some places. This is an indicator of downward shift in climatic boundary of Kail zone. It means that Kail zone is expanding towards lower elevation. Oak and other broad-leaved species were common in the past, but they were unable to reproduce due to heavy grazing by domestic animals and lopping.

Sub-tropical pine forests
This zone lies on steep to very steep mountains between 1050 to1600 meters above sea level on cooler aspects and 1200 to 1800 m on hotter aspects. The chir (*Pinus roxburghii*) is the dominant tree species. This area usually receives annual precipitation in the range of 1250 to1500 mm. The climatic conditions favour the growth of chir pine species and that is found in pure stands. On the upper cooler and wet locations *Pinus wallichiana* is found mixed with *Pinus roxburghii*. The broad-leaved species like *Quercus incana* and *Pyrus pashia* (batangi) are also found as an associate. In the lower limits chir pine is found mixed with scrub vegetation comprising of *Acacia modesta*, *Olea ferruginea*, *Dodonaea viscosa*. The under growth in this zone is Myrsine *africana* (Khukhal), Berberis spp., *Carissa spinarum* (granda) (Champion *et al.*, 1965).

2.2 Basic Socioeconomic Profile

2.2.1 Population

There are three to four villages around each forest. The population of these village varies from two to four thousand per village. **Satti and Abbasi** are the two main tribe of this area. The landowners and right and concession holders usually belong to these tribes and called ***Raja***. It has been worked out that thirty **thousand people and four thousand households** are meeting their fuel wood and grazing needs from these forests. The inhabitants of these villages have rights and concessions in these forest. They can collect dead dry fuel wood for domestic use, timber for house construction. They are allowed to graze their livestock and collect grass from the forest on subsidized rates.

2.2.2 Wood Consumption

The timber and fuel wood consumption has been worked out by conducting the survey and interviews of community members and staff of forest department. It has been estimated that per capita timber consumption per annum is 0.0463 cubic meter whereas per capita fuel wood consumption is 0.201 cubic meter per annum. Therefore, 1389 cubic meter timber and 6030 cubic meter fuel wood is being provided by these forest annually.

2.2.3 Communication

Being hilly area houses and helmets are quite scattered and it is not possible to construct roads to connect each and every household. However, most of these villages are connected with main communication network. Being high rainfall area, the condition of roads is not very good due to soil erosion and frequent occurrence of landslides. These villages and hamlets are at a distance ranging from 15 to 30 kilometres from tehsil headquarter of Murree, Kahuta and Kotli Sattian or other bigger towns like Lehtrar, Galehragali and Punjar.

2.2.4 Health and Education

There are two Basic Health units and one Rural Health Centre (RHC) in this area. Tehsil Head quarter Hospital are available, in addition a good Combined Military Hospital is available at Murree which is also providing health services to the local communities. Tehsil headquarters are around 15 to 30 kilometre away from these villages. Health workers like Lady Health Workers, nurses, Homeopaths and Hakeem's are also providing health facilities to the rural population.

Rural population is now well aware of the importance of education. Bothe male and female population is well educated. 80 percent of women and men is educated. Awareness level regarding political and environmental issues is quite high which will be an asset and immense help for the REDD + implementation. Almost hundred percent children of the school going age are going to schools. There are primary school in each village, the bigger villages have middle and high school as well. Number of private educational institutions are also working in the area. People prefer to send their children to private schools, which are considered to have better education standard and discipline. Degree colleges are available at tehsil headquarters.

2.2.5 Sources of Livelihoods

The major source of income is government or private service transport and tourism related jobs. Young male population prefer to go into hotel, restaurants, and transport business. Young females prefer to join education and health department. The rural community is agro pastoral in nature, but this is not their sole source of sustenance because the people have very small land holding ranging from half acre to one acre per household. Therefore, the people have very little stake in agriculture.. Major crops are wheat and maize. The women take equal part in farming specially harvesting of crops, rearing of livestock and procurement of fuel wood and water is the responsibility of rural women.
Small land holdings and consequent little stake in agriculture have degrade the soils due to soil erosion. This weakness can be converted into strength by making the communities aware of REDD+ programme, organizing them and motivating them to function as a part of global movement for a better environment.

Historically, the major source of livelihood has been agro-pastoralism. The population heavily depended on the natural forest for grazing livestock, NTFPs, timber and fuel-wood. The population is slowly switching to other sources of income including Government Jobs, businesses, and trade. Migration to Rawalpindi /Islamabad in search of job opportunities, education, and health care. The uneducated and unskilled individuals are still heavily dependent on livestock, natural resources, and farming. Poultry farming was a good sustenance source a few years back, but the introduction of controlled sheds has made this cottage industry uncompetitive. The community is keen to capitalize on the potentials of eco-tourism to generate alternate employment especially for youth.

2.2.6 Rights and Concessions

The forest user community in Coniferous Forests of Punjab are the households of surrounding villages who have use rights in the Coniferous Forests of Punjab. These rights include timber for house construction and repair, timber for firewood for burial of dead bodies. Collection of deadwoods as fuel, non-timber forest products (NTFP) and grazing. The members of the user community can also collect wood for construction of cattle sheds, agriculture tools etc. The households who have agricultural land and settlements inside or around forests have traditionally influence forest management, they have written and admitted rights in the "Record of Rights." These households resist illegal cutting and even over cutting especially in areas close to their settlements. This is the reason that Coniferous Forests of Punjab is in better shape in spite of the tremendous increase of population pressure. The government has increased focused on tourism and tourist activity during the last few years in the area. People have very little land holding and therefore, have little stake in agriculture. These households are usually attached with hoteling and tourism and are establishing tourist facilities in their areas. A number of restaurant and hotels have already been built at suitable places. Coniferous Forests of Punjab being the dense patch of forest in addition to the very pleasant weather in summer and snowfall in wintered are an attractive place for tourist activity.

The tourism potential of the area is still under explored and underutilised specially in Kotli Sattian area. Share of local population in the tourism related activities is however substantial. The detail of rights and concessions is given in Appendix)

2.3 Stakeholder Analysis

The stakeholder analysis (**Annex 2**) was conducted to acquire information about major actors, and their interest and influence on forest resources utilization, management, or restoration. The stakeholder analysis was conducted at two levels; first their interest and influence on forest management; and then their interest and influence on carbon pool. The interest and influence explored through stakeholder analysis indicate who is doing what in managing forest and who has the legal rights in the forest. The stakeholders identified were categorized as primary and secondary based on the level of their participation and partnership in social, technical, financial, and legal aspects of forest management and REDD+.

The Coniferous Forests of Punjab fall in the legal category of Reserved Forest. Forest Department is the owner, manager, and controller of the forest. The communities have use rights and privileges, thus an important stakeholder. The community provides voluntary assistance to the Forest Department in the protection of forests in events of forest fire. The community will also form a Village Conservation Committee to protect the forests. Other stakeholders include the Revenue Department as government agency tasked as custodian of land, Tourism department to facilitate and enhance tourism and security agencies which intervene only if called by relevant authorities.

During stakeholder analysis it was found that the community and the forest department are interested in exploring alternative sources of energy to protect the forest. Few households use Liquid Petroleum Gas (LPG) in addition to fuel-wood for cooking. The purpose however is not to reduce fuel-wood extraction but ease and comfort, because LPG is used by those who can afford to pay. Moreover, LPG is not easily available in remote areas, where fuel wood is the only source. Buying LPG however is extremely expensive even then it is an affordable alternative source of energy. Most households still relay on fuel-wood for both heating and cooking. The stakeholders and their roles identified were further analysed by using the influence-interest matrix to explore their type and level of influence and interest in forest management (**Table 1**) and carbon pools. Table 1 helps in understanding the actual influence and interests and may help identifying the need for increasing the involvement of specific stakeholders. It was found that the Forest Department and local community with land adjacent to the

forest are the major players with greater interest in forest management. The households with legal rights for grazing and collection of forest products but no land inside or adjacent to the forest and some of these who also harvest wood to sell for cash income fall under neglected players and need special attention to safeguard their interest.

The law enforcement agencies also occasionally contribute to forest protection when called in events of forest offenses, but since the protection of forest is not their core area of responsibility they fall in the category of marginal players in the matrixes. The Ministry of Climate Change has a high interest, but until now little influence on local forest management and carbon pools on ground. This may change through REDD+ programme and the distribution of resources for carbon sequestration. The Revenue Department deals with matters related to land as records and decision related to land are entrusted with this department. The Revenue Department has little interest in forest management and only get involved when there is a dispute regarding land ownership. Therefore, it falls in the category of marginal players.

Table 1. Interest influence matrix on Forest Management and carbon pools

	Neglected players: Need special attention to safeguard their interests	**Major players:** Need to be fully involved
INTEREST **Hight** Score 2 and 3	Local community members who harvest for selling (Illegal harvesters)	Forest Department Local community members with use rights and irrigated land and settlements inside or around the forest Local community with use rights and no land ownership. Village Conservation Committee
	Marginal players Low priority	**Risk factors** Need to be addressed
INTERST **Low** Score 0 and 1	Law enforcement agencies Revenue Department	None
	INFLUENCE Low Score 0 and 1	**INFLUENCE High** Score 2 and 3

The major players in forest management are those having major interests and influence on using and protecting carbon pools. The stakeholders themselves may not be aware of this since the concepts are new. They may need awareness raising about this, especially of the importance and benefits of management of carbon pools.

2.4 Forest institutions

The socio-economic data of Coniferous Forests of Punjab (**Annex 1**) indicates institutional dimensions which may be relevant in management of drivers of deforestation (**Table 2**) and maintaining future trend in favour of REDD+. The following institutions are relevant for management of Coniferous Forests of Punjab.

Traditional Jirga (Counsel of wise people)

In every village there is an informal system of conflict resolution, called Jirga. The *Jirga* makes decisions pertaining to all communal matters of the village. This includes conflict resolution. If the *jirga* is not able to resolve any conflict, the parties involved in the conflict may take the case to the formal judicial system. It is important to note that seeking intervention of the *jirga* for conflict resolution is not mandatory. Most cases which involve conflict over communal resources however are resolved through the *jirga*.

Village Conservation Committee

In Soon valley there is no formal Village Conservation Committee (VCC), however the elderly people and educated segment of community play some role in protecting forest from illegal cuttings as well as from forest fire.

2.5 Analysis of drivers of deforestation, forest degradation and barriers to enhancement

Table 2 provides data on drivers of deforestation and degradation and degree of severity and ranking of the drivers and barriers. As indicated in socio-economic data (Table 3), the community depends on forest resources for their domestic needs for timber, firewood and grazing their livestock and other forest products. As stated earlier, the Coniferous Forests of Punjab fall in Protected Reserved Forest category owned by the government where the local community has few rights and certain concessions.

Table 2. Major drivers of Deforestation, Forest degradation and barriers to Forest Enhancement

Ranking	Major drivers	Underlying causes	Degree Of severity
Deforestation			
2	Illegal cutting and theft of wood by locals for sale	1. Lack of Livelihoods Alternatives	2
Forest Degradation			
1	Cutting of Trees for Energy/fuelwood	1. Lack of Alternate Energy Sources	1
Barriers to Enhancement			
3	Over grazing / exploitation	1. Livestock rearing for livelihoods	3
4	Lack of water availability	1. Over exploitation of ground water for agriculture	2

2.6 Carbon stock assessment of Kotli Sattian and Patriata Forests

This part of field survey was conducted in August 2021 to collect data from 12 sample plots selected in Kotli Sattian and Patriata Forest sites. The location of sample plots is provided in following map (Figure 2). At the observation points, sample plots were nested circular plots of 17.64 m, 5.64 m, and 0.56 m radius. All living trees and standing dead woods with DBH above 5cm and stumps were measured from the full plot of 17.84 meters (~1000 m^2). Fallen trees and stumps, dead wood with diameter above 5cm were also recorded from 17.84-meter plot. The plot included two sub-plots: 5.64 meters (~100 m^2) for collecting data of seedlings and shrubs and 0.56-meter plots (~1 m2) for data on litter, leaves, grasses, etc. From a plot of 5.64 m, all seedlings were counted, and shrubs were cut

down and fresh weight of the sample was recorded, collected the sample in bags to find the oven dried biomass in the lab. The above-ground non-tree biomass including leaves, litter, grasses, etc. was collected from 0.56 m radius sub-plot and weighed and soil organic carbon values are taken from the national forest inventory, which was conducted in 2018 as the time required to detect a significant change in soil organic carbon is generally more than 10 years. The data from these samples was analysed for estimation of carbon stock (table 5). The coordinates of each sample plot were noted, and fixed-point photos taken during the inventory.

2.6.1 Plot level Carbon Stock Estimation

Based on the field data carbon stock (tons per hectares) for Above Ground Carbon (AGB) and Below Ground Carbon (BGB) was worked out using the standard sets for tree species, tree DBH and hight, and dry biomass of shrubs and litter (**Table 3**). The tree species level carbon stock is given in Annex 3. Based on this data individual plots level carbon stock values are given in table 3. The estimated stock of carbon per hectares (ha) was then used to estimate the total carbon stock in the selected site of Kotli Sattian Forest.

Table 3. Plot level above and below ground carbon stock

Plot No.	Average AGC (ton/ha)2	Average of BGC (ton/ha)3
1	1.555566716	0.388891679
2	1.404076023	0.351019006
3	4.454095357	1.113523839
4	9.799305351	2.449826338
5	0.231986281	0.05799657
6	0.540738396	0.135184599
7	17.97250645	4.493126613
8	8.653818626	2.163454657
9	1.718529964	0.429632491
10	1.703557748	0.425889437
11	2.71019349	0.677548373
12	1.89991932	0.47497983
Grand Total	**2.696484232**	**0.674121058**

2.6.2 Forest cover assessment

The change in forest cover was assessed by using Landsat multispectral 30m spatial resolution satellite images on the path (150) and row (37) and Google Earth Engine Cloud Computing platform for the classification of forest cover by applying Random Forest Machine Learning Algorithm. The analysis indicates decrease of 2.34 ha in forest cover in the past 10 years at an average rate of 0.23 ha per year (**Table 4**). The amount of carbon trapped in 5 carbon pools (above ground biomass, below ground biomass, soil organic carbon, deadwood and litter on forest floor is grouped here into three carbon pools (above ground, below ground and soil).

Table 4. Forest cover assessment (2011 -2021)

No	Landsat Satellite Sensor	Landsat data acquisition	Forest Cover (ha)
1	Landsat-8	2021-10-06	5188.5
2	Landsat-5	2011-09-25	5186.16
Change in Forest Cover in last 10 years			-2.34
Per year change in forest cover			-0.23

Table 5 provides **three scenarios** of forest cover in the coming ten years that may be followed:

1. Adding 10% more forest cover in addition to reversing the current average annual reduction of 0.23 ha.
2. Adding 20% more forest cover in addition to reversing the current average annual reduction of 0.23 ha.
3. Adding 50% more forest cover in addition to reversing the current average annual reduction of 0.23 ha.

The above scenarios mean that for the forest cover to recover from the current annual loss of 0.23 ha (as observed in the last 10 years) and enhancing it by 10%, 6 ha of forest cover in total would be required to be added, which will increase the forest cover to 5,188.5 ha instead of 5,183.4 ha in the business as usual scenario by the year 2031. Similarly, in 20% and 50% scenarios the forest cover can be replenished by the year 2030 and 2029, respectively. Since the total area of the forest is 5188.5 ha, there is no land available on site to increase forest cover than plugging the current deforestation trend.

Table 5 : Forest Cover Scenarios based on trend in the past 10 years

Rate of change per year	-0.23	-0.02	-0.05	-0.12
Year	**Forest Cover (ha) - Business as usual**	**Forest Cover (ha) - 10% increase**	**Forest Cover (ha)- 20% increase**	**Forest Cover (ha) - 50% increase**
2010	5188.5			
2011	5188.3			
2012	5188.0			
2013	5187.8			
2014	5187.6			
2015	5187.3			
2016	5187.1			
2017	5186.9			
2018	5186.6			
2019	5186.4			
2020	5186.2			
2021	5185.9	5185.9	5185.9	5185.9
2022	5185.7	5186.2	5186.2	5186.3
2023	5185.5	5186.4	5186.5	5186.6
2024	5185.2	5186.7	5186.8	5187.0
2025	5185.0	5187.0	5187.0	5187.3
2026	5184.8	5187.2	5187.3	5187.7
2027	5184.5	5187.5	5187.6	5188.0
2028	5184.3	5187.7	5187.9	5188.4
2029	5184.1	5188.0	5188.2	5188.7
2030	5183.8	5188.2	5188.5	5189.1
2031	5183.6	5188.5	5188.7	5189.4
2032	5183.4	5188.8	5189.0	5189.8

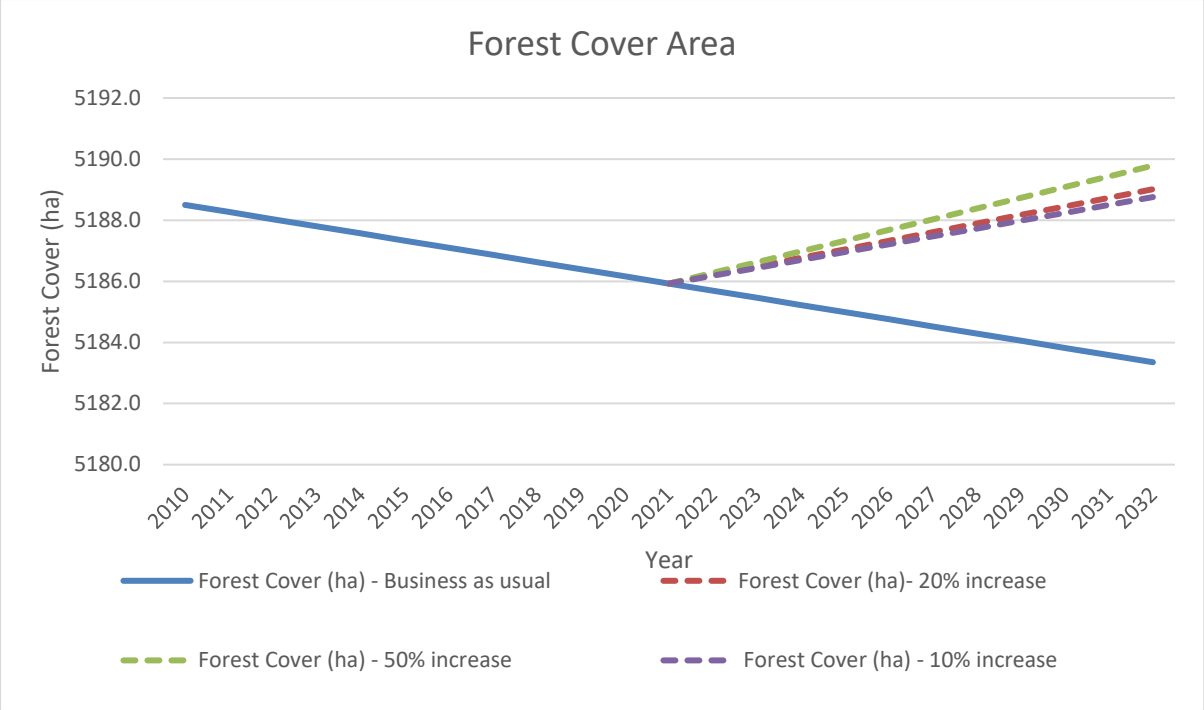


Figure 3. Forest cover scenarios

2.6.3 Total Carbon stocks estimation

The field data and biomass collected from 12 samples was used to calculate Above Ground Biomass (AGB) using locally developed allometric equations ((Chave et al., 2014; Khan et al., 2021) for 2010-2021. In Kotli Sattian forest, the cumulative carbon stock in three carbon pools (above, below and soil) was estimated at 65,222.59 tonnes of Organic Carbon (Corg) in 2010 which decreased to 65,193.17 tonnes in 2021. This change corresponds to the decreased forest cover from 5188.5 ha in 2011 to 5186.16 ha in year 2021. The annual change in carbon stock is provided in **Table 6.** The below figure 4 provides visual interpretation of the forest cover in 2011 and 2021.

Figure 4. Forest Cover Maps used for Change Analysis

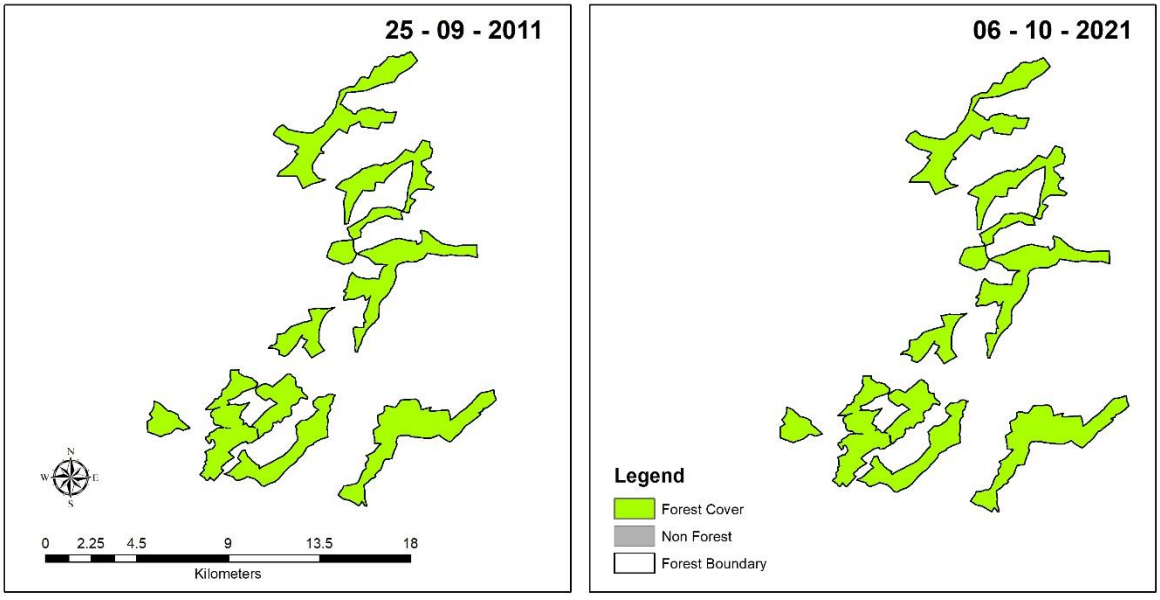


Table 6. Carbon stock estimation (2011-2021)

Carbon pool	Mean carbon stock (ton C stock per hectare)	Forest Cover (ha)	Total stock (ton C stock)	CO_2 (ton CO_2 eq)
2011 (2011-09-25)				
Above	2.70	5189	13,990.71	
Below	0.67		3,497.68	
Litter	1.50		7,800.54	
Soil*	9.2		47,734.20	
Accumulative			73,023	267,751
2021 (2021-10-06)				
Above	2.70	5186	13,984.40	
Below	0.67		3,496.10	
Litter	1.50		7,797.02	
Soil	9.2		47,712.67	
Accumulative			72,990	267,631
Rate of change per year				
2020-2010		**-0.23**	**-3.29**	**12**

*PhD thesis of Syed Moazzam Nizami: estimation of carbon stocks in subtropical managed and unmanaged forests of Pakistan

2.6.4 CO_2 emissions reduction Scenarios for deforestation

This section presents the future CO_2 emissions reduction scenarios applying 10%, 20% and 50% reduction to current emissions rate over the past 10 years due to deforestation (As per definition of forest adopted by Pakistan for REDD+). The current CO_2 emissions rate is 12 tonnes CO_2 eq per annum because of deforestation. In case of 10% emissions reduction scenario by increasing forest cover the emissions from the forest will reduce by 1 tonne CO_2 eq per annum, while with 20% and 50% emissions reduction scenario the emissions will reduce by 2 and 6 tonnes CO_2 eq annually.

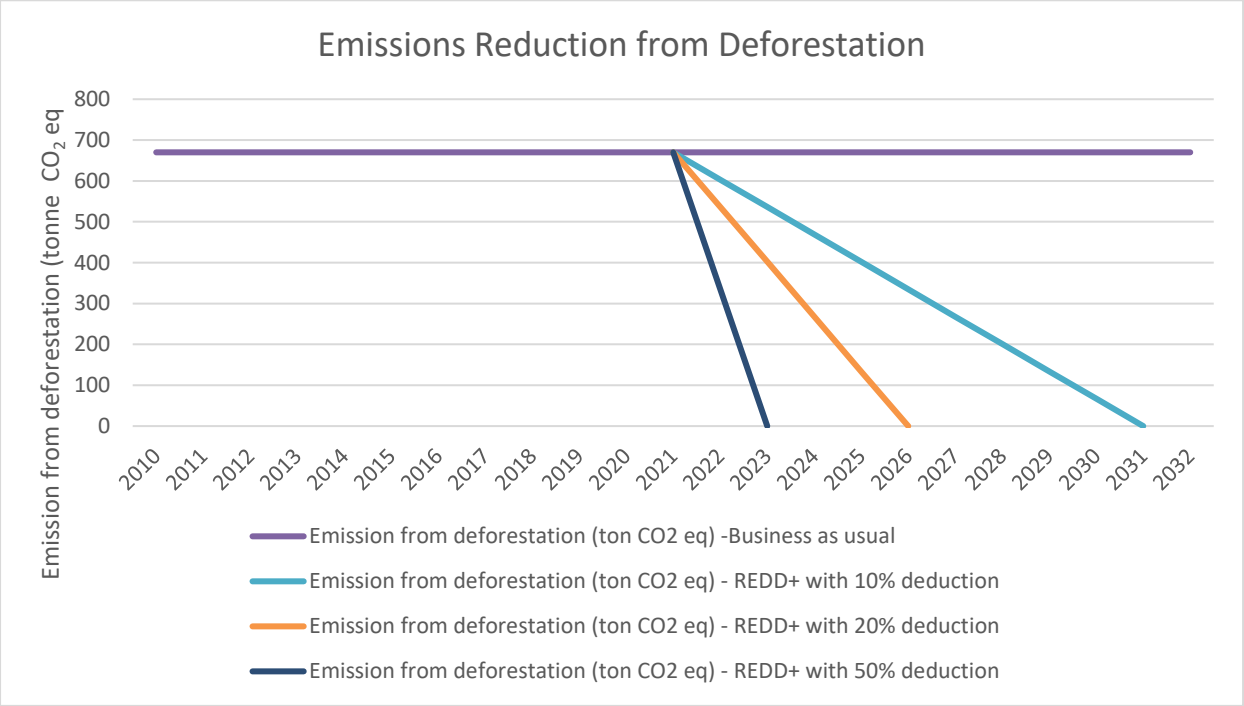
Table 7. Deforestation Emissions trend and Different Emissions reduction scenarios

Rate of change per year	12	-1	-2	-6
Year	**Emission from deforestation (tonne CO_2 eq) - Business as usual**	**Emission from deforestation (tonne CO_2 eq) - REDD+ with 10% reduction**	**Emission from deforestation (tonne CO_2 eq) - REDD+ with 20% reduction**	**Emission from deforestation (tonne CO_2 eq) - REDD+ with 50% reduction**
2010	12			
2011	12			
2012	12			
2013	12			
2014	12			
2015	12			
2016	12			
2017	12			
2018	12			
2019	12			
2020	12			
2021	12	12	12	12
2022	12	11	10	6
2023	12	10	7	0
2024	12	8	5	

Rate of change per year	12	-1	-2	-6
Year	Emission from deforestation (tonne CO_2 eq) - Business as usual	Emission from deforestation (tonne CO_2 eq) - REDD+ with 10% reduction	Emission from deforestation (tonne CO_2 eq) - REDD+ with 20% reduction	Emission from deforestation (tonne CO_2 eq) - REDD+ with 50% reduction
2025	12	7	2	
2026	12	6	0	
2027	12	5		
2028	12	4		
2029	12	2		
2030	12	1		
2031	12	0		
2032	12			

The above table shows that under REDD+ implementation if the deforestation trend is reversed at a rate of 10% then the forest will stop CO_2 emissions due to deforestation by the 10th year, if the deforestation rate is reduced by 20% then the deforestation will be controlled by the 5th year and at 50% reduction the CO_2 emissions because of deforestation can be set aside by the end of 2nd year as shown in the figure 5 below.

Figure 5. Emissions reduction scenarios - deforestation



i. CO_2 Emissions Trend – forest degradation

Fuelwood and Timber consumption for the pilot site was estimated based on population of the area, population growth rate and per capita fuelwood and timber consumption statistics collected during the field survey. The total population of the pilot site in 2017 was 30,000 with a growth rate of 2.7 per annum. The fuelwood and timber consumption per capita per annum was calculated as 0.2 m^3 and 0.05 m^3, respectively. Based on this data emissions from forest degradation are calculated and presented in the **Table 8**.

Table 8. Forest Degradation Emissions trend

Year	Population	Fuelwood Consumption (FC) (m^3/year)	Timber Consumption (TC) (m3/year)	Fuelwood Emissions[1] (FC*D*BEF2*CF*44/12) (tonne CO_2 eq)	Timber Emission (TC*D*BEF2*CF*44/12) (tonne CO_2 eq)	Emission from Forest Degradation (tonne CO_2 eq) - Business as usual
2010	24769	4954	1238	6260	1565	7825
2011	25456	5091	1273	6433	1608	8042
2012	26163	5233	1308	6612	1653	8265
2013	26889	5378	1344	6795	1699	8494
2014	27635	5527	1382	6984	1746	8730
2015	28402	5680	1420	7178	1794	8972
2016	29190	5838	1460	7377	1844	9221
2017	30000	6000	1500	7582	1895	9477
2018	30810	6162	1541	7786	1947	9733
2019	31642	6328	1582	7997	1999	9996
2020	32496	6499	1625	8212	2053	10266
2021	33374	6675	1669	8434	2109	10543
2022	34275	6855	1714	8662	2165	10827
2023	35200	7040	1760	8896	2224	11120
2024	36151	7230	1808	9136	2284	11420
2025	37127	7425	1856	9383	2346	11728
2026	38129	7626	1906	9636	2409	12045
2027	39158	7832	1958	9896	2474	12370
2028	40216	8043	2011	10163	2541	12704
2029	41302	8260	2065	10438	2609	13047
2030	42417	8483	2121	10720	2680	13399
2031	43562	8712	2178	11009	2752	13761
2032	44738	8948	2237	11306	2827	14133

[1] Wood Density (D)

Pinus roxburghii	*0.43*
Pinus wallichiana	*0.32*
Dalbergia sissoo	*0.69*
Quercus incana	*0.63*
Average	*0.52*
Biomass Expansion Factor: BEF2	1.35 (IPCC Table 3A.1.10)
CF = carbon fraction of dry matter	0.5

ii. Net Emissions from Deforestation and Forest Degradation

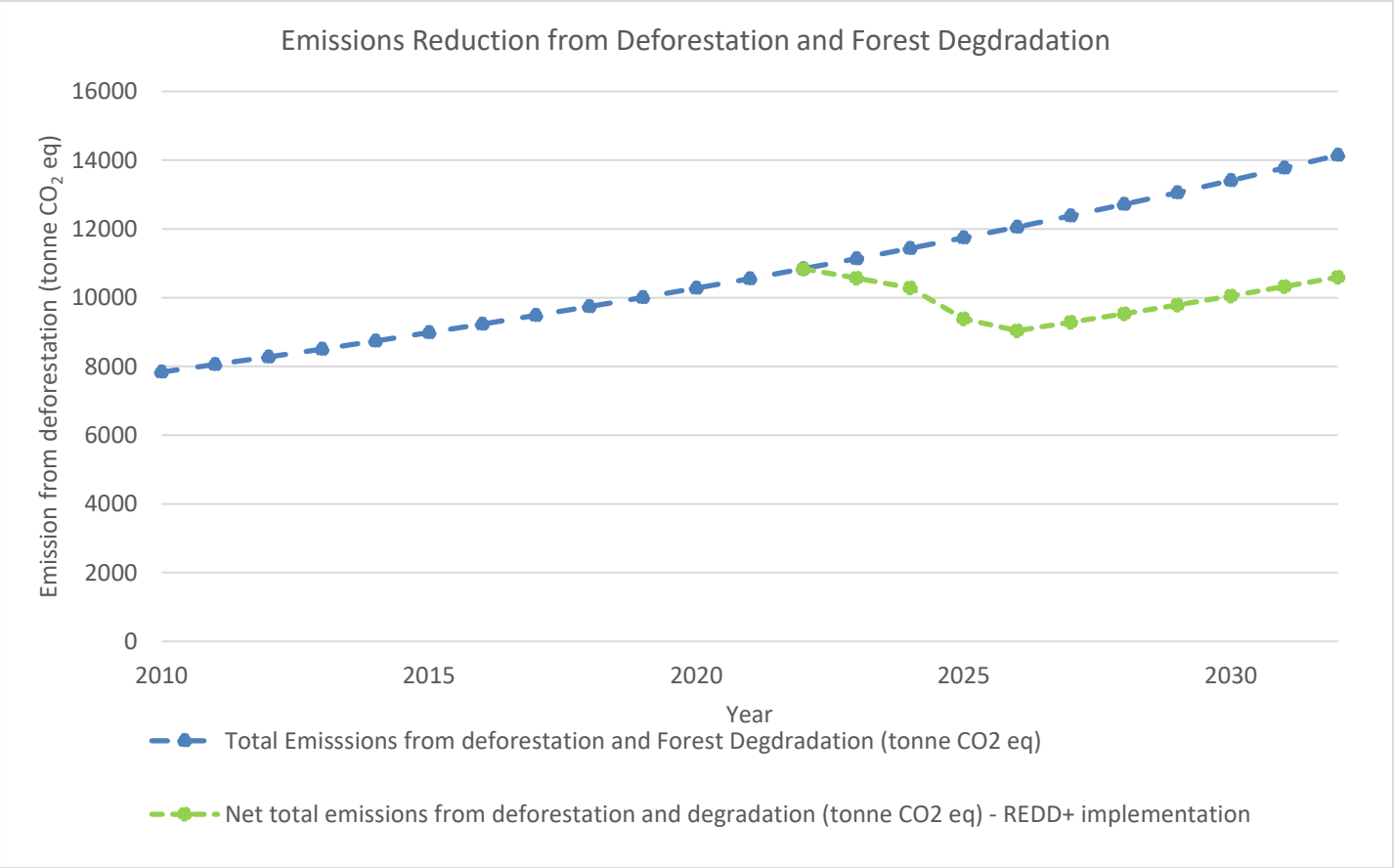
The **table 9** below provides a net CO_2 sequestration scenario based on 10% forest cover enhancement in addition to addressing existing negative trend and reducing emissions from forest degradation in an incremental manner annually from 5% to 25% with REDD+ activity. In this scenario, the net emissions from the forest will continue declining till 2026 due to cumulative effect of increasing forest cover and reduction in forest degradation due to REDD+ implementation but will again start climbing due to steady increase in population resulting in increase in demand for fuel and local use timber. Since the deforestation rate is negligible in comparison with the forest degradation, more emphasis is needed to address the pressure for fuelwood and local use timber to enhance the forest carbon pools.

Table 9. Sequestration Scenario from Forest Enhancement and Reducing degradation

Rate of change per year	12					-1	
Year	**Emission from deforestation (tonne CO_2 eq) -Business as usual**	**Emission from Forest Degradation (tonne CO2 eq) - Business as usual**	**Total Emissions from deforestation and Forest Degradation (tonne CO2 eq)**	**5-25% Reduction in Degradation emissions**	**Net emissions from degradation**	**Emission from deforestation (tonne CO_2 eq) - REDD+ with 10% reduction**	**Net total emissions from deforestation and degradation (tonne CO2 eq) - REDD+ implementation**
2010	12	7825	7837				
2011	12	8042	8054				
2012	12	8265	8277				
2013	12	8494	8506				
2014	12	8730	8742				
2015	12	8972	8984				
2016	12	9221	9233				
2017	12	9477	9489				
2018	12	9733	9745				
2019	12	9996	10008				
2020	12	10266	10278				
2021	12	10543	10555			12	
2022	12	10827	10839		10827	11	10838
2023	12	11120	11132	556	10564	10	10573
2024	12	11420	11432	1142	10278	8	10286

Rate of change per year	12					-1	
Year	Emission from deforestation (tonne CO_2 eq) -Business as usual	Emission from Forest Degradation (tonne CO2 eq) - Business as usual	Total Emissions from deforestation and Forest Degradation (tonne CO2 eq)	5-25% Reduction in Degradation emissions	Net emissions from degradation	Emission from deforestation (tonne CO_2 eq) - REDD+ with 10% reduction	Net total emissions from deforestation and degradation (tonne CO2 eq) - REDD+ implementation
2025	12	11728	11740	2346	9383	7	9390
2026	12	12045	12057	3011	9034	6	9040
2027	12	12370	12382	3093	9278	5	9282
2028	12	12704	12716	3176	9528	4	9532
2029	12	13047	13059	3262	9785	2	9788
2030	12	13399	13412	3350	10050	1	10051
2031	12	13761	13773	3440	10321	0	10321
2032	12	14133	14145	3533	10600		10600

Figure 6. Sequestration scenarios – forest enhancement and reduced degradation



3. Proposed Intervention

A number of interventions have been proposed here based on the participatory forest inventory, socio-economic data, drivers of deforestation and stakeholders' analysis. The analysis ascertained that in order to achieve effective results for sustainable forest management and incremental Carbon sequestration, the activities required under this PFMP need to cater to the important watersheds of Rawal, Simli, Mangla dams and Karot hydro power project and other related issues. The following interventions are, therefore, suggested for managing the coniferous Forests of the Punjab as a REDD+ pilot site:

Table 10. Proposed interventions addressing major driver's deforestation and degradation

S. #	**Details of Interventions**	**Drivers of deforestation and degradation and Barriers to Enhancement addressed**
1	Notification of the relevant forums after stakeholders reaching at collective decisions	Illegal cutting of trees and theft of wood by locals for sale
2	Appointment of community forest guards (Twelve)	Illegal cutting of trees and theft of wood by locals for sale Addressing issues of over grazing and firewood collection
3	Preparation for implementation of endorsed PFMP and periodical follow up meetings (communities and other stakeholders)	Illegal cutting of trees and theft of wood by locals for sale Addressing issues of over grazing and firewood collection
4	Introduction of energy efficient stoves, heaters and geysers fueled by agriculture waste pallets and briquettes.	Addressing issues of firewood collection
5	Community / youth motivational events	Illegal cutting of trees and theft of wood by locals for sale
6	Nursery establishment and maintenance for planting activities (4 nurseries to collectively produce 300,000 (Three hundred thousand) plants per year)	Illegal cutting of trees Forest Enhancement, addressing issues of over grazing and firewood collection
7	Trainings to promote alternative sources of livelihoods (e.g., NTFPs collection)	Illegal cutting of trees and theft of wood by locals for sale
8	Introduction of solar energy as an alternative source of household energy.	Cutting of Trees for Energy/fuelwood
9	Soil Conservation and afforestation through bioengineering techniques to improve the health of this important watershed area.	Barrier to restoration, Lack of water availability
10	Training /exposure of forest officials and community in accordance with their roles in REDD+	All
11	Establishment of a Biomass briquetting plant	Cutting of Trees for Energy/fuelwood
12	Soil conservation and planting works in blank, degraded and low-density patches (approximately two million plants (2,000,000) plants in 10 years)	Barrier to restoration, Over exploitation

The total indicative budget of the PFMP implementation is PKR 790.2 millions (Table 11)

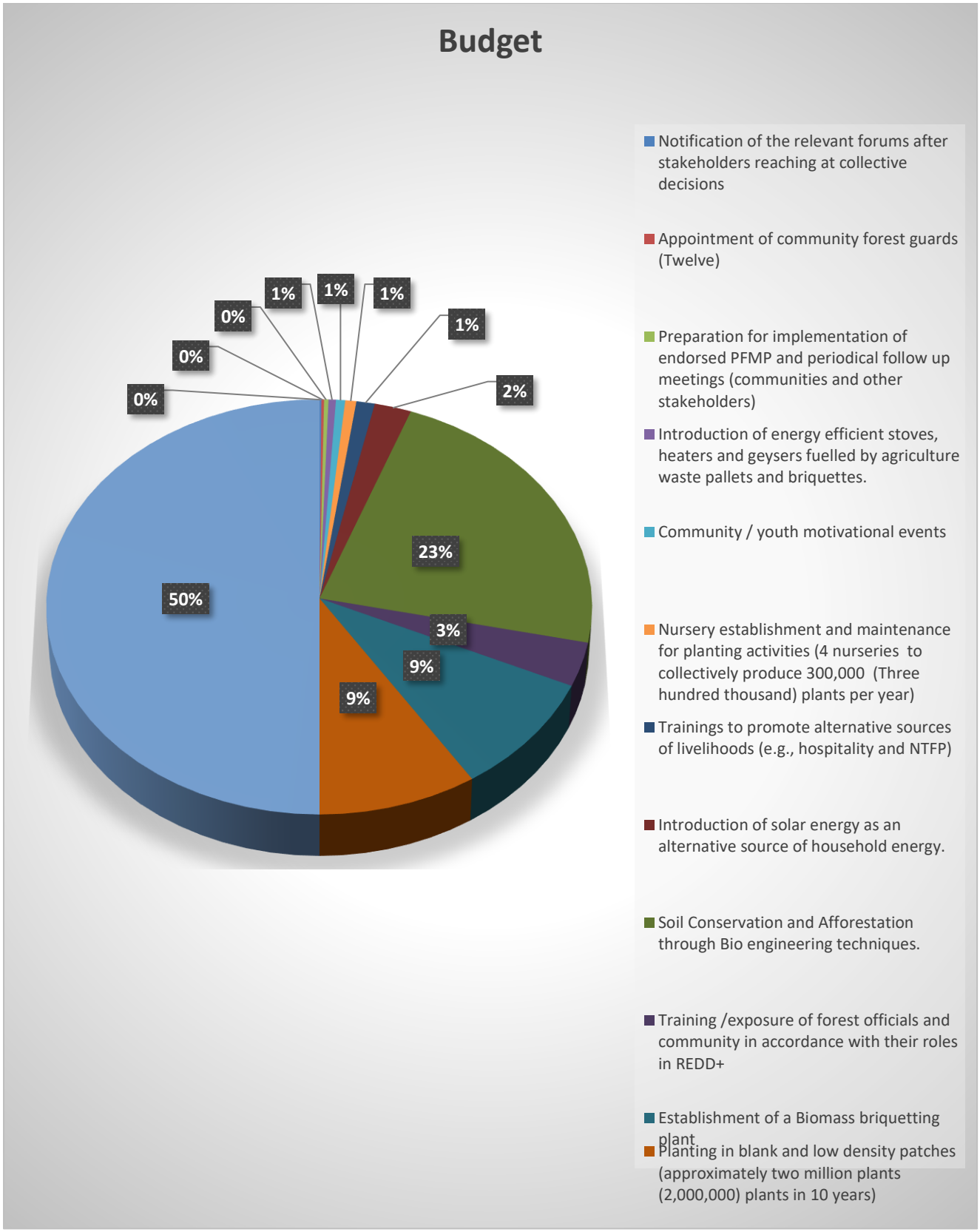


Figure 7. Visuationsation of budget in percentages

Table 11. Indicative operational plan and budget of the PFMP for 10 years

				Operational Plan											
S.N.	**Details of Activity**	**Unit**	**Unit cost**	**1 year**	**2 year**	**3 year**	**4 year**	**5 year**	**6 year**	**7 year**	**8 year**	**9 year**	**10 year**	**Total units**	**Total cost (Million)**
1	Notification of the relevant forums after stakeholders reaching at collective decisions		500,000											12	6
2	Appointment of community forest guards (Twelve)	Number	60,000	12	12	12	12	12	12	12	12	12	12	120	7.2
3	Preparation for implementation of endorsed PFMP and periodical follow up meetings (communities and other stakeholders)	Number	100,000	12	12	12	12	12	12	12	12	12	12	120	12
4	Introduction of energy efficient stoves, heaters and geysers fueled by agriculture waste pallets and briquettes.	Numbers	20000	100	100	100	100	100						500	10
5	Community / youth motivational events	Numbers	500,000	5	5	5	5	5	5	5	5	5	5	50	25
6	Nursery establishment and maintenance for planting activities (4 nurseries to collectively produce 300,000 (Three hundred thousand) plants per year)	Numbers	10	300000	300000	300000	300000	300000	300000	300000	300000	300000	300000	3,000,000	30

				Operational Plan											
S.N.	Details of Activity	Unit	Unit cost	1 year	2 year	3 year	4 year	5 year	6 year	7 year	8 year	9 year	10 year	Total units	Total cost (Million)
7	Trainings to promote alternative sources of livelihoods (e.g., hospitality and NTFP)	Numbers	100,000	50	50	50	50	50	50	50	50	50	50	500	50
8	Introduction of solar energy as an alternative source of household energy.	Numbers	100,000	100	100	100	100	100						500	50
9	Soil Conservation and afforestation through bio engineering techniques.	hectare	200,000	50	100	100	100	100	50					500	100
10	Training /exposure of forest officials and community in accordance with their roles in REDD+	Numbers	500,000	12	12	12	12	12	12	12	12	12	12	120	60
11	Establishment of a Biomass briquetting plant	Numbers	20,000,000		1	1								2	40
12	Planting in blank and low-density patches (approximately two million plants (2,000,000) plants in 10 years)	Numbers	200	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	2,000,000	400
	Total														790.2

4. Implementation Mechanism for the PFMP

4.1 Resources for activities

The Forest Department as custodian of the forest and having linkages with national and international funding sources will take a lead this activity. The key stakeholders identifying in this plan, especially the FD and the Village Conservation Committees will jointly look for resources for implementation of activities identified in this plan. The FD will submit proposals for potential funding sources including the Ministry of Climate Change, Public Sector Development Programme (PSDP), international donors and private sector investors.

4.2 Suggested institutional mechanism for implementation of activities

Village, Sub-division, and district level REDD+ implementation committees notified by the Forest Department will oversee implementation of activities. The notifications will include description of responsibilities of Forest Department, the respective communities, and other relevant stakeholders.

The village level implementation committees will consist of representative of the community surrounding each forest. Presently Village Committees are not in place, however, these will be constituted in due course of time. The members of joint VCC of surrounding villages of each forest will represent the community in the village level implementation committee to be notified by the FD. The in-charge forest guard will represent the department in the village implementation committee. The representative of the community will be responsible to harness support of the community for implementation of activities.

The village implementation committee will be supervised by subdivision level committee chaired by the sub-divisional forest officer with members from the VCCs. The District Conservation Committee will consist of Divisional Forest officer, District officer agriculture, Deputy Commissioner, and a representative of District Government. The district committee will monitor progress on implementation of activities and harnessing support from the relevant actors including government departments. The district committee will also act as final forum for conflict resolution.

4.3 Benefit Distribution Mechanism

The implementation of the REDD+ interventions package and other support activities will increase the volume of carbon stock in the forest. The increase in carbon stock in the forest pool measured by variable means and the trade of carbon will hopefully generate substantial income for the stakeholders in due course of time.

The income earned by trading carbon stock will be distributed in proportions as per the use rights held by stakeholders or mechanism specifically developed for carbon benefit sharing. It is expected that the income generated by this mechanism will be significant and the stakeholders are expected to value standing trees rather than cutting it for other uses. Since the community will be reducing harvest of fuel wood, restrict grazing for encouraging regeneration and voluntarily participate in restocking of forest, they must get a proportionate share from results base payments from reduced carbon emissions.

The analysis of forest cover revealed that since 2010 the Kotli Sattian Forest is decreasing at a small rate of -0.23 hectares per year, causing 12 tonnes CO2 eq emissions annually. Enhancing the forest resource base by 10%, will require 6 ha of forest cover to be added annually, which will increase the forest cover to 5,188.5 ha instead of 5,183.4 ha in the business-as-usual scenario by the year 2031.

The activities included in this PFMP if properly implemented, will further enhance this trend through collaborative forest management efforts of the stakeholders. This plan has proposed distribution of carbon and non-carbon benefits accrued by the implementation of plan according to which 80% benefits will go to the Government, and 20% will go to the customary right holders and users. These benefits will only be distributed if the targets are achieved. The plan therefore provides scenarios to reduce or increase benefits so that the stakeholders can enjoy results-based payment and benefits. The success of this plan, therefore, is contingent to the commitment of all the stakeholders involved.

A specific and definitive distribution of benefits in case of REDD+ programme is yet to be developed by the government, which will form basis for sharing of benefits in the case of private forests. This proposed ratio will be finalized or confirmed only after finalizing Punjab's benefit sharing mechanism.

5. Conflict and Grievance Redressal Mechanism

5.1 Conflict within the community

Traditionally, in village culture ***Jirga*** system resolves conflicts within the community and the decisions taken are acceptable for the parties. Under REDD+ redressal, it is suggested that the same ***Jirga*** may take lead role to resolve conflicts arising among the community regarding implementation of REDD+ activities. The structure and function of J*irga* system has been described in earlier section in this document.

5.2 Conflict between the villages

The VCCs with the help of J*irgas* of the village will settle any disputes between the villages. Any unsettled disputes will be referred to the district implementation committee which will be the final authority for conflict resolution.

5.3 Community's grievance towards the Forest Department

The REDD+ is a new concept for communities as well as for the FD, therefore both partners (Community and the FD) might be facing some conflict of interest in due course of time. In case of any such grievances arises, these will be dealt through the grievance redressal mechanism developed under the REDD+ obligation. This mechanism is also reflected well in Provincial REDD+ Action Plan.

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- ADB, 2017. Climate change profile of Pakistan. Asian Development Bank 6 ADB Avenue, Mandaluyong City, 1550 Metro Manila, Philippines

Annex: 1. Socio-economic data of Coniferous Forests of Punjab

I. Stakeholder group (names)	Communities of villages - Users of Coniferous Forests of Punjab
2. General information Location of stakeholder groups (e.g., different villages/hamlets in and outside forest area) and names and indicate on map if possible	See Figure 1 for location
3. Social organization in the forest area	
A. Traditional organizations (e.g., Jirga)	
Organization (name; purpose; membership) Every village has a Jirga or Council of elderly people	Managing matters related to village including communal resources and conflict resolution/ all households through selected members
B. Formal organization (e.g., social; welfare organization or village development committee	
Organization (name; purpose; membership)	None
Organization (name; purpose; membership)	None
4. Use of forest and forest area (for what are you using the forest area?)	
Timber for personal use like house construction, etc. (where; locate on the map)	Yes, all over the forest, minor uses as small implements and tool handles, shelters for animals etc
Timber for commercial selling (where; locate on the map)	No
Firewood (where; locate on the map)	Yes, all over the forest
Grazing (where; locate on the map)	Yes, all over the forest,
Grass cutting (where; locate on the map	Yes, all over the forest,
Other products, e.g., mushroom, vegetables, stones, minerals, medicinal plants (where; locate on the map)	Mushrooms, medicinal plants from all over the forest
Forest areas related daily labour/employment (employed by whom; for what?)	Local community works as daily labour inside forest during execution of forest operations
Tourism (what; where; locate on the map)	Murree is very famous destination of tourists, Patriata chairlift and cable car has added to its attraction. Area of Kotli Sattian and Kahuta tehsils is still under explored and utilised.
What would it mean if you had no access to these forest products? (Any alternatives? Threat to livelihood?)	The people have little stake in agriculture however, the major source of lively hood is pastoral, people earn a lot from rearing cattle's, sheep, and goats. People would be forced to migrate if grazing, and firewood is not allowed. People have to buy fodder and costly substitute of energy (LPG) and construction material (concrete). People will not afford buying these products if access to forest products are not available. Specially land less community will suffer a lot.

5. Rights and concessions in forest area	
Do you have formal, legal, or traditional, customary rights on forest products (use)? Which ones? If documented rights, where?	Yes, we have certain rights and privileges, We can collect dead dry wood for fuel, small timber for agriculture use, brush wood for fencing and making shelters for livestock. We can graze our livestock in forest which is our main source of income.
Timber	We have the right to get timber for house construction and funeral. We collect timber specially tool handles as per need with the permission of the authorities keeping in view the sustainability of produce.
Fodder: grass cutting/grazing	Yes
Firewood	Yes (dead fallen, and pruning of trees)
Other products:	Yes (NTFP) honey, medicinal plants, mushrooms
6. Conflicts / disputes	
On different land uses: Describe nature of conflict, between which groups and put location on map if possible	No major conflict, small disputes are resolved at village and range level.
Do they have effect on forest management? And how?	No
On social issues: Describe nature of conflict, between which groups and put location on map if possible	None
Do they have effect on forest management? And How?	None
Existing Conflict resolution mechanisms: - traditional (e.g., Jirga) - formal (court)	Through local *Jirga*, FOREST DEPARTMENT, Revenue Department, and Court of Law.
7. Other Forest Management Projects	
Are there any other Forest Management Projects in the area? If so, which projects? What are their activities?	Ten Billion Trees Tsunami project is under implementation. This will have positive impacts on forest cover. It is also providing job opportunities to unskilled labour. Resin tapping from chir pine forest was a good source of employment but has been discontinued. this should be started again to provide jobs and to protect forest from fire.

Annex: 2. Participatory Stakeholder Analysis

STAKEHOLDER	**INTEREST in Forest**		**INFLUENCE on Forest**	
	Type of interest	Level of interest*	Type of influence	Level of influence*
Forest Department	Sustainable management of forest resources and avoid forest degradation as legal representative of the Government	3	Legal controller: decision on use, protection, and improvement of forest resources Ban on timber extraction	3
Community -households with no land ownership	Grazing, Timber Fuel wood, NTFP, Water	3	Local use and control of forest benefits; De facto control to stop any illegal harvesting of timber and grazing by outsiders in areas near their settlements	2
Community-Households with land holding	Grazing, Timber Fuel wood, NTFP, Water Protecting cropland, establishing tourist facilities on their properties	3	Local use and control of forest benefits; De facto control to stop any illegal harvesting of timber and grazing by outsiders Control on free grazing, securing cropland and adjoining forests	3
Law & Enforcement Agencies	None	0	Legal action on need basis	1
Village Conservation Committee and *Jirga*	Protection of Forest, extraction of fuel wood and small timber	2	Maintaining timber extraction ban. Consensus building among communities for forest protection, advocacy for rights of the legal users, conflict resolution	3
Illegal cutting of wood (they have legal rights for domestic use but also harvest for sale)	Illegal harvesting of timber and firewood for cash income	2	Manipulation / illegal act	1
Revenue Department	None	0	Land monitoring and related dispute management	2
Tourism Department	Sustainable management of forest resources and avoid forest degradation to enhance tourism as l representative of the Government	3	Advise on use, protection, and improvement of forest resources to enhance tourism	3
Ministry of Climate Change	Sustainable management of forest resources and avoid forest degradation		Indirect influence through policies and (international) lobby	

***Scale**	**Level of interest**	**Level of influence**
0	None	Negligible or ignored
1	Little	Little
2	Significant	Significant

Annex: 3. Plot level Carbon Stock

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
2	72.5798	33.86	Chir	Pinus roxburghii	46	9		339.0687972	3.39	1.59	0.40
2	72.5798	33.86	Chir	Pinus roxburghii	47	6.3		249.5973032	2.50	1.17	0.29
2	72.5798	33.86	Reen	Quercus incana	61	5.1	0.635	647.2537122	6.47	3.04	0.76
2	72.5798	33.86	Chir	Pinus roxburghii	37	5.4		134.5557469	1.35	0.63	0.16
2	72.5798	33.86	Chir	Pinus roxburghii	35	7.3		162.0458725	1.62	0.76	0.19
2	72.5798	33.86	Chir	Pinus roxburghii	37	4.7		117.4927974	1.17	0.55	0.14
2	72.5798	33.86	Chir	Pinus roxburghii	65	10.4		767.2368113	7.67	3.61	0.90
2	72.5798	33.86	Reen	Quercus incana	51	2.2	0.635	200.8647554	2.01	0.94	0.24
2	72.5798	33.86	Chir	Pinus roxburghii	17	16.9		89.76021533	0.90	0.42	0.11
2	72.5798	33.86	Chir	Pinus roxburghii	62	20.8		1376.760521	13.77	6.47	1.62
2	72.5798	33.86	Chir	Pinus roxburghii	9	1.7		2.750076645	0.03	0.01	0.00
2	72.5798	33.86	Chir	Pinus roxburghii	44	9.8		337.8306002	3.38	1.59	0.40
2	72.5798	33.86	Chir	Pinus roxburghii	15	4.9		20.97679795	0.21	0.10	0.02
2	72.5798	33.86	Reen	Quercus incana	12	3.1	0.635	16.65915717	0.17	0.08	0.02
3	73.52	33.8	Chir	Pinus roxburghii	61	21.5		1377.539186	13.78	6.47	1.62
3	73.52	33.8	Chir	Pinus roxburghii	58	15.5		906.8286457	9.07	4.26	1.07
3	73.52	33.8	Chir	Pinus roxburghii	49	17.2		722.1338037	7.22	3.39	0.85
3	73.52	33.8	Chir	Pinus roxburghii	55	20.4		1069.026031	10.69	5.02	1.26
3	73.52	33.8	Chir	Pinus roxburghii	53	21.6		1051.500493	10.52	4.94	1.24
3	73.52	33.8	Chir	Pinus roxburghii	52	16.1		760.3188941	7.60	3.57	0.89
3	73.52	33.8	Chir	Pinus roxburghii	54	19.3		977.0343046	9.77	4.59	1.15
3	73.52	33.8	Chir	Pinus roxburghii	50	16.4		717.0575472	7.17	3.37	0.84
4	73.49	33.77	Chir	Pinus roxburghii	58.2	23.5		1370.788832	13.71	6.44	1.61
4	73.49	33.77	Chir	Pinus roxburghii	85.7	26.5		3282.592712	32.83	15.43	3.86
4	73.49	33.77	Chir	Pinus roxburghii	72	25.5		2249.723325	22.50	10.57	2.64
4	73.49	33.77	Chir	Pinus roxburghii	71.1	19.7		1706.063766	17.06	8.02	2.00
4	73.49	33.77	Chir	Pinus roxburghii	67.9	25		1967.84298	19.68	9.25	2.31
4	73.49	33.77	Chir	Pinus roxburghii	72	19.5		1731.163639	17.31	8.14	2.03
4	73.49	33.77	Chir	Pinus roxburghii	77.6	25.1		2564.27872	25.64	12.05	3.01

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
4	73.49	33.77	Chir	Pinus roxburghii	66.3	23.7		1782.827212	17.83	8.38	2.09
4	73.49	33.77	Chir	Pinus roxburghii	59.8	23.7		1457.380052	14.57	6.85	1.71
4	73.49	33.77	Chir	Pinus roxburghii	92.2	21.9		3143.150429	31.43	14.77	3.69
4	73.49	33.77	Chir	Pinus roxburghii	64.7	23.4		1678.73277	16.79	7.89	1.97
5	73.48	33.75	Shisham	Dalbergia sissoo	22	6.4	0.6934	120.2419517	1.20	0.57	0.14
5	73.48	33.75	Chil	Pinus roxburghii	10	3.7		7.221221096	0.07	0.03	0.01
5	73.48	33.75	Chil	Pinus roxburghii	9	3.9		6.188111608	0.06	0.03	0.01
5	73.48	33.75	Chil	Pinus roxburghii	18	4		24.56571015	0.25	0.12	0.03
5	73.48	33.75	Shisham	Dalbergia sissoo	11	4	0.6934	19.64374837	0.20	0.09	0.02
5	73.48	33.75	Shisham	Dalbergia sissoo	10	2	0.6934	8.291260594	0.08	0.04	0.01
5	73.48	33.75	Chil	Pinus roxburghii	31	11.3		195.8915339	1.96	0.92	0.23
5	73.48	33.75	Shisham	Dalbergia sissoo	17	2.6	0.6934	30.17627102	0.30	0.14	0.04
5	73.48	33.75	Shisham	Dalbergia sissoo	19	5.1	0.6934	72.3653739	0.72	0.34	0.09
5	73.48	33.75	Shisham	Dalbergia sissoo	8	3.4	0.6934	9.002650018	0.09	0.04	0.01
6	73.56	33.75	Chil	Pinus roxburghii	23	15		144.1901209	1.44	0.68	0.17
6	73.56	33.75	Chil	Pinus roxburghii	23	15		144.1901209	1.44	0.68	0.17
6	73.56	33.75	Chil	Pinus roxburghii	23	15		144.1901209	1.44	0.68	0.17
6	73.56	33.75	Chil	Pinus roxburghii	23	15		144.1901209	1.44	0.68	0.17
6	73.56	33.75	Chil	Pinus roxburghii	23	15		144.1901209	1.44	0.68	0.17
6	73.56	33.75	Chil	Pinus roxburghii	23	15		144.1901209	1.44	0.68	0.17
6	73.56	33.75	Chil	Pinus roxburghii	23	15		144.1901209	1.44	0.68	0.17
6	73.56	33.75	Chil	Pinus roxburghii	23	15		144.1901209	1.44	0.68	0.17
6	73.56	33.75	Chil	Pinus roxburghii	23	15		144.1901209	1.44	0.68	0.17
6	73.56	33.75	Chil	Pinus roxburghii	21	15		120.7145227	1.21	0.57	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	15		120.7145227	1.21	0.57	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	15		120.7145227	1.21	0.57	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	15		120.7145227	1.21	0.57	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	15		120.7145227	1.21	0.57	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	21	14.5		116.7829164	1.17	0.55	0.14
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14.5		106.1666563	1.06	0.50	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14		102.5895829	1.03	0.48	0.12
6	73.56	33.75	Chil	Pinus roxburghii	20	14		102.5895829	1.03	0.48	0.12
6	73.56	33.75	Chil	Pinus roxburghii	16	14		66.34363223	0.66	0.31	0.08
6	73.56	33.75	Chil	Pinus roxburghii	15	14		58.48546352	0.58	0.27	0.07

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
6	73.56	33.75	Chil	Pinus roxburghii	15	14		58.48546352	0.58	0.27	0.07
7	73.53	33.75	Chil	Pinus roxburghii	71	33		2815.974008	28.16	13.24	3.31
7	73.53	33.75	Chil	Pinus roxburghii	78	36		3683.886725	36.84	17.31	4.33
7	73.53	33.75	Chil	Pinus roxburghii	83	41		4722.599935	47.23	22.20	5.55
7	73.53	33.75	Chil	Pinus roxburghii	81	37		4073.289504	40.73	19.14	4.79
8	73.52	33.73	Chil	Pinus roxburghii	56	30		1613.848786	16.14	7.59	1.90
8	73.52	33.73	Chil	Pinus roxburghii	56	29		1561.286609	15.61	7.34	1.83
8	73.52	33.73	Chil	Pinus roxburghii	63	31		2097.455782	20.97	9.86	2.46
8	73.52	33.73	Chil	Pinus roxburghii	67	36		2737.431059	27.37	12.87	3.22
8	73.52	33.73	Chil	Pinus roxburghii	65	34		2439.992141	24.40	11.47	2.87
8	73.52	33.73	Chil	Pinus roxburghii	50	26		1124.658044	11.25	5.29	1.32
8	73.52	33.73	Chil	Pinus roxburghii	63	31		2097.455782	20.97	9.86	2.46
8	73.52	33.73	Chil	Pinus roxburghii	63	30		2031.347281	20.31	9.55	2.39
8	73.52	33.73	Chil	Pinus roxburghii	55	27		1405.676824	14.06	6.61	1.65
8	73.52	33.73	Chil	Pinus roxburghii	44	23		777.2631065	7.77	3.65	0.91
8	73.52	33.73	Chil	Pinus roxburghii	64	34		2367.202647	23.67	11.13	2.78
9	73.47	33.72	Chil	Pinus roxburghii	9	4.9		7.733566915	0.08	0.04	0.01
9	73.47	33.72	Chil	Pinus roxburghii	34	8.1		169.4947508	1.69	0.80	0.20
9	73.47	33.72	Chil	Pinus roxburghii	27	4.2		56.88549967	0.57	0.27	0.07
9	73.47	33.72	Chil	Pinus roxburghii	68	17.3		1377.433234	13.77	6.47	1.62
9	73.47	33.72	Chil	Pinus roxburghii	68	18.5		1470.677864	14.71	6.91	1.73
9	73.47	33.72	Chil	Pinus roxburghii	65	16.6		1211.358075	12.11	5.69	1.42
9	73.47	33.72	Chil	Pinus roxburghii	15	3.9		16.78485081	0.17	0.08	0.02
9	73.47	33.72	Chil	Pinus roxburghii	19	5.9		39.90767826	0.40	0.19	0.05
9	73.47	33.72	Chil	Pinus roxburghii	8	2.3		2.935239724	0.03	0.01	0.00
9	73.47	33.72	Chil	Pinus roxburghii	18	4.5		27.56068402	0.28	0.13	0.03
9	73.47	33.72	Chil	Pinus roxburghii	8	2.8		3.556994946	0.04	0.02	0.00
9	73.47	33.72	Chil	Pinus roxburghii	7	3.5		3.407640637	0.03	0.02	0.00
10	73.43	33.73	Chir	Pinus roxburghii	21	16		128.5686772	1.29	0.60	0.15
10	73.43	33.73	Chir	Pinus roxburghii	18	13.6		81.17546435	0.81	0.38	0.10
10	73.43	33.73	Chir	Pinus roxburghii	38	18		459.4327518	4.59	2.16	0.54
10	73.43	33.73	Chir	Pinus roxburghii	32	19		346.2315405	3.46	1.63	0.41

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
10	73.43	33.73	Chir	Pinus roxburghii	17	22		116.1318043	1.16	0.55	0.14
10	73.43	33.73	Chir	Pinus roxburghii	18	12		71.83459587	0.72	0.34	0.08
10	73.43	33.73	Chir	Pinus roxburghii	19	17.5		115.4092356	1.15	0.54	0.14
10	73.43	33.73	Chir	Pinus roxburghii	16	19		89.39940627	0.89	0.42	0.11
10	73.43	33.73	Chir	Pinus roxburghii	15	16		66.63289321	0.67	0.31	0.08
10	73.43	33.73	Chir	Pinus roxburghii	17	12.4		66.33640032	0.66	0.31	0.08
10	73.43	33.73	Chir	Pinus roxburghii	20	13		95.42638767	0.95	0.45	0.11
10	73.43	33.73	Chir	Pinus roxburghii	47	16		620.2802612	6.20	2.92	0.73
10	73.43	33.73	Chir	Pinus roxburghii	63	21		1433.809431	14.34	6.74	1.68
10	73.43	33.73	Chir	Pinus roxburghii	46	19.5		721.5326227	7.22	3.39	0.85
10	73.43	33.73	Chir	Pinus roxburghii	40	18		507.8514083	5.08	2.39	0.60
10	73.43	33.73	Chir	Pinus roxburghii	27	15.3		201.0768697	2.01	0.95	0.24
10	73.43	33.73	Chir	Pinus roxburghii	33	16		310.8687991	3.11	1.46	0.37
10	73.43	33.73	Chir	Pinus roxburghii	43	43		1369.222225	13.69	6.44	1.61
10	73.43	33.73	Chir	Pinus roxburghii	17	40		208.2279075	2.08	0.98	0.24
10	73.43	33.73	Chir	Pinus roxburghii	19.7	46		318.3273242	3.18	1.50	0.37
10	73.43	33.73	Chir	Pinus roxburghii	18	49		283.8649954	2.84	1.33	0.33
11	73.42	33.75	Chil	Pinus roxburghii	40	18.1		510.6068885	5.11	2.40	0.60
11	73.42	33.75	Chil	Pinus roxburghii	37	18		436.1118846	4.36	2.05	0.51
11	73.42	33.75	Chil	Pinus roxburghii	53	16.7		817.8538066	8.18	3.84	0.96
11	73.42	33.75	Chil	Pinus roxburghii	40	16.9		477.5171235	4.78	2.24	0.56
11	73.42	33.75	Chil	Pinus roxburghii	58	18.9		1100.648143	11.01	5.17	1.29
11	73.42	33.75	Chil	Pinus roxburghii	38	15.1		386.9938651	3.87	1.82	0.45
11	73.42	33.75	Chil	Pinus roxburghii	63	20		1367.086027	13.67	6.43	1.61
11	73.42	33.75	Chil	Pinus roxburghii	35	13		284.7206775	2.85	1.34	0.33
11	73.42	33.75	Chil	Pinus roxburghii	46	17.2		638.2925873	6.38	3.00	0.75
11	73.42	33.75	Chil	Pinus roxburghii	36	11.7		271.4103809	2.71	1.28	0.32
11	73.42	33.75	Chil	Pinus roxburghii	40	18		507.8514083	5.08	2.39	0.60
11	73.42	33.75	Chil	Pinus roxburghii	53	16		784.3546744	7.84	3.69	0.92
11	73.42	33.75	Chil	Pinus roxburghii	40	19.3		543.6455395	5.44	2.56	0.64
11	73.42	33.75	Chil	Pinus roxburghii	46	15		558.428403	5.58	2.62	0.66
11	73.42	33.75	Chil	Pinus roxburghii	37	13.4		326.9012059	3.27	1.54	0.38

Plot No.	Latitude	Longitude	Species Name	Scientific Name	DBH (cm)	Tree height (m)	Wood Density (g/cm3)	AGB (kg)	AGB (ton/ha)	AGC (ton/ha)	BGC (ton/ha)
11	73.42	33.75	Chil	Pinus roxburghii	25	19		213.7679898	2.14	1.00	0.25
12	73.5	33.82	Chil	Pinus roxburghii	40	16.3		460.951931	4.61	2.17	0.54
12	73.5	33.82	Chil	Pinus roxburghii	35	12.4		271.8788949	2.72	1.28	0.32
12	73.5	33.82	Chil	Pinus roxburghii	22	6.7		60.16774608	0.60	0.28	0.07
12	73.5	33.82	Chil	Pinus roxburghii	34	8.4		175.6234537	1.76	0.83	0.21
12	73.5	33.82	Chil	Pinus roxburghii	31	9.4		163.6544902	1.64	0.77	0.19