# Participatory Forest Management Plan (PFMP)
## Makhnyal Valley Forest, Haripur
## 2022 – 2031



**Makhnyal Valley Conservation Committee
& Divisional Forest Officer Haripur**

**Forestry, Environment and Wildlife Department
Khyber Paktunkhwa Pakistan**

**March 2022**

**Credentials:**

# Participatory Forest Management Plan (PFMP)
## Makhnyal Valley Forest, Haripur

## <u>Endorsement</u>

1. <u>**Chairman, Makhnyal Valley Conservation Committee**</u>

2. <u>**REDD+ Focal Person, KP Forest Department**</u>

**Disclaimer:**

This Participatory Forest Management Plan is not a funding commitment from Forestry, Environment and Wildlife Department Khyber Pakhtunkhwa (KP). It is a proposal to be considered for future implementation of REDD+ Programme if funds are committed by the KP 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 KP will form the basis for implementing this Plan. Information on these aspects are suggestive and not binding on the Forestry, Environment and Wildlife Department KP and any other stakeholders mentioned in this document.

وضاحت

خیبر پختونخواہ کا محکمہ جنگلات ، ماحولیات وجنگلی حیات 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 خیبر پختونخواہ کے محکمہ جنگلات ، ماحولیات وجنگلی حیات کے بنائے گئے انتظامی وہ مالی رہنمااصولوں کے تحت ہوگا۔

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# Acronyms

| | |
|---|---|
| AGB | Above Ground Biomass |
| BGB | Below Ground Biomass |
| ANR | Assisted Natural Regeneration |
| FE&WD | Forestry, Environment & Wildlife Department |
| FCPF | Forest Carbon Partnership Facility |
| GIS | Geographic Information System |
| GOP | Government of Pakistan |
| JFMC | Joint Forest Management Committee |
| LPG | Liquid Petroleum Gas |
| MW | Mega Watt |
| MoCC | Ministry of Climate Change |
| NCCP | National Climate Change Policy |
| NTFP | Non-Timber Forest Product |
| PFMP | Participatory Forest Management Plan |
| PFRA | Participatory Forest Resource Assessment |
| PSDP | Public Sector Development Programme |
| REDD+ | Reducing Emission from Deforestation and Forest Degradation |
| TFCC | Planning Commission Task Force on Climate Change |
| $tCO_2$ | Ton Carbon dioxide (Carbon credit) |
| VFP&CC | Village Forest Protection & Conservation Committee |
| 10 BTTP | 10 Billion Trees Tsunami Project |

# Executive Summary

Makhnyal Valley Forest located in District Haripur of Abbottabad Civil Division is one of the three sites selected by the Forestry, Environment & Wildlife Department in consultation with Makhnyal stakeholders as a pilot site to demonstrate implementation of REDD+ activities in Khyber Pakhtunkhwa. Makhnyal forest border with Islamabad and are under pressure due to rapid urbanization and increasing tourism in the area due to its close proximity to Islamabad.

This management plan 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 (PFMP) have been developed for REDD+ implementation in all four Provinces, Gilgit-Baltistan and Azad Jammu and Kashmir.

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 readiness phase. Pakistan has made substantial progress in meeting REDD+ readiness requirements. Pakistan has developed a National REDD+ Strategy in 2021. Whereas the Khyber Pakhtunkhwa Forests, Environment and Wildlife Department has developed a Subnational / Provincial REDD+ Action Plan. This action plan is a decentralised framework for KP to proceed with REDD+ implementation. PFMP 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 successful implementation of REDD+.

The analysis of forest cover revealed that since 2011 the Makhnyal forest is increasing at the rate of 76.90 hectares per year and sequestering 23,410 tonnes $CO_2$ eq annually. This increase is clearly a case of steady progress in forest cover. With the current forest cover increase trend and the available area for the site, the site will achieve 100% forest cover by 2023. In fact, the site would need to thin the forest to improve the health of the trees as currently the forest contains a lot of pole crop at a very close spacing and profuse regeneration in the area. This plan has proposed distribution of carbon and non-carbon benefits accrued by the implementation of plan according to which in case of Reserved forests 80% benefits will go to the Government, and 20% will go to the customary right holders out of which 10% will go to the users. These benefits will only be distributed if the targets are achieved. In case of Guzara forests, the benefit sharing will change. The owners will receive 80% whereas the government will receive 20%, out of which customary users will receive 10% of the benefits as an incentive to reduce degradation. The plan is founded on results-based payment and benefits. The success of this plan, therefore, is contingent to the commitment of all the stakeholders involved.

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 Forest Department in consultation with the relevant stakeholders. The plan will be implemented by village and district committees to be notified by the Forest Department, along with the relevant stakeholders.

**خلاصہ**

خیبر پختونخوا کے ضلع ہری پور میں واقع وادی مُخنیال کا جنگل محکمۂ جنگلات، ماحولیات اور جنگلی حیات کی جانب سے منتخب کردہ اُن تین مقامات میں سے ایک پائلٹ سائٹ کے طور پر اہم فریقین 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 مشترک 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 جبکہ خیبر پختونخوا کے جنگلات، ماحولیات اور جنگلی حیات کے محکمے نے صوبائی سطح پر ایک جامع ریڈ پلس ایکشن پلان تیار کیا ہے۔ خیبر پختونخوا 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 کی تیاری کے منصوبوں 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 منظر ناموں یعنی موجودہ حالات اور اخراج میں کمی کا اندازہ لگایا جائے گا۔ اس مقصد کے لیے سماجی اقتصادی شراکتی تفصیلی تجزیے، ماحولیاتی صورتِ حال اور چیلنجز اور منصوبے میں واضح کردہ جنگلاتی وسائل کا جائزہ لیا جائے گا۔ یہ منصوبہ شراکت داروں کے کردار اور وزنے داریوں کے تجزیے، جنگلات پر انحصار کرنے والی لوگوں کے حقوق کے استعمال، تنازعات کے حل اور مشترک فوائد کے حصول کا طریقہ کار بھی پیش کرتا ہے۔ ریڈ پلس پر کامیاب عمل درآمد اور شراکتی سرگرمیوں کا تعین کرنے کے لیے یہ معلومات ضروری ہیں۔

جنگل کے رقبے کے تجزیے سے پتا چلتا ہے کہ 2011ء کے بعد سے مُخنیال جنگل میں 76.90 ہیکٹر سالانہ کی شرح سے اضافہ ہو رہا ہے جس سے سالانہ 23,410 ٹن کاربن ڈائی آکسائڈ کا انجذاب عمل میں آ رہا ہے۔ یہ اضافہ واضح طور پر جنگلات کے رقبے میں مسلسل پیش رفت کی مثال ہے۔ جنگل میں اضافے کے اس رجحان اور دستیاب زمین کے وجہ سے اس سائٹ پر جنگل 2023 تک 100 فی صد ہو جائے گی جب کہ درختوں کی صحت کے لیے جنگل کو ہلکا کرنے کی ضرورت ہو گی۔ اس PFMP میں شامل سرگرمیاں اگر مناسب طریقے سے لاگو ہوتی ہیں تو جنگلات کے مربوط انتظام کے لیے فریقین کی کوششوں اس جنگل کی ترقی کو مزید فروغ دیں گی۔

مجوزہ منصوبے کے مطابق اس منصوبے پر عمل درآمد سے حاصل ہونے والے کاربن اور نان کاربن محصولات میں سے محفوظ جنگلات کے صورت میں 80 فی صد حکومت کو حاصل ہوں گے اور 20 فی صد جنگل کے حقوق رکھنے والوں اور صارفین کو ملیں گے۔ جب کہ گذارہ جنگلات کے صورت میں 80 فی صد مالکان کو حاصل ہوں گے اور 20 فی صد حکومت کو ملیں گے جس میں سے 10 فی صد جنگل کے استعمال کے حقوق رکھنے والے صارفین کو جنگلات کی تنزلی میں کمی میں معاونت کے لیے ملیں گے۔ یہ فوائد صرف اہداف حاصل ہونے کی صورت میں تقسیم کیے جائیں گے۔ اس لیے اس منصوبہ فوائد میں کمی یا اضافے کا منظر نامہ پیش کرتا ہے تاکہ فریقین نتائج پر مبنی ادائیگی اور فوائد سے مستفید ہو سکیں۔ لہٰذا اس 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۔ یہ مشترک فوائد پر مبنی خیبر پختونخوا 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 مدت دس سال ہو گی تاہم یہ منصوبہ ایک زندہ دستاویز ہو گا اور سالانہ جائزے کے لیے پیش ہو گا۔ 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 Ministry of Climate Change (MOCC), Government of Pakistan (GoP) is implementing a REDD+ readiness programme funded by the Forest Carbon Partnership Facility (FCPF) of the World Bank. The Khyber Pakhtunkhwa government is committed to pursue REDD+ under its Green Growth initiatives since 2013 to mitigate climate change effects. This Participatory Forest Management Plan (PFMP) is to demonstrate integration and implementation of REDD+ activities in forest management in various socio-ecological systems.

The PFMP translates 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 contribute to mitigate global climate change. REDD+ also provides mechanisms for the enhancement, measurement, and trade of carbon.

This PFMP provides information including description of 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 to maintain forest as carbon pool have been explained in this plan. It is expected that the implementation of the PFMP will enable the stakeholders of Makhnyal Forest to trade carbon credits in the national and international markets 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.

The proposed activities include strengthening of social organization for communities to play a role in decision making such as issuance of timber permits, transportation of timber, assistance in regeneration of forests, manage grazing, NTFP promotion, linkages and promotion of tourism and wildlife activities. The area has a great potential for NTFP as a major source of livelihood. These include natural herbs, shrubs of economic importance and medicinal plants. Budget has been provided to sustainably manage these sources at local level. In order to reduce the pressure on natural forests alternative sources of energy such as solar energy, biomass technology, and energy efficient stoves/bio-briquette have been included.

## 1.2   Objectives of PFMP

**The specific objectives of this plan are as under:**
1. To promote sustainable forest management in Makhnyal Forests.
2. To protect, improve forest health and enhance Carbon stocks in Makhnyal forests while addressing drivers of deforestation and forest degradation
3. To enable the Makhnyal 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 (FPCF) 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. Makhnyal valley was one of the three potential sites selected for preparation of PFMP.

ii. Participatory data collection. Local community of Makhnyal 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 12 sample plots selected in Makhnyal Valley Forest. 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 KP Forest Department and relevant community.

**Haripur Forest Division, Makhnial Block, Khyber Pakhtunkhwa**



| | Sample Plots Location | |
|---|---|---|
| id | Y | X |
| 1 | 3742685.66 | 328488.22 |
| 2 | 3748409.86 | 329184.38 |
| 3 | 3744429.42 | 329823.66 |
| 4 | 3747286.01 | 332143.56 |
| 5 | 3744378.08 | 334763.73 |
| 6 | 3743846.93 | 332743.97 |
| 7 | 3746443.63 | 325902.22 |
| 8 | 3741886.91 | 325703.83 |
| 9 | 3744818.13 | 336938.24 |
| 10 | 3744580.66 | 327715.83 |
| 11 | 3742406.79 | 330531.28 |
| 12 | 3746417.68 | 328802.15 |

**Legend**
● Sample Plots
▭ Guzara Forests
▭ Reserve Forests
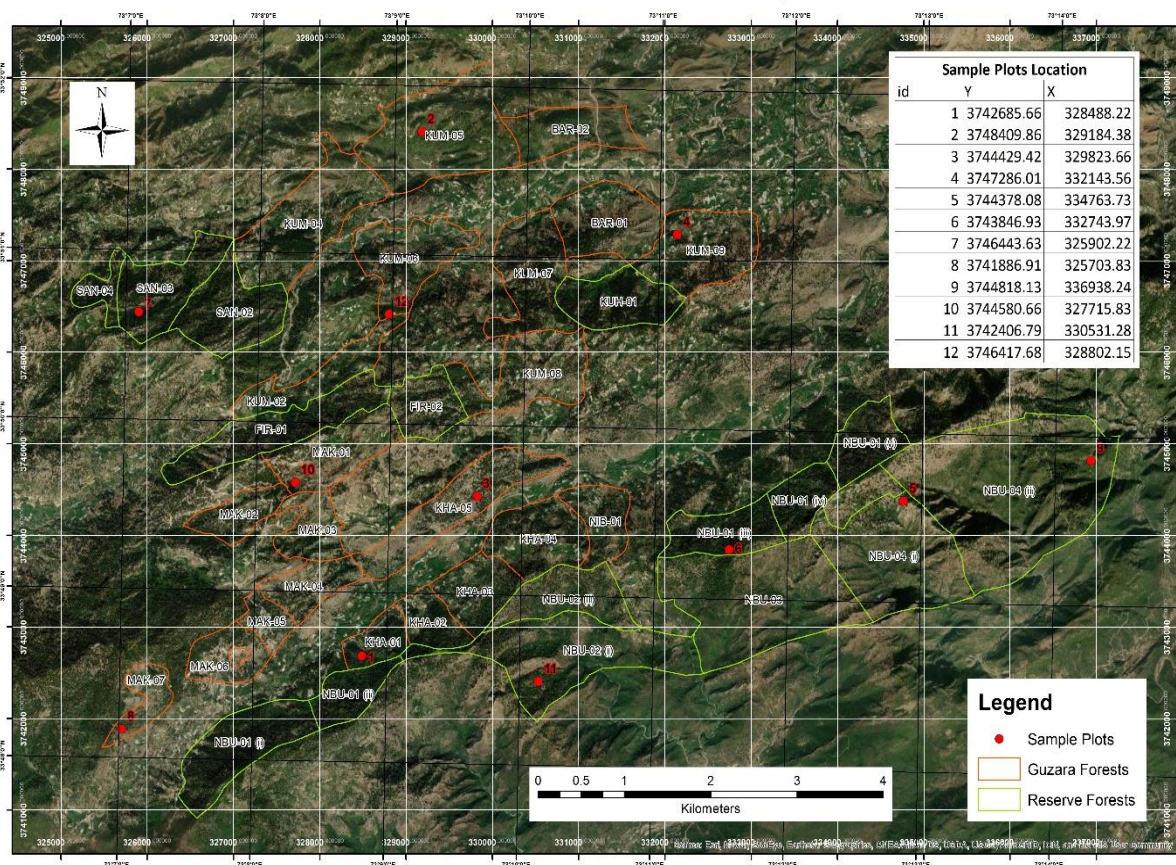
**Figure 1. Location of sample plot**

## 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+.

   **A. Global Commitment:**

Reducing Emissions from Deforestation and forest Degradation plus, the Sustainable Management of Forests, and the conservation and enhancement of forest carbon stocks (REDD+), is an essential part of the global efforts to mitigate climate change (FAO, 2021). The REDD+ is a framework created by Conference of Parties (CoP) of UNFCC to incentivise developing countries either to reduce emissions of Green House Gases (GHGs) or to increase sink of $CO_2$ in forest lands (UNFCC, 2021).

   **B. National Policies/commitments**

Pakistan is an active member of the international negotiation forum on climate change and making efforts to reduce emission reduction suiting to the priorities of its citizens (GCISC, 2018). Pakistan's report on intended Nationally Determined Contributions seeks 20% reduction of the current national GHG emissions (GOP, 2017). From 2016 onwards, continued investments in nature-based solutions (Nbs) through the largest ever afforestation programs in the history of the country Ten Billion Tree Tsunami Program (TBTTP) will sequester 148.76 MtCO2e emission over the next ten years.

The National Climate Change Policy (NCCP) 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. Mitigation in the forestry sector entails 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 most likely 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, 2010).

Pakistan has also approved its National Forest Policy 2015 with a goal of expansion, protection, and sustainable use of national forests, protected areas, natural habitats, and watersheds for restoring ecological functions, improving livelihoods and human health in line with the national priorities and international agreements.

### C.  Provincial Policies and commitments:

Climate Change remains a pressing challenge for KP province due to its vulnerability to its ecological diversity and relatively low coping capacity. KP has announced the country's first Provincial Strategy for Financing Climate Actions in 2018. KP has already promulgated its Forest Policy 1999. The Green Growth Initiatives of the province to enhance climate resilience has a high emphasis on forestry interventions since 2013.  The province also pioneered a Billion Trees Afforestation Project. A REDD+ Strategy was drafted, and Environmental and Social Management Framework (ESMF) was developed. Forest Reference Emission Level and Forest Reference Level (FREL/FRL) have also been developed for the province.  A draft Provincial REDD+ strategy is also prepared for KP. The role of forests in mitigation, adaptation, enhanced resilience, and improved livelihoods is duly recognized in the Strategy. Efforts are underway to identify Markets for sale of Carbon credits. Makhnyal has been identified as a pilot area. The activities mentioned in this PFMP to manage Makhnyal Forest align well with the actions suggested in draft KP REDD+ Strategy and Action Plan.

# 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. The results are presented in the following sections.

## 2.1 Ecological

### 2.1.1 Site description

Makhnyal is surrounded by Chir Guzara and Reserved Forests. The total area of Makhnyal Forest selected for demonstration of REDD+ is 5,388 ha comprising 36 forest compartments, of which Guzara forests are 3,893 ha and Reserved Forests are 1,495 ha. There is great Cohesion in the Community but the rivalry due to hidden sale of land in Guzara Forests through the property dealers to influential people is increasing rifts among the community members. The role of Forests, however, is critical for their livelihoods. The use of firewood, timber, grass, fodder, and other non-wood forestry products such as wild pomegranate, Bauhinia (Kachnar buds) etc. are inevitable in their life.
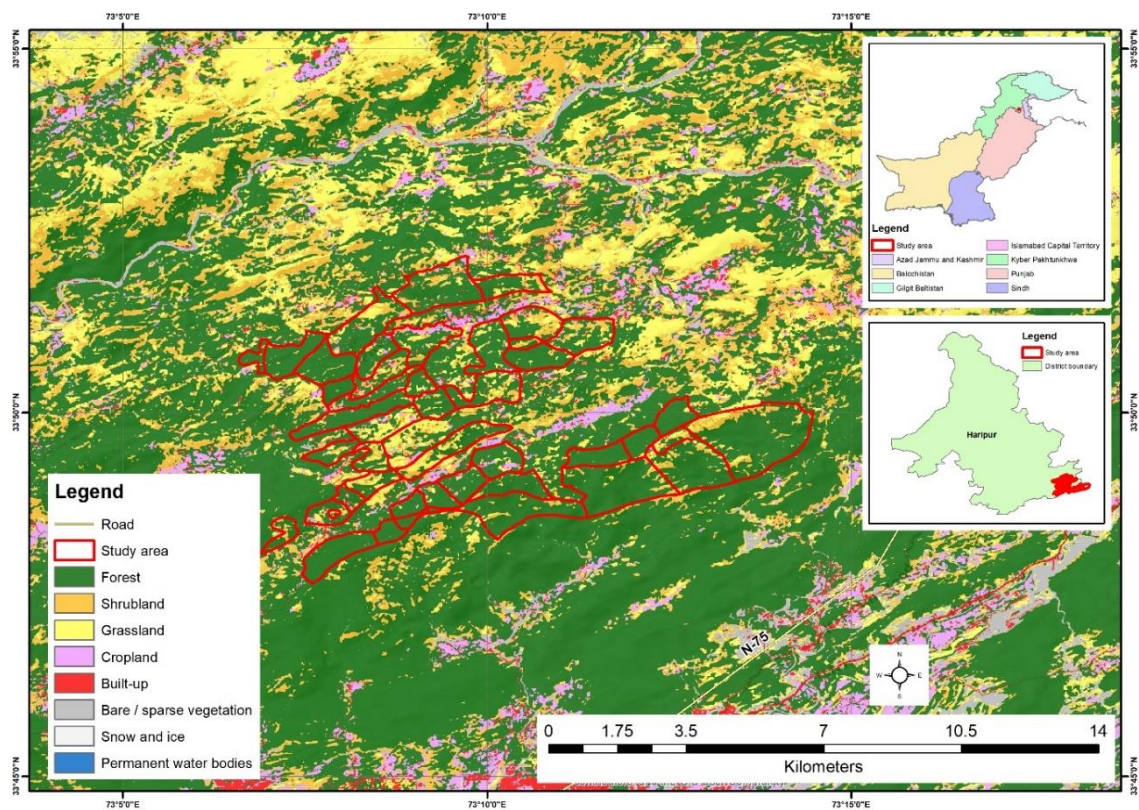


**Figure 2. Land Use and Location Map of Makhnyal Forest**

The above figure shows that inside the PFMP site forests dominate the land cover followed by grasslands whereas most of the croplands are outside the forest boundaries.

### 2.1.2 Location

The PFMP site is located at Latitude 33 49 48 N and Longitude 73 8 24 E. Makhnyal is a small scenic village, rapidly turning into a Town, located at the boundary of Khyber Pakhtunkhwa District Haripur with the Islamabad Capital Territory (ICT) Capital of Pakistan. The road leading via Daman e Koh, Pir Sohawa (Monal Restaurant) touches Makhnyal and join Haripur, Murree Road near Jabri. It is pertinent to mention that the site is located just 30 kilometres away from the Capital City Islamabad and is easily

approachable. It is therefore prone for encroachment for commercial activities as well as residential purposes.

### 2.1.3   Vegetation type

The main plant species include *Pinus roxburghii, Thuja orientalis, Cupressus sempervirens, Bombax ceiba, Bauhinia variegata, Cassia fistula, Juglans regia, Salvinia, Albizia lebbeck, Dalbergia sissoo, Ziziphus jujuba, Rosa indica, Dodonaea viscosa, Prunus* spp., Citrus spp. etc. Flora of Haripur Forest Division is attached as **Annex 3**. There are no restrictions on the collection of dry firewood, grazing and grass cutting from these Guzara Forests. For construction timber, the approval of Divisional Forest Officer is a Pre-requisite. In case of emergency the Range Officer could issue permits in anticipation of approval.

### 2.1.4   Climate

The elevation of Makhnyal valley ranges from 946 meters to 1378 meters above sea level. The climate type is sub-tropical where summer season of the valley is pleasant, and winters are cold. Monthly data regarding temperature and precipitation is presented in graph below:
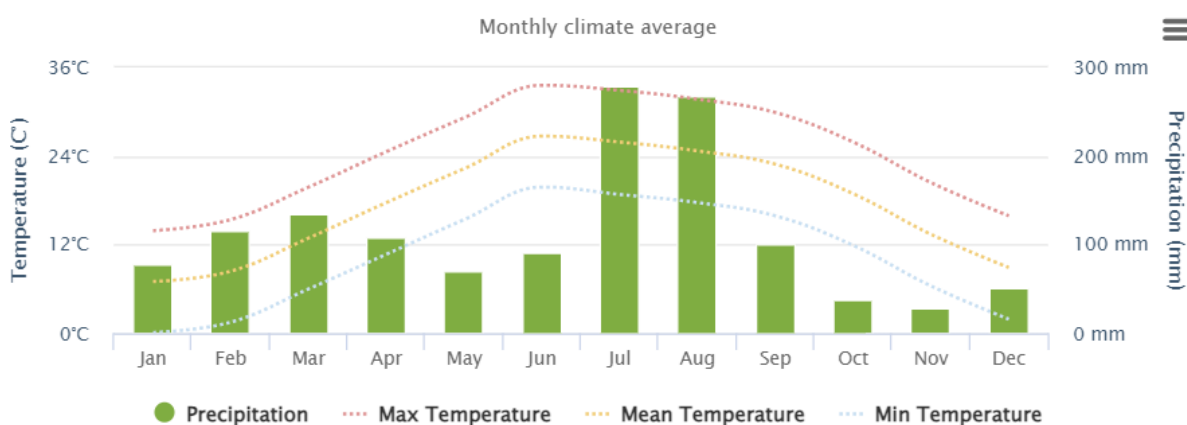


## 2.2   Socio-economic data

Socio-economic data of the Makhnyal was collected during Focus Group Discussion and key informant interviews. Summary of the data is given in **Annex 1** which is summarised below under major headings.

### 2.2.1   Demography

Total population of Makhnyal Sub-Division is about 170,000 with about 33,333 Households, whereas population dependent upon the project site is about 20370 with 3987 households. The entire population is Hindko speaking and is native of the area with nearly 2% community with Pashtun background. Majority households have close connections with the neighbouring cities due to irregular migration for jobs. Mostly young population goes out for jobs, women, and old / retired people (and also those who practice agriculture) live in the location. Most of the community is literate and exposed to other urban environments

### 2.2.2   Health and education

There are two basic health units and two private clinics. There is a higher secondary school, one girl's high school, one combined Govt middle school. There are 12 boy's primary and 7 girls' primary schools.

### 2.2.3  Sources of livelihoods

People are generally agriculturists with small land holding being practiced in the hilly slopping terraces. Due to limited and small uneconomical land holdings, they mostly seek employment in surrounding cities of Islamabad, Murree, Abbottabad, Haripur and Khanpur. They also keep herds of goats and sheep and graze in the Forest area. Scrub Forest and Chir regeneration is badly affected. For livestock there are two private clinics.

### 2.2.4  Dependence on forests

There are no restrictions on the collection of dry firewood, grazing and grass cutting from these Guzara Forests. For felling of trees for construction purpose the approval of Divisional Forest Officer is a Pre-requisite. In case of emergency the Range officer could issue in anticipation of approval. Local community is entitled for Seigniorage fee, but no payment had been made to the right holders for sale of trees from the Reserved Forests. There is a lot of illegal hunting & fishing by local community for personal use.

### 2.2.5  Forest rights

Makhnyal forest constitutes Reserved and Guzara Forests:

**a) Reserved Forests**
- The forests are owned by the state with concessions to forest users. The state has the right to withdraw concessions if circumstances require.
- The Reserved Forests comprise of eight (08) segments known as Kotla, Nilan Boto, Feroz pur, Sangreri, Kohmal, Narota, Babutri and Khui Kuma
- Chirpine and scrub forest species are the main crop
- Fire occurrence during summer is the main threat to these forests

**b) Guzara Forests**
- These forests are privately owned according to Rule 4, 5, 6 and 7 of KP Guzara Forest Rules 2004. These Guzara Forests are burdened with rights of harvesting of dry and green wood for meeting needs for fuel, agriculture implements and construction of houses of owners/right holders.
- Dry wood, whether standing or fallen, may be collected without any restrictions by owners as well as right holders
- The increase in population resulted in multiplication of rights causing denudation of some of these forest areas.

The local people (the owners as well as right holders) exercise the following rights and concessions in the forests:
- 80% share in the sale proceed to the entitled (in Guzara Forests)
- Timber on permit for construction and repair of residential buildings to the entitled
- Grazing of domestic livestock free of charge
- Grass cutting and lopping of fodder trees of charge.
- Collection of firewood free of charge.

The forest users of the forest products having no legal rights fall under neglected players and required special attention to safeguard their interests. The law enforcement agencies also play an active role when needed. They fall in the category of marginal players as this is not their core area of responsibility.

### 2.2.6 Changes in forests over time

During the last 30 years, biotic pressure including human, and cattle population exerted a considerable pressure on forests in the form of illicit cutting, lopping, and grazing with the result that the condition, distribution and quality of forest crop is considerably affected. With population increase, encroachments are rampant, illicit cutting of trees is common and forests are also cleared for cultivation. The whole area is open to uncontrolled grazing seriously hampers the survival of regeneration. Under BTTAP & 10 BTTAP, the area was increased by natural & artificial regeneration and became slightly better reversing the degradation conditions. Conflict between community and FD over permits issued by FD to outsiders is a main cause of conflict. Illegal harvesting of forest by local offenders is also a major issue. The demand for fuel wood is more that the annual increment of forest.

### 2.2.7 Stakeholders

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 and carbon pools (**Annex 2**). It helps in understanding the actual influence and interests and may help identifying the need for increasing the involvement of specific stakeholders:

#### A. Forest department

Forest Department has the main control in this area. There is regular watch & ward; herdsmen; fencing of enclosures and providing permits for felling. Joint watch and ward by FD and community is also in practice. Timber harvesting is based on permits issued by FD. Apart from Forest Guard appointed by Forest Department. Under 10BTTAP Nigehbans are appointed through Village Development Committees for protection and conservation of forests. On the demand of community, the FD has stopped issuing permits for commercial harvesting of forest.

#### B. Forest institutions

The socioeconomic data of Makhnyal Forest indicates that the following community institutions are relevant for management of Makhnyal Forest.

##### Traditional Jirga
The *Jirgas* system is in place in Makhnyal. The Jirga members are the notables and respective of the area headed by one of the members among them. The main purpose of the Jirga is to take decision 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 seek support of religious leaders or 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 Development Committee/Joint Forest Management Committee
In Makhnyal a Local Support under the control of Deputy Commissioner, Haripur namely Community Development Local Department (CDLD). CDLD is working actively in the to identify, prioritize and implementation development works in the area. Moreover, there are a number of local organizations were working in the area but recently these not active. A Joint Forest Management Committee (JFMC) was formed to protect the forests. However, the Village Development Committees (VDC) also formed under 10BTTP in order to protect and conserve the forest. These committees recommended the local for appointment as Naghebans for the conservation and protection of forests by establishing enclosures.

### 2.2.8  Stakeholders' analysis

The stakeholders identified were further analysed by using the influence-interest matrix to explore their type and level of influence and interest in forest management and carbon pools. **Table 1** helps understanding the actual influence and interests and may help in identifying the need for increasing the involvement of specific stakeholders.

Forest Department and local community are the major players with greater interest in forest management. The law enforcement agencies also occasionally contribute to forest protection when called in the 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. 10 BTAP and other forestry development projects have a high interest in KP's forest resources and also have a significant influence on local forest management and carbon pools on ground.

The Revenue Department deals with matters related to land as records and decisions related to land are entrusted with this department. The Revenue Department has little direct interest in forest management and only involves when there is a dispute regarding land ownership or distribution of share to respective shareholders/concessionists received from the forest department. Therefore, it falls in the category of low interest stakeholders. Property dealers and land grabbers have a very significant influence on conversion of land for housing and are playing a controlling role with respect to above ground carbon pools.

**Table 1. Interest influence matrix of Forest Management and Carbon pools**

|  | **Neglected players:** Need special attention to safeguard their interests | **Major players:** Need to be fully involved |
|---|---|---|
| **INTEREST** **High** Score 2 and 3 | Users Illegal harvesters | Forest Department Owners Property dealers & land *10 BTAP* |
|  | **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 |

## 2.3  Analysis of drivers of deforestation, forest degradation and abrriers to enhancement

In Makhnyal PFMP either the forest is Reserved or Guzara as earlier mentioned. In case of Reserved forests, the land and forest both belong to the Govt. and community has no rights and concessions in the forest except for the minor concessions such as right of way, etc. However, in case of Guzara forests land and forests are the property of the individuals being managed by the Forests department and are heavily burdened with the rights of ownership as well as use. Since these are demarcated forests so any violation like deforestation or encroachment is proceeded under Forest Ordinance 2002. However, extraction of timber for construction of houses in the area and outside, conversion of land for housing and expansion of agriculture land and smuggling are the major drivers of deforestation.

Degradation of Forests is a common phenomenon in Makhnyal Forests. These forests are under tremendous pressure to meet local use timber and firewood requirements of the community. The major driver as ranked in Table 4 below for degradation of Forests is Cutting of trees for Firewood. During the PRA, however, an estimated $0.4m^3$ firewood per person per year was calculated. This is followed by Cutting of trees for timber for construction and repair of houses of the local community. The annual per capita consumption was found about $0.1m^3$.

Other drivers of degradation are grazing in Forest and unplanned tourism activities.

**Table 2: Major drivers of deforestation, forest degradation and barriers to enhancement**

| Ranking | Major drivers | Underlying causes | Degree Of severity |
|---|---|---|---|
| **Deforestation** | | | |
| 2 | Cutting of Trees for Constructional Timber Local and outside | 1. Lack of Alternatives<br>2. Permit system for outsiders | 2 |
| 3 | Timber Smuggling for greed and Profit making | 1. High demand for Coniferous timber | 3 |
| 7 | Conversion of land for housing and expansion of agriculture land | 1. Increasing local population<br>2. Influential people wanting to construct their houses in the forest | 1 |
| **Forest Degradation** | | | |
| 1 | Cutting of Trees for Energy/fuelwood | 1. Lack of Alternate Energy Sources<br>2. Affordable alternates | 1 |
| | | 1. | |
| 5 | Issues in Law enforcement | 1. Lack of infrastructure<br>2. Lack of Equipment<br>3. Lack of Staff and Training<br>4. Slow and Low punishment to Culprits | 2 |
| 8 | Forest Fires | 1. Lack of fire management system and resources<br>2. Dry season in summer | 3 |
| **Barriers to Enhancement** | | | |
| 6 | Unplanned Tourism activities | 1. Lack of Coordination between Tourism and Forest Deptt<br>2. Lack of land use planning | 3 |
| 4 | Grazing in Forest Area | 2. Higher no. of Animal heads | 3 |

## 2.4 Carbon stock assessment of Makhnyal Forest

### 2.4.1 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 1. 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 Makhnyal Forest.

**Table 3.Plot level above and below ground carbon stock**

| Plot No. | Average AGC (tonnes/ha) | Average of BGC (tonnes/ha) |
|---|---|---|
| 1 | 1.384730303 | 0.346182576 |
| 2 | 13.20569965 | 3.301424913 |
| 3 | 5.389725222 | 1.347431306 |
| 4 | 0.922290749 | 0.230572687 |
| 5 | 27.06356813 | 6.765892031 |
| 6 | 2.640130969 | 0.660032742 |
| 7 | 20.40467849 | 5.101169623 |
| 8 | 1.507768428 | 0.376942107 |
| 9 | 8.115617219 | 2.028904305 |
| 10 | 8.115617219 | 2.028904305 |
| 11 | 8.115617219 | 2.028904305 |
| 12 | 30.94858553 | 7.737146383 |
| **Average** | **10.64296262** | **2.660740654** |

### 2.4.1 Forest Cover Assessment

The change in forest cover was assessed by using Landsat multispectral 30m spatial resolution satellite images on the path (151) and row (036) and google Earth Engine Cloud Computing platform for the classification of forest cover by applying Random Forest Machine Learning Algorithm. The analysis indicates an increase of 768.96 ha in forest cover in the past 10 years at an average rate of 76.9 hectare (ha) per year (**Table 4**).

**Table 4. Forest cover assessment (2011 -2021)**

| No | Landsat Satellite Sensor | Landsat data acquisition | Forest Cover (ha) |
|---|---|---|---|
| 1 | Landsat-8 | 2021-10-06 | 3126.96 |
| 2 | Landsat-5 | 2011-09-25 | 2358 |
| Change in Forest Cover in last 10 years | | | 768.96 |
| Per year change in forest cover | | | 76.90 |

Table 5 provides **the business-as-usual scenario** of forest cover and under this scenario the actual forest cover is growing at a rate of 76.9 ha annually and the current forest cover of 3,126.96 ha comprises 96% of the available forest area i.e., 3,250 ha and the remaining area will convert into forest cover by 2023. However, majority of the crop in this Chir pine forest is young and pole crop, the forest will have to undergo some silvicultural treatment such as thinning for opening up of the forest to support the tree growth.

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

| Rate of change per year | 76.90 |
|---|---|
| Year | Forest Cover (ha) - Business as usual |
| 2011 | 2358 |
| 2012 | 2435 |
| 2013 | 2512 |
| 2014 | 2589 |
| 2015 | 2666 |
| 2016 | 2742 |
| 2017 | 2819 |

| | | |
|---|---|---|
| 2018 | | 2896 |
| 2019 | | 2973 |
| 2020 | | 3050 |
| 2021 | | 3127 |
| 2022 | | 3204 |
| 2023 | | 3250 |
| 2024 | | |
| 2025 | | |
| 2026 | | |
| 2027 | | |
| 2028 | | |
| 2029 | | |
| 2030 | | |
| 2031 | | |
| 2032 | | |

This scenario is presented visually in **Figure 3,** Forest cover scenario.



Figure 3: Forest Cover (ha)
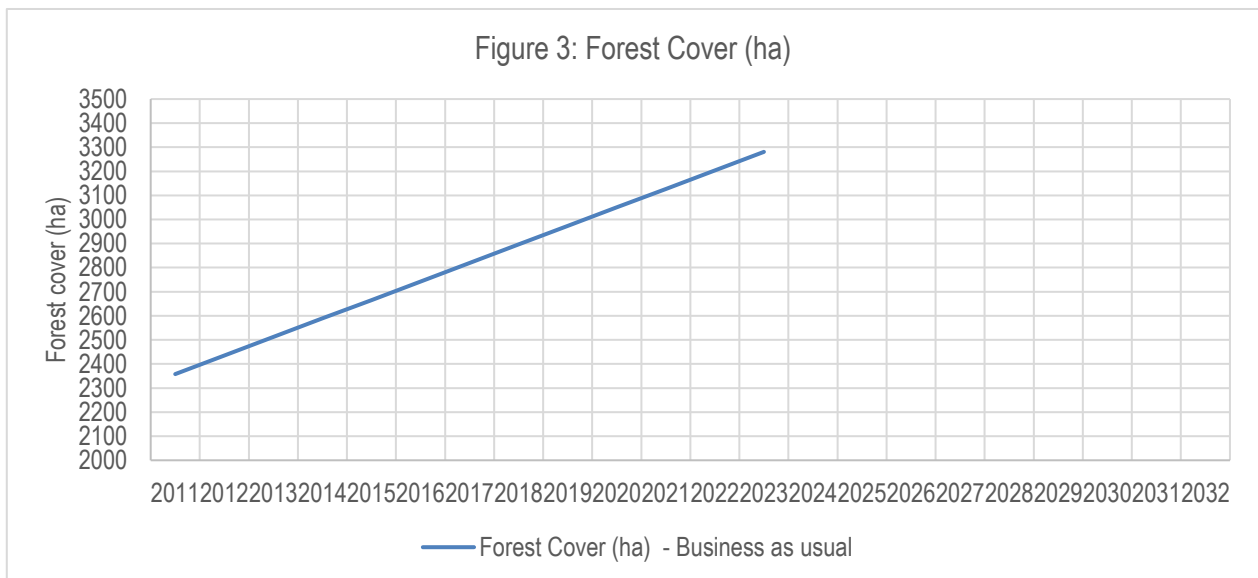
### 2.4.2   Carbon stock estimation and CO2 emissions

The field data and biomass collected from 11 samples was used to calculate Above Ground Biomass (AGB) using locally developed allometric equations (Ismail et al, 2018) for 2011-2021 (**Table 6**). In Makhnyal forest, the cumulative carbon stock in five carbon pools was estimated to as 195,781 tonnes of Organic Carbon (Corg) back in 2011 which increased to 259,627 tonnes in 2021. This change corresponds to the increase in forest cover from 2358 ha in 2011 to 3126.96 ha in year 2021 (see figure 4 and table 6). The average annual rate of change of forest cover, Carbon stocks and corresponding $CO_2$ sequestration is 76.9 ha, 6,384.55 tonnes of C and 23,410 tonnes $CO_2$ eq, respectively.

Figure 4: Forest Cover Maps used for Change Analysis
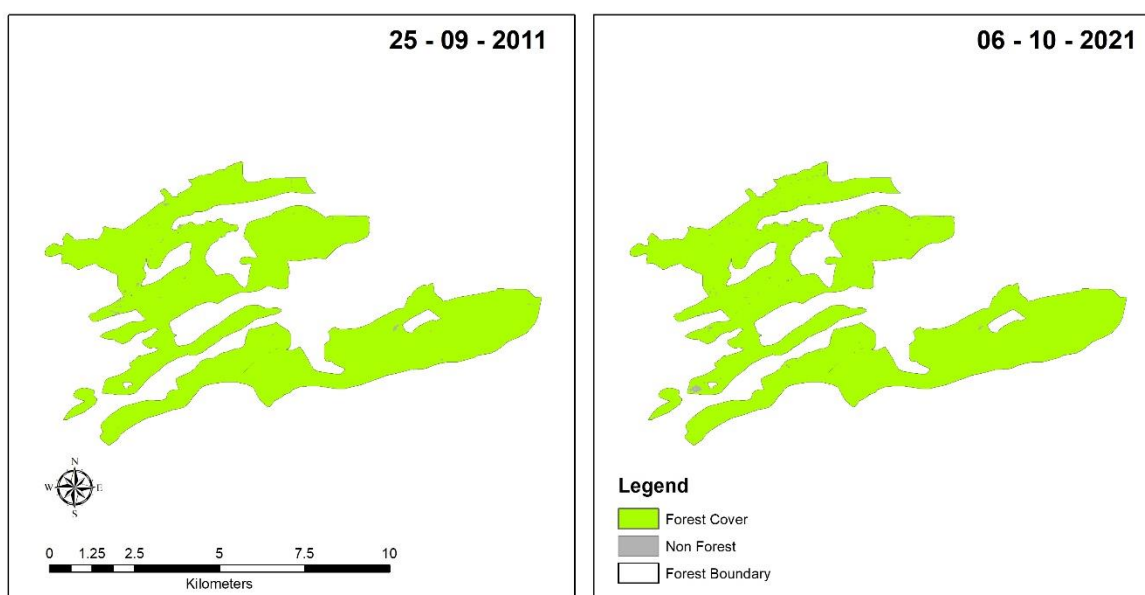
**Table 6. Carbon stock estimation (2010-2021)**

| Carbon pool | Mean carbon stock (tonnes C stock per hectare) | Forest Cover (ha) | Total C stock (tonnes C stock) | $CO_2$ (tonnes $CO_2$ eq) |
|---|---|---|---|---|
| **2011 (2011-05-20)** | | | | |
| Above | 10.64 | | 25,096.11 | |
| Below | 2.66 | | 6,274.03 | |
| Deadwood | 0.20 | 2358 | 474.56 | |
| Litter | 0.02 | | 55.32 | |
| Soil* | 69.5 | | 163,881.00 | |
| **Cumulative** | | | **195,781** | **717,863.72** |
| **2021 (2021-03-28)** | | | | |
| Above | 10.64 | | 33,280.12 | |
| Below | 2.66 | | 8,320.03 | |
| Deadwood | 0.20 | 3126.96 | 629.32 | |
| Litter | 0.02 | | 73.36 | |
| Soil | 69.5 | | 217,323.72 | |
| **Cumulative** | | | **259,627** | **951,964.01** |
| **Rate of change per year** | | | | |
| **2021-2011** | | **76.90** | **6,384.55** | **23,410** |

*Estimation of soil carbon pools in the forests of Khyber Pakhtunkhwa Province, Pakistan, Anwar Ali

### 2.4.3    $CO_2$ 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 25,702 with a growth rate of 2.19 per annum. The fuelwood and timber consumption per capita per annum was calculated as 0.4 m$^3$ and 0.1 m$^3$ respectively[1]. Based on this data emissions from forest degradation are calculated and presented in the Table 7.

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[1] **These averages were determined from …… as a reference**

**Table 7: Forest Degradation Emissions trend**

| Year | Population | Fuelwood Consumption (FC) (m³/year) | Timber Consumption (TC) (m3/year) | Fuelwood Emissions[2] (FC*D*BEF2*CF*44/12) (tons CO₂ eq) | Timber Emissions (TC*D*BEF2*CF*44/12) (tons CO₂ eq) | Total Emissions from Forest Degradation (tons CO₂ eq) - Business as usual |
|---|---|---|---|---|---|---|
| 2011 | 22504 | 9002 | 2250 | 13562 | 3391 | 16953 |
| 2012 | 23008 | 9203 | 2301 | 13866 | 3466 | 17332 |
| 2013 | 23523 | 9409 | 2352 | 14176 | 3544 | 17720 |
| 2014 | 24050 | 9620 | 2405 | 14494 | 3623 | 18117 |
| 2015 | 24589 | 9835 | 2459 | 14818 | 3705 | 18523 |
| 2016 | 25139 | 10056 | 2514 | 15150 | 3787 | 18937 |
| 2017 | 25702 | 10281 | 2570 | 15489 | 3872 | 19361 |
| 2018 | 26265 | 10506 | 2626 | 15828 | 3957 | 19785 |
| 2019 | 26840 | 10736 | 2684 | 16175 | 4044 | 20219 |
| 2020 | 27428 | 10971 | 2743 | 16529 | 4132 | 20661 |
| 2021 | 28029 | 11211 | 2803 | 16891 | 4223 | 21114 |
| 2022 | 28642 | 11457 | 2864 | 17261 | 4315 | 21576 |
| 2023 | 29270 | 11708 | 2927 | 17639 | 4410 | 22049 |
| 2024 | 29911 | 11964 | 2991 | 18025 | 4506 | 22532 |
| 2025 | 30566 | 12226 | 3057 | 18420 | 4605 | 23025 |
| 2026 | 31235 | 12494 | 3124 | 18824 | 4706 | 23529 |
| 2027 | 31919 | 12768 | 3192 | 19236 | 4809 | 24045 |
| 2028 | 32618 | 13047 | 3262 | 19657 | 4914 | 24571 |
| 2029 | 33332 | 13333 | 3333 | 20087 | 5022 | 25109 |
| 2030 | 34062 | 13625 | 3406 | 20527 | 5132 | 25659 |
| 2031 | 34808 | 13923 | 3481 | 20977 | 5244 | 26221 |
| 2032 | 35571 | 14228 | 3557 | 21436 | 5359 | 26795 |

[2] Wood Density (D)

| | |
|---|---|
| *Diospyros lotus* | *0.71* |
| *Olea ferruginea* | *0.887* |
| *Pinus roxburghii* | *0.327* |
| *Punica granatum* | *0.5* |
| *Pyrus pashia* | *0.643* |
| *Quercus dilatata* | *0.635* |
| *Average* | *0.62* |
| Biomass Expansion Factor: BEF2 | 1.35 (IPCC Table 3A.1.10) |
| CF = carbon fraction of dry matter | 0.5 |

### 2.4.4 Net Emissions from Forest Cover enhancement and Forest Degradation

The table 8 below provides a net $CO_2$ sequestration scenario based on business as usual i.e., forest continues sequestering $CO_2$ based on the trend in the past 10 years and emissions from forest degradation increasing with the increase in population. Since the forest area is already on an increasing trend and has 96% forest cover in 2022 but majority of the crop is young with higher no. of young trees/saplings per ha the forest would need to be thinned and no. of plants per ha reduced. In this situation 5% thinning intensity is applied on forest cover. Based on 5% thinning, 5-25% reduction in fuelwood and local timber demand (Degradation) including thinning used to discount degradation, a scenario is developed in which initially the emissions decrease till 2026 before starting to increase due to increasing firewood demand with increase in population. In order to increase the sequestration potential of the forest the interventions should focus on reducing the demand for firewood and local use timber. Figure 5 graphically presents the business-as-usual scenario and the REDD+ scenario in which it can be clearly scene that in business-as-usual scenario net $CO_2$ (tonnes $CO_2$ eq) are regularly declining and are becoming negative in the year 2026 due to increase in demand for the firewood because of increasing population.

**Table 8: Sequestration Scenario from Forest Enhancement and Reducing degradation**

| Year | Forest Enhancement | | | Forest Degradation | | | | Business as usual | REDD+ Scenario |
|---|---|---|---|---|---|---|---|---|---|
| | Annual Sequestration from forest enhancement (ton CO$_2$ eq) - Business as usual | 5% reduction due to thinning | Net CO$_2$ Sequestration after 5% thinning | Annual Emission from Forest Degradation (tons CO$_2$ eq) - Business as usual | Net CO$_2$ emissions from degradation discounting thinning | 5-25% Reduction in Degradation emissions (tons CO$_2$ eq) | Net Emissions from Forest Degradation (tons CO$_2$ eq) - Scenario 5-25 reduction in fuelwood demand | Net CO$_2$ (tons CO$_2$ eq) | Net CO$_2$ (tons CO$_2$ eq) emissions from forest enhancement, thinning and forest degradation |
| 2011 | 23410 | | | 16953 | | | | -6458 | |
| 2012 | 23410 | | | 17332 | | | | -6078 | |
| 2013 | 23410 | | | 17720 | | | | -5690 | |
| 2014 | 23410 | | | 18117 | | | | -5293 | |
| 2015 | 23410 | | | 18523 | | | | -4887 | |
| 2016 | 23410 | | | 18937 | | | | -4473 | |
| 2017 | 23410 | | | 19361 | | | | -4049 | |
| 2018 | 23410 | | | 19785 | | | | -3625 | |
| 2019 | 23410 | | | 20219 | | | | -3191 | |
| 2020 | 23410 | | | 20661 | | | | -2749 | |
| 2021 | 23410 | | | 21114 | | | | -2296 | |
| 2022 | 23410 | | | 21576 | | | | -1834 | |
| 2023 | 23410 | 1171 | 22240 | 22049 | 23102 | 1155 | 21947 | -1361 | 292 |
| 2024 | 23410 | 1171 | 22240 | 22532 | 23585 | 2359 | 21227 | -878 | 1013 |
| 2025 | 23410 | 1171 | 22240 | 23025 | 24079 | 4816 | 19263 | -385 | 2977 |
| 2026 | 23410 | 1171 | 22240 | 23529 | 24583 | 6146 | 18437 | 119 | 3802 |
| 2027 | 23410 | 1171 | 22240 | 24045 | 25098 | 6275 | 18824 | 635 | 3416 |
| 2028 | 23410 | 1171 | 22240 | 24571 | 25625 | 6406 | 19219 | 1161 | 3021 |
| 2029 | 23410 | 1171 | 22240 | 25109 | 26163 | 6541 | 19622 | 1699 | 2617 |
| 2030 | 23410 | 1171 | 22240 | 25659 | 26713 | 6678 | 20035 | 2249 | 2205 |
| 2031 | 23410 | 1171 | 22240 | 26221 | 27275 | 6819 | 20456 | 2811 | 1784 |
| 2032 | 23410 | 1171 | 22240 | 26795 | 27849 | 6962 | 20887 | 3385 | 1353 |

Figure 5: Sequestration scenarios – Forest Enhancement and Reduced degradation

Net total emissions from forest enhancement, thinning and reducing degradation (tonnes $CO_2$ eq) - REDD+ implementation

Net $CO_2$ (tonnes $CO_2$ eq)

Years

Net CO2 (tonnes CO2 eq) -Business as usual

Net CO2 Sequestered (tonnes CO2 eq) emissions from forest enhancement, thinning and forest degradation
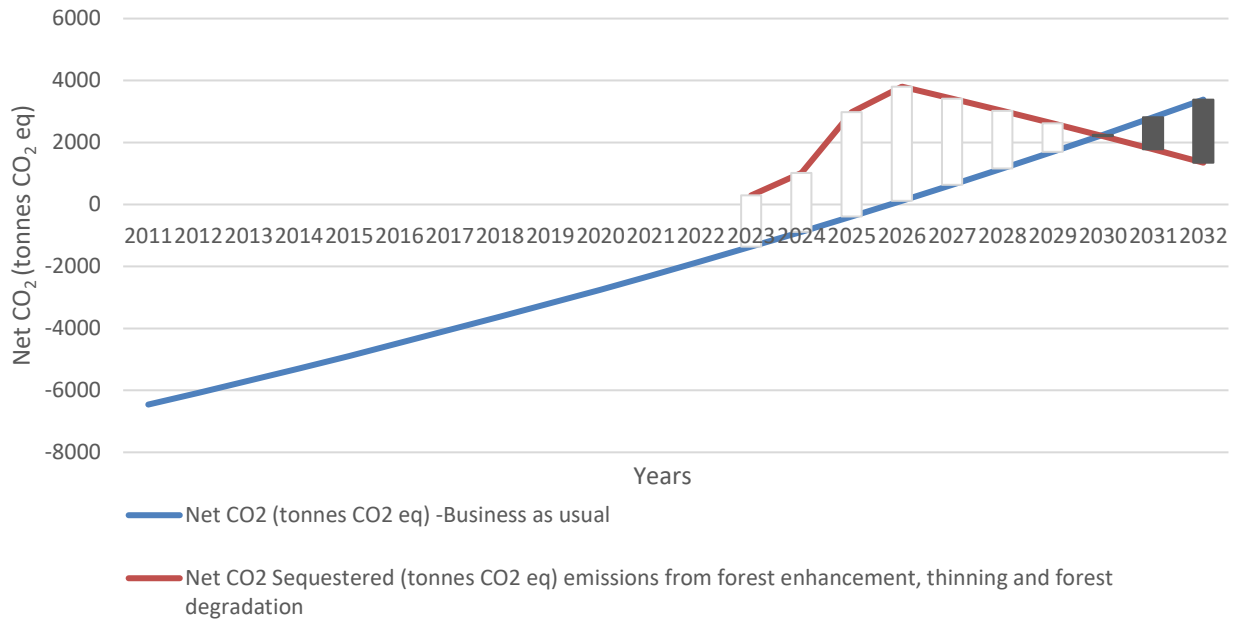
# 3 Proposed Interventions

The following interventions have been identified as a result of a number of consultative meetings with local communities to address the drivers of deforestation and degradation in Makhnyal valley forest. 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 larger Makhnyal valley related issues. The proposed interventions addressing major drivers of deforestation and degradation have been reflected in the table.

**Table: 9: Proposed interventions addressing major drivers deforestation and degradation**

| # | Proposed interventions | Drivers of deforestation and degradation and Barriers to Enhancement addressed | Remarks |
|---|---|---|---|
| 1 | • Strengthening of Village Conservation and Protection Committee.<br><br>• Assessment of genuine timber & firewood need (visits / meetings).<br><br>• Facilitation in rights & concessions in Guzara as well as Reserved Forests and distribution of benefits on equity basis<br><br>• Energy Efficient stoves and bio-briquette | Cutting of Trees for Energy/fuelwood | |
| 2 | • Strengthening of Forest Department & Village Conservation and Protection Committee.<br><br>• Assessment of genuine timber & firewood need (visits / meetings).<br><br>• Facilitation in rights & concessions and distribution of benefits | Cutting of Trees for Constructional Timber Local and outside | |
| 3 | • Linkages, facilitation and promotion of Tourism and Wildlife activities<br><br>• Promotion & value addition of non-timber forest products (trainings / equipment's)<br><br>• Raising fruit orchards<br><br>• Distribution of fruit plants | Timber Smuggling for greed and Profit making | Through these interventions, the income of the locals will increase. The burden on forest will be reduced and eliminated. |
| 4 | • Rotational grazing (small scale application) | Grazing in Forest Area | These activities will give enough time to regenerate the |

| # | Proposed interventions | Drivers of deforestation and degradation and Barriers to Enhancement addressed | Remarks |
|---|---|---|---|
| | • Rotational grazing (large scale application)<br><br>• Raising of improved breeding through artificial insemination<br><br>• De-Worming | | fodder. Further by artificial insemination improved breed of domestic animals will reduce cattle heads and enhance quality & quantity of products. |
| 5 | • Strengthening of Forest Department (for vigilance, patrolling, protection from fire hazards, encroachment) as well as Village Conservation & Protection Committees. | Issues in Law enforcement Conversion of land for housing and agriculture Forest Fires | By empowering locals & their involvement in decision making will resolve this issue. |
| 6 | • Linkages, facilitation and promotion of Tourism and Wildlife activities | Unplanned Tourism activities | Coordinated efforts by locals will regulate the activities. |

The total indicative budget of the PFMP implementation is PKR 27,360,219 (See justification of higher budget in the last paragraph in the section on introduction).

**Table 10. Indicative operational plan and budget of PFMP for 10 year**

| S.N. | Activity | Unit | Unit cost | Operational Plan 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total units | Total cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | **Strengthening of Social Organization** | | | | | | | | | | | | | | |
| 1 | Strengthening of Forest Conservation, Management & Protection Committees | No | 5000 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 120 | 600,000 |
| 2 | Facilitation in Rotational Grazing (Visits/Meetings) | No | 5000 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 3 | 3 | 3 | 45 | 225,000 |
| 3 | Assessment of Genuine Timber & Firewood need (Visits/Meetings) Facilitation in rights & concessions and distribution of benefits | LS | 5000 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 60 | 300,000 |
| 4 | Linkages, facilitation and promotion of Tourism and Wildlife activities | LS | 5000 | 6 | 12 | 12 | 12 | 6 | 6 | 6 | 6 | | | 66 | 330,000 |
| **B** | **Forest Fire protection measures** | | | | | | | | | | | | | | |
| 5 | Collection of fallen needles, clearance & maintenance of fire lines and extinguishing fire) (6 dry months/year) | Fire Watcher | 20000 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 1200 | 24,000,000 |
| 6 | Strengthening of Forest Department (Patrolling for protection from illegal cutting, fire control etc) | Vehicle (No.) | 4500000 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4,500,000 |
| **C** | **Managed Rotational Grazing** | | | | | | | | | | | | | | |
| 7 | Rotational Grazing (Small Scale Application) | No | 100000 | | 3 | | | | | | | | | 3 | 300,000 |
| 8 | Rotational Grazing (Large Scale Application) | Herdsman | 20000 | | 3 | 3 | 3 | 3 | 3 | | | | | 15 | 3,600,000 |
| **D** | **Promotion of Sustainable Energy Technology** | | | | | | | | | | | | | | |

| S.N. | Activity | Unit | Unit cost | Operational Plan 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total units | Total cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | Energy Efficient stoves and bio-briquette | No | 3000 | | 300 | 300 | 300 | 300 | 300 | 300 | | | | 1800 | 5,400,000 |
| E | **Promotion & Value Addition of Non-Timber Forest Products (Trainings/Equipment's)** | | | | | | | | | | | | | | |
| 10 | Medicinal Plants | No | 60000 | | 2 | 2 | 2 | 2 | | | | | | 8 | 480,000 |
| F | **Livestock Extension Support** | | | | | | | | | | | | | | |
| 11 | Raising of improved breeding through artificial insemination | No | 1000 | 50 | 50 | 50 | 50 | 50 | | | | | | 250 | 250,000 |
| 12 | De-Worming | No | 100 | 1000 | 1000 | 1000 | 1000 | 1000 | | | | | | 5000 | 500,000 |
| G | **Horticulture Promotion** | | | | | | | | | | | | | | |
| 13 | Raising fruit orchards | No | 100000 | | 6 | 6 | 6 | 6 | | | | | | 24 | 2,400,000 |
| 14 | Distribution of fruit plants | No | 25 | | 3000 | 3000 | 3000 | 3000 | 3000 | | | | | 15000 | 375,000 |
| H | **Soil and Water Conservation Activities** | | | | | | | | | | | | | | |
| 15 | Land slide and Gully Plugging (Planting of 4300 bare rooted plants per hectare & check damming etc,) | Hectare | 300000 | | 5 | 5 | 5 | 5 | | | | | | 20 | 6,000,000 |
| | **Total** | | | | | | | | | | | | | | **27,360,219** |

# 4    Implementation Mechanism for the PFMP

## 4.1    Resources for activities

The FE&WD as custodian of the forests and having linkages with national and international funding sources will take a lead. The key stakeholders identified in this plan, especially the FE&WD and the Makhnyal JFMCs and Village Development Committees and local *jirgas*, will jointly look for resources for implementation of activities identified in this plan. The FE&WD will submit proposals for potential funding sources including the Ministry of Climate Change, Annual Development Programme (ADP), international donors and private sector investors.

## 4.2    Suggested institutional mechanism for implementation of activities

The FE&WD in consultation with the community will decide on formation of suitable institutional mechanism for implementation of this plan. It is suggested that village and district level REDD+ implementation committees may be notified by the FE&WD to oversee implementation of activities. The notifications will include description of responsibilities of FE&WD, the respective communities, and any other relevant stakeholders.

**Makhnyal REDD+ Committee (MRC):** In consultation with the community, the FE&WD may notify a committee namely Makhnyal REDD+ Committee. The MRC may consist of representatives from the community (VDCs/JFMCs) and the DFFW. The community will nominate representatives for the MRC to represent them. The representatives of the community will be responsible to ensure and harness community support for the implementation of activities. Representatives of the households having land and settlements inside the forest will be crucial for success of REDD+ activities. The FE&WD will ensure its representation through respective SDFO/RFO. The MRC may be Co-chaired by a community member nominated by the community and respective SDFO/RFO.

## 4.3    Benefit Distribution Mechanism

The implementation of the REDD+ interventions package and other support activities will contribute to increasing the volume of carbon stock in the forest. If the plan is duly implemented, the increase in carbon stock in the forest pool measured by variable means and the trade of carbon will generate substantial income for the stakeholders of 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. Due to the financial benefit, the stakeholders may be expected to value standing trees than to cut for other uses. Since the community will reduce harvesting of trees for fuel, restrict grazing for encouraging regeneration, and voluntarily participate in restocking of forest, they will expect a major share from results base payments from reduced carbon emissions. A clear mechanism for distribution of benefits is in vogue and applied in past particularly in the case Guzara forests; the same mechanism will be applied. Taking the example of wildlife, (80:20 benefit sharing mechanism between the community and the FE&WD from trophy hunting), the same may be adopted for NTFP benefit sharing.

This plan has proposed distribution of carbon and non-carbon benefits accrued by the implementation of plan according to which in case of Reserved forests 80% benefits will go to the Government, and 20% will go to the customary right holders out of which 10% will go to the users. These benefits will only be distributed if the targets are achieved. In case of Guzara forests, the benefit sharing will change. The owners will receive 80% whereas the government will receive 20%, out of which customary users will receive 10% of the

benefits as an incentive to reduce degradation. The plan is founded on 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 KP based benefit sharing mechanism.

# 5   Conflict and grievance redressal mechanism

## 5.1   Conflicts within the community

Traditionally, a *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 *jirga* system has been described in earlier section in this document.

## 5.2   Conflict between the two villages

The MRC with the help of *jirgas* will settle any disputes between two villages. Any unsettled disputes will be referred to the Divisional Forest Office. If conflicts are still not resolved, the matter will be taken up to the court of the formal judicial system.

## 5.3   Community's grievance towards the Forest Department

The REDD+ is a new mechanism for communities as well as for the DFFW, therefore, both partners (Community and the DFFW) 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 at the level of DFO office. This mechanism is also reflected well in Provincial REDD+ Action Plan and the institutional mechanism for REDD+ implementation.

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8. Working Plan for Haripur Forest Division Haripur.
11. 2017 Forestry Planning and Monitoring Circle Khyber Pakhtunkhwa REDD+ Strategy

| I. Stakeholder group (name) | Forest Department, community, |
|---|---|
| **II. General information** | |
| Location of stakeholder groups (e.g., different villages/hamlets in and outside forest area) and names and indicate on map if possible | The user group community of this site consists of inhabitants of villages. |
| **III. Social organization in the forest area** | |
| *2. Traditional organizations (e.g., jirga)* | |
| 2.1. Organization (name; purpose; membership) | Local Jirga |
| 2.2. Organization (name; purpose; membership | |
| 2.3. Organization (name; purpose; membership | |
| 3. Formal organization (e.g., social; welfare organization or village development committee | |
| 3.1. Organization (name; purpose; membership) | Local Support Organization & Village Development Committee/Joint Forest Management Committee |
| 3.2 Organization (name; purpose; membership) | |
| 3.3 Organization (name; purpose; membership) | |
| **IV. Use of forest and forest area** | |
| **4.** For what are you using the forest area? | |
| Timber for personal use like house construction, etc. (where; locate on the map) | Yes |
| Timber for commercial selling (where; locate on the map) | No |
| Firewood (where; locate on the map) | Yes |
| Grazing (where; locate on the map) | Yes |
| Grass cutting (where; locate on the map | Yes |
| Other products, e.g., mushroom, pine nuts, pine needles, vegetables, stones, minerals, medicinal plants (where; locate on the map) | Yes |
| Forest areas related daily labour/employment (employed by whom; for what?) | Yes / self-employment |
| Tourism (what; where; locate on the map) | Yes |
| Hunting/Fishing | Illegal hunting & Fishing by local community for personnel use Illegal hunting |
| 5.What would it mean if you had no access to these forest products? (Any alternatives? Threat to livelihood?) | LPG, timber. |
| **5. Rights and concessions in forest area** | |

| | |
|---|---|
| 6. Do you have formal, legal, or traditional, customary rights on forest products (use)? Which ones? If documented rights, where? | Yes. Under regular land management, the local people have rights and concessions in the forests. |
| Timber (shares) | Timber as per need through permission from FD |
| Fodder: grass cutting/grazing | Yes |
| Firewood | Yes (dead fallen, and pruning of trees) |
| Other products: | Yes, medicinal plants, NTFP |
| **VI. Control of forest area** | |
| 7. Who is controlling access to the forest area? | Forest Department, Community |
| 8. What are forest control mechanisms? E.g., watch and ward; herdsmen; fencing; providing permits. | Joint watch and ward by FD and community. Timber harvesting is based on permits issued by FD. |
| 9. Explain control mechanisms: Are there any traditional mechanisms like nagha; herdsman; watchman? How is it organized? Who pays for it? Are there formal mechanisms like permits by FD; watch and ward by watchman or forest guard? How does it work? | Apart from Forest Guard appointed by Forest Department. Under 10BTTAP Nigehbans are appointed through Village Development Committees for protection and conservation of forests. On the demand of community, the FD has stopped issuing permits for commercial harvesting of forest. |
| **VII. Changes over time in forest area** | |
| 10. What changes took place regarding the availability of forest products (timber; firewood; grasses; NTFP) during the last 30 years? | Biotic factors like human and cattle population exert a considerable pressure on forests in the form of illicit cutting, lopping, and grazing with the result that the condition, distribution and quality of forest crop is considerably affected. |
| 11. What are (according to you) the reasons for change? | Population increase, encroachments, illicit cutting of trees, forests are cleared for cultivation. The whole area is open to uncontrolled grazing seriously hampers the survival of regeneration. |
| 12. Were there any efforts in the past for forest restoration and by whom? | Under BTTAP & 10 BTTAP the area was increased by natural & artificial regeneration. |
| **VIII. Main problems** | |
| 13. What are the main problems in forest management with respect to: | |
| a. rights | None |
| b. different uses | None |
| c. control | Conflict between community and FD over permits issued by FD to outsiders. |
| d. managing drivers (of deforestation, degradation, and forest enhancement) | Illegal harvesting of forest by local offenders. The demand for fuel wood is more that the annual increment of forest. |
| **IX. Conflicts / disputes** | |
| 14. On different land uses: 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 |
| 15. On social issues:<br>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 |
| 16. Existing Conflict resolution mechanisms:<br>  - traditional (e.g., jirga)<br>  - formal (court) | Through local Jirga, revenue department, and court of law. |
| **X. Other Forest Management Projects** | |
| 17. Are there any other Forest Management Projects in the area? If so, which projects? What are their activities? | Nil |
| **XI. Recommendations** | |
| 18. What are your recommendations for forest management activities? | Area should be protected from grazing, forest fires, cutting of trees supplemented by sowing & planting of the areas. |

| STAKEHOLDER | INTEREST in Forest Management | | INFLUENCE on Forest Management | | Relevant forest carbon pools | | Influence on forest carbon pools | |
|---|---|---|---|---|---|---|---|---|
| | Type of interest | Level of Interest | Type of influence | Level of influence | Type of carbon Pool | Level of interest | Type of Influence | Level of influence |
| Forest Department | For management and conservation of Forests | 3 | Controller | 3 | All | 3 | Owner & Manager | 3 |
| Owners | Browsing, illicit cutting, lopping, grazing, grass cutting, NTFP collection | 3 | Local control on forest benefits | 2 | Above ground mass, dead wood, litter etc | 3 | Rights & Concessions | 3 |
| Users | Browsing, illicit cutting, lopping, grazing, grass cutting, NTFP collection | 3 | Local use of forest benefits | 1 | Above ground mass, dead wood, litter etc | 2 | Concessions | 1 |
| Law Enforcement Agencies | Law enforcement | 1 | None | 0 | None | 0 | None | 0 |
| Illegal harvesters | Business | 3 | None | 0 | Above ground | 3 | Uncontrolled use of above ground pools | 3 |
| Revenue Department | Land management | 1 | little | 1 | Below ground biomass | 0 | Legal control of land | 2 |
| 10 BTAP | Increase in Forest cover | 2 | Significant | 2 | Biomass above ground | 3 | Decision on increase in forest cover | 3 |
| Property dealers & land grabbers | Selling land | 2 | Significant | 2 | Above ground biomass | 2 | Change in land use | 3 |

| Plot No. | Lat | Long | Species Name | Scientific Name | DBH (cm) | Tree height (m) | AGB (kg) | AGB (ton/ha) | AGC (ton/ha) | BGC (ton/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 10.8 | 26 | 56.3563 | 0.56 | 0.26 | 0.07 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 14.9 | 30 | 121.5219 | 1.22 | 0.57 | 0.14 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 9.8 | 27 | 48.36398 | 0.48 | 0.23 | 0.06 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 14.6 | 28 | 109.1777 | 1.09 | 0.51 | 0.13 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 22.2 | 34 | 299.2329 | 2.99 | 1.41 | 0.35 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 26.7 | 33 | 416.8 | 4.17 | 1.96 | 0.49 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 33.7 | 38 | 753.8673 | 7.54 | 3.54 | 0.89 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 27 | 31 | 400.7624 | 4.01 | 1.88 | 0.47 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 23 | 29 | 274.5183 | 2.75 | 1.29 | 0.32 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 21 | 31 | 245.2924 | 2.45 | 1.15 | 0.29 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 22.9 | 33 | 308.8042 | 3.09 | 1.45 | 0.36 |
| 1 | 33.81 | 73.15 | Chir | *Pinus roxburghii* | 27.7 | 37 | 500.7842 | 5.01 | 2.35 | 0.59 |
| 2 | 33.86 | 73.15 | Chir | *Pinus roxburghii* | 38.22 | 110 | 2722.218 | 27.22 | 12.79 | 3.20 |
| 2 | 33.86 | 73.15 | Chir | *Pinus roxburghii* | 38.22 | 101 | 2504.467 | 25.04 | 11.77 | 2.94 |
| 2 | 33.86 | 73.15 | Chir | *Pinus roxburghii* | 40.45 | 115 | 3176.042 | 31.76 | 14.93 | 3.73 |
| 2 | 33.86 | 73.15 | Chir | *Pinus roxburghii* | 46.82 | 96 | 3542.852 | 35.43 | 16.65 | 4.16 |
| 2 | 33.86 | 73.15 | Chir | *Pinus roxburghii* | 36.62 | 92 | 2103.037 | 21.03 | 9.88 | 2.47 |
| 3 | 33.83 | 73.16 | Chir | *Pinus roxburghii* | 41 | 84 | 2399.405 | 23.99 | 11.28 | 2.82 |
| 3 | 33.83 | 73.16 | Chir | *Pinus roxburghii* | 34 | 78 | 1548.274 | 15.48 | 7.28 | 1.82 |
| 3 | 33.83 | 73.16 | Chir | *Pinus roxburghii* | 36 | 44 | 989.6681 | 9.90 | 4.65 | 1.16 |
| 3 | 33.83 | 73.16 | Chir | *Pinus roxburghii* | 26.1 | 49 | 586.5811 | 5.87 | 2.76 | 0.69 |
| 3 | 33.83 | 73.16 | Chir | *Pinus roxburghii* | 28.9 | 67 | 971.6126 | 9.72 | 4.57 | 1.14 |
| 3 | 33.83 | 73.16 | Chir | *Pinus roxburghii* | 24 | 71 | 715.281 | 7.15 | 3.36 | 0.84 |
| 3 | 33.83 | 73.16 | Chir | *Pinus roxburghii* | 35 | 68 | 1432.986 | 14.33 | 6.74 | 1.68 |
| 3 | 33.83 | 73.16 | Chir | *Pinus roxburghii* | 27.7 | 57 | 763.7496 | 7.64 | 3.59 | 0.90 |

| Plot No. | Lat | Long | Species Name | Scientific Name | DBH (cm) | Tree height (m) | AGB (kg) | AGB (ton/ha) | AGC (ton/ha) | BGC (ton/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 33.83 | 73.16 | Chir | *Pinus roxburghii* | 37.5 | 74 | 1780.899 | 17.81 | 8.37 | 2.09 |
| 3 | 33.83 | 73.16 | Chir | *Pinus roxburghii* | 20 | 39 | 279.0441 | 2.79 | 1.31 | 0.33 |
| 4 | 33.85 | 73.19 | Chir | *Pinus roxburghii* | 34.39 | 78 | 1583.155 | 15.83 | 7.44 | 1.86 |
| 4 | 33.85 | 73.19 | Chir | *Pinus roxburghii* | 23.89 | 62 | 620.9897 | 6.21 | 2.92 | 0.73 |
| 4 | 33.85 | 73.19 | Chir | *Pinus roxburghii* | 12.42 | 27 | 76.82775 | 0.77 | 0.36 | 0.09 |
| 4 | 33.85 | 73.19 | Chir | *Pinus roxburghii* | 33.44 | 91 | 1742.39 | 17.42 | 8.19 | 2.05 |
| 4 | 33.85 | 73.19 | Chir | *Pinus roxburghii* | 22.29 | 62 | 542.3444 | 5.42 | 2.55 | 0.64 |
| 4 | 33.85 | 73.19 | Chir | *Pinus roxburghii* | 26.75 | 71 | 884.1101 | 8.84 | 4.16 | 1.04 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 7.64 | 17 | 5.081162 | 0.05 | 0.02 | 0.01 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 4.46 | 11 | 1.248507 | 0.01 | 0.01 | 0.00 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 7.64 | 20 | 5.081162 | 0.05 | 0.02 | 0.01 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 6.69 | 24 | 3.594051 | 0.04 | 0.02 | 0.00 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 22.29 | 44 | 82.90623 | 0.83 | 0.39 | 0.10 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 27.71 | 71 | 146.2459 | 1.46 | 0.69 | 0.17 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 10.83 | 23 | 12.6218 | 0.13 | 0.06 | 0.01 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 8.6 | 20 | 6.918503 | 0.07 | 0.03 | 0.01 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 12.1 | 28 | 16.85388 | 0.17 | 0.08 | 0.02 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 13.69 | 26 | 23.25518 | 0.23 | 0.11 | 0.03 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 7.32 | 18 | 4.544709 | 0.05 | 0.02 | 0.01 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 6.05 | 14 | 2.765057 | 0.03 | 0.01 | 0.00 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 10.19 | 26 | 10.76803 | 0.11 | 0.05 | 0.01 |
| 4 | 33.85 | 73.19 | Anar | *Punica granatum* | 9.24 | 28 | 8.342636 | 0.08 | 0.04 | 0.01 |
| 4 | 33.85 | 73.19 | Kahu | *Olea cuspidata* | 5.41 | 16 | 33.9232 | 0.34 | 0.16 | 0.04 |
| 4 | 33.85 | 73.19 | Kahu | *Olea cuspidata* | 8.92 | 21 | 100.788 | 1.01 | 0.47 | 0.12 |
| 4 | 33.85 | 73.19 | Kahu | *Olea cuspidata* | 4.78 | 13 | 24.40112 | 0.24 | 0.11 | 0.03 |
| 4 | 33.85 | 73.19 | Kahu | *Olea cuspidata* | 5.41 | 12 | 27.41398 | 0.27 | 0.13 | 0.03 |
| 4 | 33.85 | 73.19 | Kahu | *Olea cuspidata* | 7.64 | 19 | 69.54795 | 0.70 | 0.33 | 0.08 |
| 4 | 33.85 | 73.19 | Kahu | *Olea cuspidata* | 3.2 | 19 | 18.70384 | 0.19 | 0.09 | 0.02 |

| Plot No. | Lat | Long | Species Name | Scientific Name | DBH (cm) | Tree height (m) | AGB (kg) | AGB (ton/ha) | AGC (ton/ha) | BGC (ton/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 33.85 | 73.19 | Kahu | *Olea cuspidata* | 5.4 | 14 | 30.58444 | 0.31 | 0.14 | 0.04 |
| 4 | 33.85 | 73.19 | Kahu | *Olea cuspidata* | 6 | 17 | 41.9135 | 0.42 | 0.20 | 0.05 |
| 4 | 33.85 | 73.19 | Batangi | *Pyrus pashia* | 5.73 | 18 | 21.29412 | 0.21 | 0.10 | 0.03 |
| 4 | 33.85 | 73.19 | Batangi | *Pyrus pashia* | 8.6 | 31 | 79.96611 | 0.80 | 0.38 | 0.09 |
| 4 | 33.85 | 73.19 | Batangi | *Pyrus pashia* | 6.69 | 26 | 41.25169 | 0.41 | 0.19 | 0.05 |
| 4 | 33.85 | 73.19 | Batangi | *Pyrus pashia* | 10.19 | 35 | 125.361 | 1.25 | 0.59 | 0.15 |
| 4 | 33.85 | 73.19 | Batangi | *Pyrus pashia* | 8.92 | 29 | 80.46529 | 0.80 | 0.38 | 0.09 |
| 5 | 33.83 | 73.21 | Chir | *Pinus roxburghii* | 96 | 156 | 23144.16 | 231.44 | 108.78 | 27.19 |
| 5 | 33.83 | 73.21 | Chir | *Pinus roxburghii* | 51.5 | 132 | 5824.475 | 58.24 | 27.38 | 6.84 |
| 5 | 33.83 | 73.21 | Chir | *Pinus roxburghii* | 33 | 108 | 2007.05 | 20.07 | 9.43 | 2.36 |
| 5 | 33.83 | 73.21 | Chir | *Pinus roxburghii* | 45 | 140 | 4739.763 | 47.40 | 22.28 | 5.57 |
| 5 | 33.83 | 73.21 | Chir | *Pinus roxburghii* | 59 | 145 | 8326.039 | 83.26 | 39.13 | 9.78 |
| 5 | 33.83 | 73.21 | Chir | *Pinus roxburghii* | 37.2 | 122 | 2856.895 | 28.57 | 13.43 | 3.36 |
| 5 | 33.83 | 73.21 | Chir | *Pinus roxburghii* | 30.5 | 108 | 1720.776 | 17.21 | 8.09 | 2.02 |
| 5 | 33.83 | 73.21 | Chir | *Pinus roxburghii* | 22 | 99 | 834.9748 | 8.35 | 3.92 | 0.98 |
| 5 | 33.83 | 73.21 | Chir | *Pinus roxburghii* | 34.7 | 118 | 2413.986 | 24.14 | 11.35 | 2.84 |
| 5 | 33.83 | 73.21 | Chir | *Pinus roxburghii* | 48 | 149 | 5713.94 | 57.14 | 26.86 | 6.71 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 23.5 | 147 | 1397.368 | 13.97 | 6.57 | 1.64 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 20.8 | 140 | 1049.727 | 10.50 | 4.93 | 1.23 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 14 | 99 | 345.3277 | 3.45 | 1.62 | 0.41 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 13.3 | 87 | 275.3647 | 2.75 | 1.29 | 0.32 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 14 | 94 | 328.2831 | 3.28 | 1.54 | 0.39 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 12.7 | 76 | 220.5001 | 2.21 | 1.04 | 0.26 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 18.9 | 103 | 645.0994 | 6.45 | 3.03 | 0.76 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 15.5 | 93 | 396.3321 | 3.96 | 1.86 | 0.47 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 13 | 84 | 254.4887 | 2.54 | 1.20 | 0.30 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 14 | 88 | 307.8015 | 3.08 | 1.45 | 0.36 |
| 6 | 33.82 | 73.19 | Chir | *Pinus roxburghii* | 20 | 138 | 958.7379 | 9.59 | 4.51 | 1.13 |

| Plot No. | Lat | Long | Species Name | Scientific Name | DBH (cm) | Tree height (m) | AGB (kg) | AGB (ton/ha) | AGC (ton/ha) | BGC (ton/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 38.2 | 184 | 4494.674 | 44.95 | 21.12 | 5.28 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 34 | 172 | 3351.811 | 33.52 | 15.75 | 3.94 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 42 | 193 | 5667.702 | 56.68 | 26.64 | 6.66 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 29.9 | 151 | 2296.312 | 22.96 | 10.79 | 2.70 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 21 | 126 | 964.9462 | 9.65 | 4.54 | 1.13 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 32.4 | 159 | 2825.213 | 28.25 | 13.28 | 3.32 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 20.3 | 121 | 868.095 | 8.68 | 4.08 | 1.02 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 23.2 | 142 | 1317.444 | 13.17 | 6.19 | 1.55 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 19 | 114 | 719.688 | 7.20 | 3.38 | 0.85 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 28 | 159 | 2124.375 | 21.24 | 9.98 | 2.50 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 23.8 | 134 | 1308.569 | 13.09 | 6.15 | 1.54 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 37.2 | 172 | 3995.648 | 39.96 | 18.78 | 4.69 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 56 | 237 | 12149.97 | 121.50 | 57.10 | 14.28 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 45.2 | 212 | 7170.141 | 71.70 | 33.70 | 8.42 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 39.1 | 192 | 4903.503 | 49.04 | 23.05 | 5.76 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 29.9 | 156 | 2370.549 | 23.71 | 11.14 | 2.79 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 22 | 123 | 1032.159 | 10.32 | 4.85 | 1.21 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 52 | 219 | 9731.969 | 97.32 | 45.74 | 11.44 |
| 7 | 33.84 | 73.12 | Chir | *Pinus roxburghii* | 66.8 | 267 | 19263.71 | 192.64 | 90.54 | 22.63 |
| 7 | 33.84 | 73.12 | Quercus | *Quercus dilatata* | 9.5 | 67 | 271.9417 | 2.72 | 1.28 | 0.32 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 10.83 | 26 | 56.6625 | 0.57 | 0.27 | 0.07 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 14.97 | 30 | 122.6396 | 1.23 | 0.58 | 0.14 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 9.87 | 27 | 49.04109 | 0.49 | 0.23 | 0.06 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 8.28 | 28 | 36.05518 | 0.36 | 0.17 | 0.04 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 22.29 | 34 | 301.6072 | 3.02 | 1.42 | 0.35 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 26.75 | 35 | 443.0712 | 4.43 | 2.08 | 0.52 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 35.67 | 36 | 799.0198 | 7.99 | 3.76 | 0.94 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 27.39 | 37 | 489.8949 | 4.90 | 2.30 | 0.58 |

| Plot No. | Lat | Long | Species Name | Scientific Name | DBH (cm) | Tree height (m) | AGB (kg) | AGB (ton/ha) | AGC (ton/ha) | BGC (ton/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 22.61 | 38 | 345.7111 | 3.46 | 1.62 | 0.41 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 20.7 | 39 | 298.4402 | 2.98 | 1.40 | 0.35 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 22.29 | 40 | 353.4909 | 3.53 | 1.66 | 0.42 |
| 9 | 33.83 | 73.24 | chir | *Pinus roxburghii* | 27.71 | 41 | 553.9878 | 5.54 | 2.60 | 0.65 |
| 10 | 33.83 | 73.14 | chir | *Pinus roxburghii* | 48 | 134 | 5151.431 | 51.51 | 24.21 | 6.05 |
| 10 | 33.83 | 73.14 | chir | *Pinus roxburghii* | 38.2 | 92 | 2283.927 | 22.84 | 10.73 | 2.68 |
| 10 | 33.83 | 73.14 | chir | *Pinus roxburghii* | 24.2 | 67 | 686.9422 | 6.87 | 3.23 | 0.81 |
| 10 | 33.83 | 73.14 | chir | *Pinus roxburghii* | 25.1 | 75 | 823.6506 | 8.24 | 3.87 | 0.97 |
| 10 | 33.83 | 73.14 | chir | *Pinus roxburghii* | 27 | 81 | 1023.98 | 10.24 | 4.81 | 1.20 |
| 10 | 33.83 | 73.14 | chir | *Pinus roxburghii* | 34 | 84 | 1664.495 | 16.64 | 7.82 | 1.96 |
| 10 | 33.83 | 73.14 | chir | *Pinus roxburghii* | 20 | 64 | 452.664 | 4.53 | 2.13 | 0.53 |
| 11 | 33.81 | 73.17 | chir | *Pinus roxburghii* | 48 | 134 | 5151.431 | 51.51 | 24.21 | 6.05 |
| 11 | 33.81 | 73.17 | chir | *Pinus roxburghii* | 38.2 | 92 | 2283.927 | 22.84 | 10.73 | 2.68 |
| 11 | 33.81 | 73.17 | chir | *Pinus roxburghii* | 24.2 | 67 | 686.9422 | 6.87 | 3.23 | 0.81 |
| 11 | 33.81 | 73.17 | chir | *Pinus roxburghii* | 25.1 | 75 | 823.6506 | 8.24 | 3.87 | 0.97 |
| 11 | 33.81 | 73.17 | chir | *Pinus roxburghii* | 27 | 81 | 1023.98 | 10.24 | 4.81 | 1.20 |
| 11 | 33.81 | 73.17 | chir | *Pinus roxburghii* | 34 | 84 | 1664.495 | 16.64 | 7.82 | 1.96 |
| 11 | 33.81 | 73.17 | chir | *Pinus roxburghii* | 20 | 64 | 452.664 | 4.53 | 2.13 | 0.53 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 38.2 | 92 | 2283.927 | 22.84 | 10.73 | 2.68 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 35.3 | 90 | 1915.931 | 19.16 | 9.00 | 2.25 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 26 | 69 | 813.3189 | 8.13 | 3.82 | 0.96 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 8.1 | 21 | 26.0792 | 0.26 | 0.12 | 0.03 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 42.6 | 113 | 3454.446 | 34.54 | 16.24 | 4.06 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 24.2 | 78 | 796.8962 | 7.97 | 3.75 | 0.94 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 16.5 | 61 | 296.6285 | 2.97 | 1.39 | 0.35 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 92 | 184 | 25024.12 | 250.24 | 117.61 | 29.40 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 94 | 167 | 23740.13 | 237.40 | 111.58 | 27.89 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 68 | 147 | 11134.99 | 111.35 | 52.33 | 13.08 |

| Plot No. | Lat | Long | Species Name | Scientific Name | DBH (cm) | Tree height (m) | AGB (kg) | AGB (ton/ha) | AGC (ton/ha) | BGC (ton/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| 12 | 33.84 | 73.15 | Quercus | *Quercus dilatata* | 40 | 62 | 1750.054 | 17.50 | 8.23 | 2.06 |
| 12 | 33.84 | 73.15 | Quercus | *Quercus dilatata* | 64 | 84 | 4004.113 | 40.04 | 18.82 | 4.70 |
| 12 | 33.84 | 73.15 | Quercus | *Quercus dilatata* | 35 | 68 | 1557.981 | 15.58 | 7.32 | 1.83 |
| 12 | 33.84 | 73.15 | Amlok | *Diospyrus lotus* | 26 | 53 | | | | |
| 12 | 33.84 | 73.15 | Batangi | *Pyrus pashia* | 29 | 34 | 938.6859 | 9.39 | 4.41 | 1.10 |
| 12 | 33.84 | 73.15 | Quercus | *Quercus dilatata* | 65 | 78 | 3890.896 | 38.91 | 18.29 | 4.57 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 80 | 131 | 13667.3 | 136.67 | 64.24 | 16.06 |
| 12 | 33.84 | 73.15 | chir | *Pinus roxburghii* | 85 | 142 | 16646.19 | 166.46 | 78.24 | 19.56 |