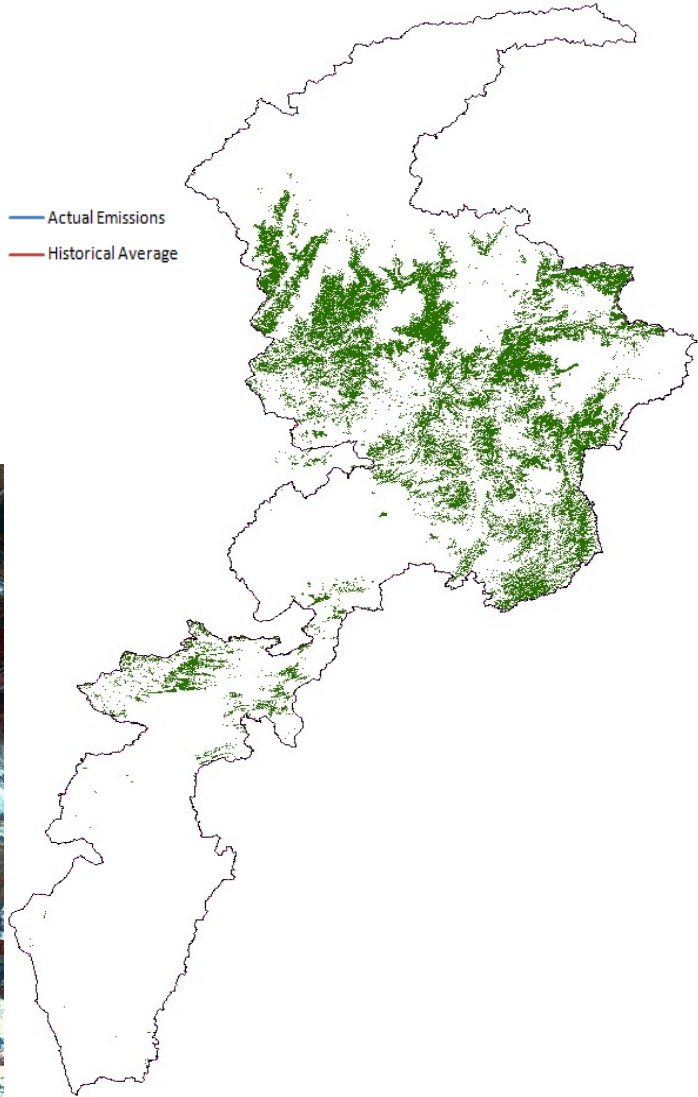
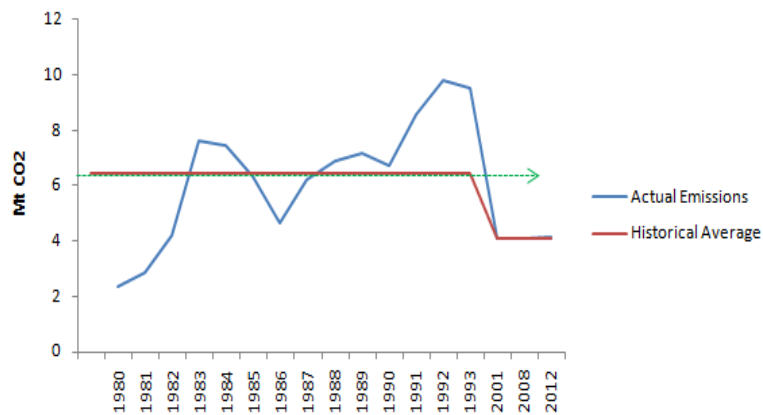




FOREST REFERENCE EMISSION LEVEL OF KHYBER PAKHTUNKHWA



FREL of Khyber Pakhtunkhwa



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List of Acronyms and Abbreviations

C	Carbon
CO ₂	Carbon dioxide
COP	Conference of the Parties
CSA	Carbon Stock Assessment
FAO	Food and Agriculture Organization
FATA	Federally Administered Tribal Areas
FDC	Forest Development Corporation
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
FSMP	Forestry Sector Master Plan
GHG	Green House Gases
ha	hectare
IC	Inter-cooperation
ICIMOD	International Centre for Integrated Mountain Development
IPCC	Inter-governmental Panel on Climate Change
KP	Khyber Pakhtunkhwa
NFRRAS	National Forest and Range Resources Assessment Study
NWFP	North West Frontier Province
PFI	Pakistan Forest Institute
REDD+	Reducing emissions from deforestation and forest degradation; and the role of sustainable forest management, conservation and enhancement of forest carbon stocks
SUPARCO	Space and Upper Atmosphere Research Commission
UNFCCC	United Nations Framework Convention on Climate Change
THBS	Timber Harvesting Ban Study

EXECUTIVE SUMMARY

Khyber Pakhtunkhwa, located in the north west of Pakistan is the most forested province of the country. The total forest area of the province is about 2.043 million hectare which is about 45% of the total forest area of the country. Similarly about 66% of the country's total coniferous forests are located in Khyber Pakhtunkhwa which have high potential for storing carbon and reducing emissions under the REDD+ Programme. Besides, the government of Khyber Pakhtunkhwa has made a significant progress for REDD+ preparation compared to other provinces. Khyber Pakhtunkhwa has developed a sub-national strategy for REDD+, conducted a comprehensive forest carbon inventory, prepared landuse maps through interpretation of high resolution satellite imageries and has developed allometric models for biomass and carbon estimation. Besides a high level steering committee has been constituted to supervise REDD+ activities in the province. On the other hand, the government of Khyber Pakhtunkhwa has successfully completed a mega afforestation project to plant one billion trees in the province which will significantly increase the carbon stock of the province.

Reducing emissions from deforestation, forest degradation, sustainable forest management, conservation and enhancement of enhancing carbon stocks in the forests known as REDD+, has emerged as a promising option for climate change mitigation in developing countries. Countries aiming to undertake REDD+ activities are required to develop REDD+ Strategy, Forest Reference Emission Level, Forest Monitoring System and Safeguards Information System.

Forest Reference Emission levels and/or Forest Reference Levels (FRELs/FRLs) are the emissions baselines which will be used to measure emissions reductions under the REDD+ Program. UNFCCC has defined FREL/FRLs as *"...benchmarks for assessing each country's performance in implementing [REDD+] activities"*. The UNFCCC does not explicitly specify the difference between a FREL and a FRL. A common understanding is that a FREL only includes activities which reduce emissions meaning that it refers to gross emissions from deforestation and degradation whereas FRL also includes activities from the "+" that can "enhance forest carbon stocks" and thus it refers to net emissions. Thus the scope of a FRL could include the same activities as a FREL plus enhancement of forest carbon stocks.

The scale of the FREL/FRL is subnational covering Khyber Pakhtunkhwa province excluding the recently merged districts of erstwhile FATA. The total forest cover of Khyber Pakhtunkhwa (excluding FATA) was 1,133,560 ha in 2012 which is the baseline year for REDD+ in Khyber Pakhtunkhwa. The FREL/FRL of Khyber Pakhtunkhwa focuses on reducing emissions from deforestation and forest degradation; and enhancement of carbon stocks through growth of the existing forests and afforestation and reforestation. The GHG included in the FREL/FRL is only CO₂. The carbon pools included aboveground biomass and belowground biomass at the moment.

The approach adopted for construction of FREL/FRL is based on historic emissions from deforestation and forest degradation. It has been established by several studies conducted by national and international organizations that before 2012 the annual deforestation rate has been about 8000 ha. Emissions from forest degradation were estimated through stock difference approach measuring the forest degradation between 2000 and 2015. Local emission factors were developed through a terrestrial carbon inventory conducted in all forest types of Khyber Pakhtunkhwa. Local allometric equations were developed through destructive sampling of more than 300 trees covering 10 major tree species of the province. Thus, these emissions factors represent Tier 3 approach which is more reliable.

Total annual emissions from deforestation and forest degradation during the period 1992-2012 have been estimated at 4.123 million tonnes of CO₂ i.e. 2.128 million tonnes from deforestation and 1,995 million tonnes from forest degradation. In the era before 1992, the total annual emissions have been 6.458 million tonnes of CO₂. On the other hand, annual carbon sequestration by the forests has been estimated at 5.968 million tonnes during 2012. Thus it is clear the forestry sector of Khyber Pakhtunkhwa is a net sink of 1.84 million tonnes of CO₂ per year. However, this sink has been tremendously increased by Billion Trees Afforestation Project during 2013-2018.

1. Introduction

Reducing emissions from deforestation, forest degradation, sustainable forest management, conservation and enhancement of enhancing carbon stocks in the forests known as REDD+, has emerged as a promising option for climate change mitigation in developing countries. Under the REDD+ programme, developed countries will provide incentives to developing countries to keep their forests standing and thus help in reducing Green House Gas (GHG) emissions. United Nations Framework Convention on Climate Change (UNFCCC) has provided comprehensive guidelines for REDD+ activities through its Warsaw Framework. UNFCCC decisions on REDD+ encourage developing countries to contribute to mitigation actions by voluntarily undertaking activities that reduce greenhouse gas (GHG) emissions and enhance carbon sinks in the forestry sector. The five activities that comprise REDD+ are:

1. Reducing emissions from deforestation;
2. Reducing emissions from forest degradation;
3. Conservation of forest carbon stocks;
5. Enhancement of forest carbon stocks.
4. Sustainable management of forests;

Countries aiming to undertake REDD+ activities are requested by the UNFCCC to develop the following four elements:

- REDD+ Strategy
- National Forest Monitoring System
- Forest Reference Emission Level/Forest Reference Level
- Safeguards Information System

Forest Reference Emission levels and/or Forest Reference Levels(FREs/FRLs) are the emissions baselines which will be used to measure emissions reductions under the REDD+ Program. The Conference of Parties (COP) to the UNFCCC has decided that FREL/FRLs are: “...*benchmarks for assessing each country’s performance in implementing [REDD+] activities*”. The UNFCCC does not explicitly specify the difference between a FREL and a FRL. A common understanding is that

a FREL only includes activities which reduce emissions meaning that it refers to gross emissions from deforestation and degradation whereas FRL also includes activities from the “+” that can “enhance forest carbon stocks” and thus it refers to net emissions. Thus the scope of a FRL could include the same activities as a FREL plus enhancement of forest carbon stocks.

Under the UNFCCC REDD+ the establishment of a FREL/FRL is required to qualify for payment against performance based emissions reduction. It can also be used to evaluate national or subnational policies and measures implemented to mitigate climate change in the forest sector and/or to contribute to international mitigation through REDD+. The UNFCCC FREL/FRL guidelines, based on relevant COP decisions, are designed to give countries flexibility in developing FREL/FRL in line with their national circumstances and capacities.

The UNFCCC guidelines for what countries should include in the FREL/FRL are:

- Information used by Parties in constructing the FREL/FRL should include historical data and details on national circumstances, in a comprehensive and transparent way;
- Transparent, complete, consistent, and accurate information, including methodological information, used at the time of construction of the FREL/FRL;
- Pools, gases and activities included in FREL/FRL and the reasons for omitting a pool and/or activity from FREL/FRL construction; and,

IPCC GOOD PRACTICE GUIDANCE

The IPCC adopted the following good practices for reporting of GHG inventories:

- **Transparency:** The principle that all assumptions and methodologies are explained and allow for external replication and assessment.
 - **Accuracy:** The principle that estimates are systematically neither over nor under true emissions or removals and that uncertainties are reduced to the extent practical.
 - **Consistency:** The principle that an inventory should be internally consistent in all elements over time. Different methodologies may be used over time if recalculations occur in a transparent manner and incorporate good practices.
 - **Comparability:** The principle that emission and removal estimates reported by Parties should be comparable among Parties.
 - **Completeness:** The principle that an inventory should cover all sources and sinks for the specified geographic area.
- Source: IPCC, 2006. Guidelines

- The definition of forest used for the construction of the FREL/FRL and, if different than the definition used in the national greenhouse gas (GHG) inventory, an explanation of why and how the definition used in the FREL/FRL construction was chosen.

2. Rationale for a subnational FREL/FRL for Khyber Pakhtunkhwa

According to UNFCCC the FREL/FRL has to be eventually at national level but as an interim arrangement, it can be developed at a subnational level. In this context, the government of Khyber Pakhtunkhwa decided to develop a subnational Forest Reference Emission Level/Forest Reference Level for the province. The reason behind this decision is that Khyber Pakhtunkhwa is the most forested province of Pakistan. It hosts more than one third of total forest area of the country and if Federally Administered Tribal Areas (FATA) is included, then this area becomes half of the total forest area of the country. Similarly more than 50% of the country's total coniferous forests are located in Khyber Pakhtunkhwa which have high potential for reducing emissions under the REDD+ Programme. Besides, the government of Khyber Pakhtunkhwa has made a significant progress for REDD+ preparation compared to other provinces. Khyber Pakhtunkhwa has developed a sub-national strategy for REDD+, conducted a comprehensive terrestrial carbon inventory, prepared landuse maps through interpretation of high resolution satellite imageries and has developed allometric models for biomass and carbon estimation. Besides a high level steering committee has been constituted to supervise REDD+ activities in the province. On the other hand, the government of Khyber Pakhtunkhwa has successfully completed a mega afforestation project to plant one billion trees in the province and increase the forest area by 2% which will significantly increase the carbon stock of the province.

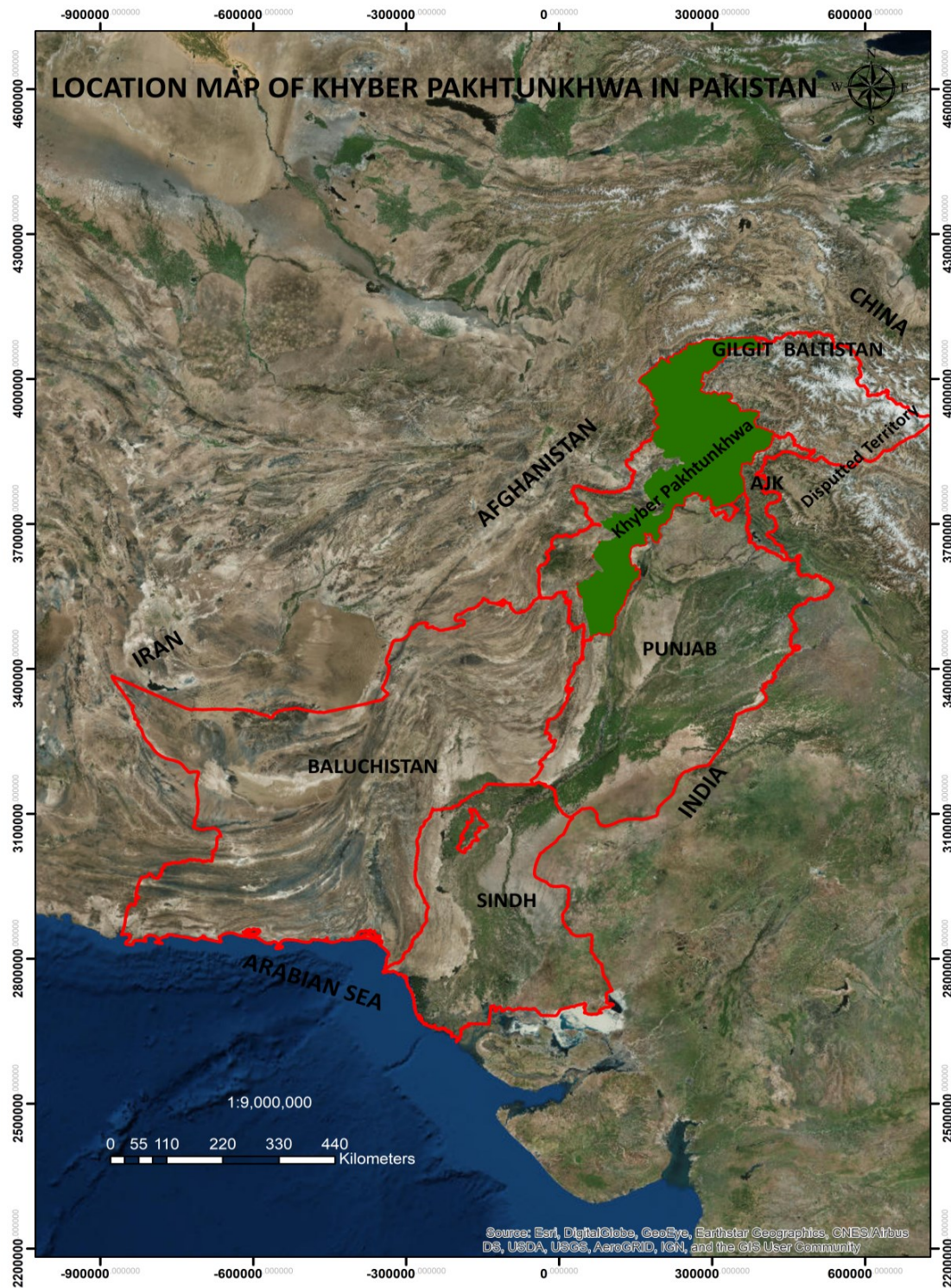


Figure 1: Location of Khyber Pakhtunkhwa in Pakistan

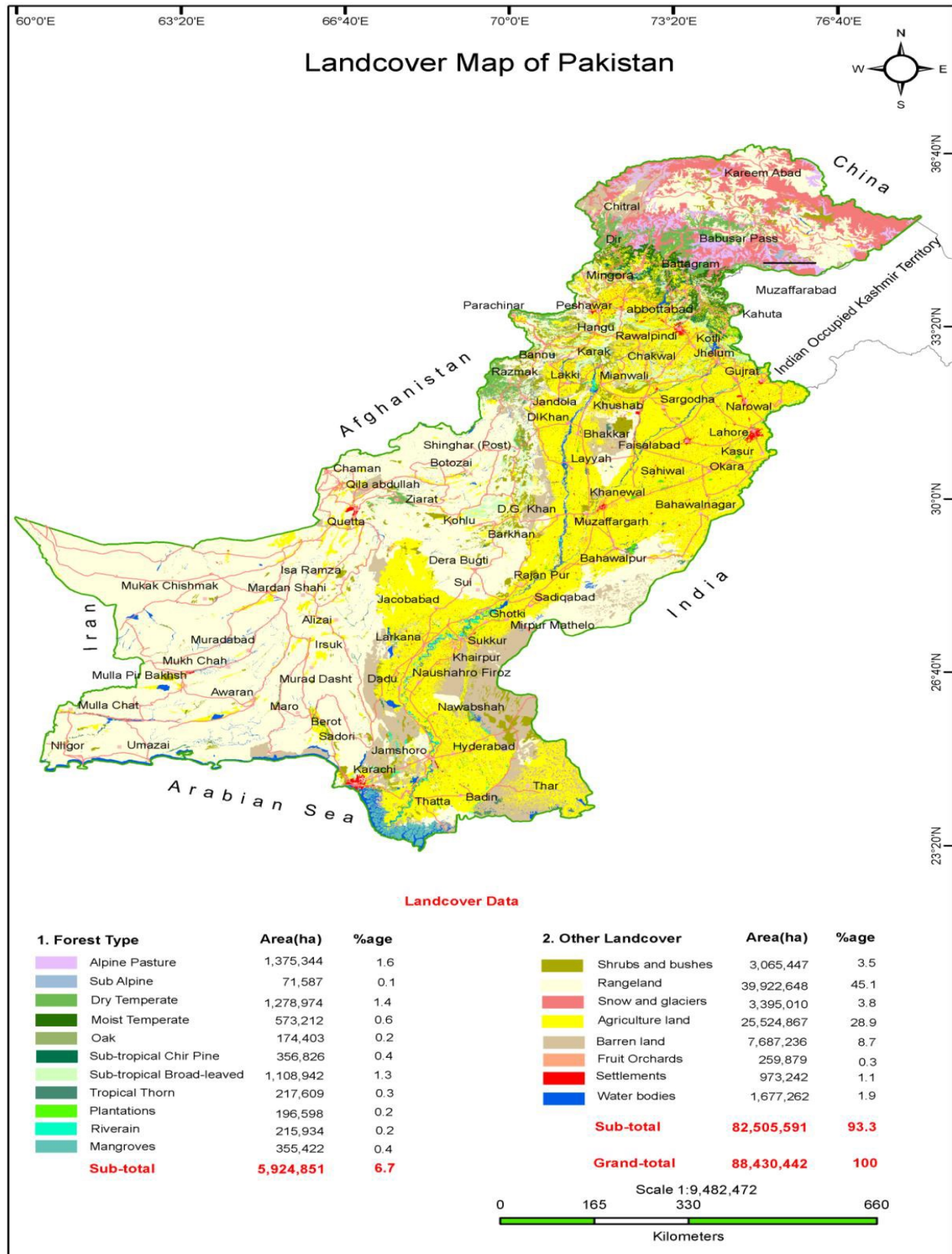


Figure 2: Landuse Map of Pakistan (Bukhari et al., 2012)

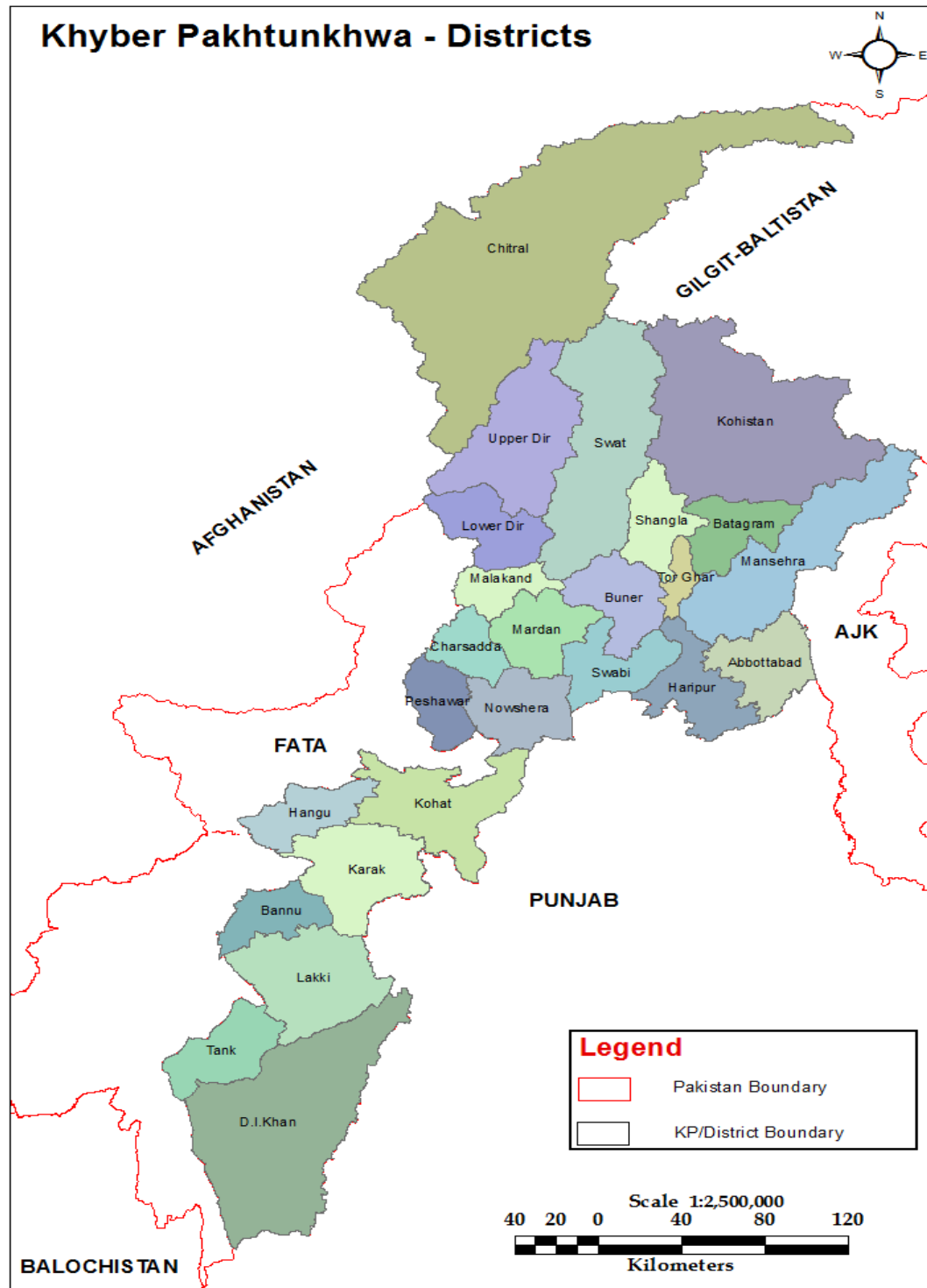


Figure 3: Districts of Khyber Pakhtunkhwa

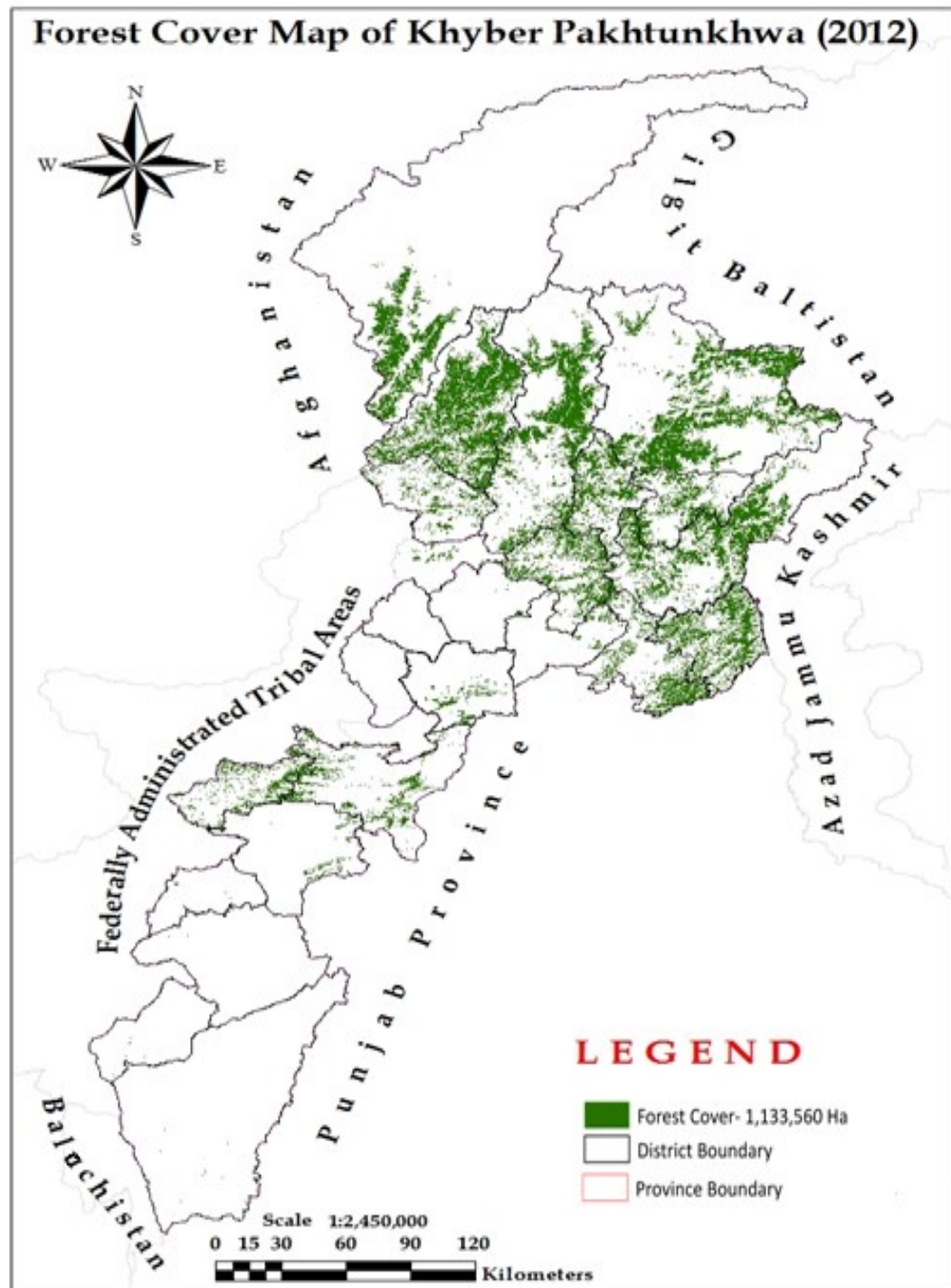


Figure 4: Forest Cover Map of Khyber Pakhtunkhwa (Ali, 2017)

3. Elements of Khyber Pakhtunkhwa's FREL/FRL

3.1 Scale

The scale of the FREL/FRL is subnational covering Khyber Pakhtunkhwa province excluding the recently merged districts of erstwhile FATA. The total forest cover of Khyber Pakhtunkhwa (excluding FATA) was 1,133,560 ha in 2012 which is the baseline year for REDD+ in Khyber Pakhtunkhwa.

3.2 Forest Definition

Forest definition adopted for the FREL/FRL of Khyber Pakhtunkhwa is based on the FAO's definition of forest which has been adopted at national level for REDD+ Programme in the country. The basic thresholds of this definition include:

Minimum Forest Area: 0.5 ha

Minimum Crown Cover: 10%

Minimum Tree Height (at maturity): 2 m

3.3 Scope

The FREL/FRL of Khyber Pakhtunkhwa focuses on the following activities:

- Reducing Emissions from Deforestation
- Reducing Emissions from forest degradation
- Enhancement of carbon stock through growth of the existing forests and afforestation and reforestation.

The GHG included in the FREL/FRL is only CO₂. As fire is not a significant factor of forest degradation or management practice in Khyber Pakhtunkhwa, other GHG gases are excluded.

The FREL/FRL of Khyber Pakhtunkhwa includes the following pools:

- Aboveground biomass (included for deforestation, forest degradation and enhancement of carbon stock).
- Belowground biomass (included only for deforestation and enhancement of carbon stock).
- Other carbon pools are not included in the current FREL/FRL due to lack of historical data to estimate changes in these pools overtime through stock difference approach.

Forests are depleted in Khyber Pakhtunkhwa through forest degradation as the forests remain forests but mature and good quality trees are removed either through approved working plans or illicit cutting by the communities resulting in decline in the forest density and stocking. As such most of the deforested areas are not converted into other landuses. As forest degradation mostly affects aboveground biomass and sufficient data is available for quantifying emissions resulting from changes in the aboveground biomass, therefore the focus of Khyber Pakhtunkhwa FREL/FRL is on changes in the above ground biomass. However, additional carbon pools will be included in the future submissions as data is being collected on other pools by the project executed by Pakistan Forest Institute (PFI).

Table 1. List of activities, pools and gases included in Khyber Pakhtunkhwa FREL/FRL

Activities	Pools	Gases
- Reducing emissions from deforestation - Reducing emissions from forest degradation - Enhancement of carbon stock	- Aboveground biomass - Belowground biomass	- CO₂

4. Activity Data

The IPCC provides three approaches to collect land activity data:

Approach 1: Data only represent net changes in land-use areas tracked over time and do not provide spatially explicit information, exact locations or patterns of land-use changes. Changes from one category to another are also not tracked.

Approach 2: Information about net losses and gains in specific land-use categories including conversions from/to other categories are included in the data, but without spatially explicit location data.

Approach 3: Provides spatially explicit observations of land-use categories and conversions, often tracking patterns at specific point locations and/or using gridded map products, such as derived from remote sensing imagery.

The available data on deforestation and forest degradation in Khyber Pakhtunkhwa can provide activity data for approach 1 as the deforestation and degradation estimates of the province are

not spatially explicit rather provide general estimates of forest loss. Exact location and pattern of landuse changes have not been properly documented. However, spatially explicit information on the landuse changes will be generated in future.

Activity data for FREL/FRL of Khyber Pakhtunkhwa includes data on deforestation, forest degradation and enhancement of carbon stock. Activity data related to deforestation is available for the year 1990, 1995, 2008, 1997, 2000, 2001, 2007 and 2012. Except ICIMOD, most of the deforestation assessment is not spatially explicit and based on vector data. Besides, definition of forest, methodology employed for image interpretation and spatial resolution of satellite data are not consistent. Therefore, spatially explicit estimates of deforestation will be produced later on. Activity data related to forest degradation is available for 1995 and 2015.

The Carbon Stock Assessment Project mapped forest cover for 2007 and 2012 using Spot-5 data (2.5m pan-sharpened) and it was estimated that 43,959 ha forest cover has been lost during this period with annual deforestation rate of 8,792 ha (Table 2). Spatially explicit areas of deforestation at district and sub-district level (e.g forest division, forest range) will be determined with availability of high resolution data in the future.

Table 2. Forest Cover Change Assessment during 2007-2012

S.No	District	2012 Forest area (ha)	2007 Forest area (ha)	Change (ha)
1	Abbottabad	77,247	69,832	7,415
2	Manshera	98,404	102,003	-3,599
3	Battagram	45,288	47,551	-2,263
4	Torghar	21,344	24,759	-3,415
5	Haripur	51,103	49,027	2,076
6	<i>Kohistan</i>	214,918	225,094	-10,176
7	Shangla	42,329	45,046	-2,717
8	Malakand	6,147	6533	-386
9	Swat	118,072	122,961	-4,889
10	Lower Dir	26,185	25,926	259
11	Upper Dir	171,888	184,163	-12,275
12	Buner	57,713	58,846	-1,133
13	Chitral	108,440	121,296	-12,856
Total				-43,959

Source: Ali, 2017

The ICIMOD attempted to assess deforestation in Khyber Pakhtunkhwa and they came up with an estimate of 20,795 ha for period 1990-2000 with annual deforestation of 2079.5 ha per year and 18,296 ha for 2000-2010 with annual deforestation of 1829.6 ha per year. Similarly, a study conducted by Swiss Agency for Inter-cooperation (IC) "Study on Timber Harvesting Ban in NWFP, Pakistan" reported a deforestation of 8,231 ha per year for the period 1996-2008. However, they did not identify the hotspots based on spatially explicit data.

A study conducted by PFI "National Forest and Range Resource Assessment Study" in 2004 reported that though there was no change in the total forest area in the period 1992 to 2001,

however, high-stock coniferous forests decreased at a rate of 8200 ha per year during this period and replaced by low-stock scrub forest.

The findings of afore-mentioned studies indicate that the deforestation rate in Khyber Pakhtunkhwa is in the tune of 8000 ha per year (Table 4).

Table 3. Change in Forest areas of Khyber Pakhtunkhwa

Forest Type	Status of Forest Cover (000 ha)			Annual change rate % (Base year 1992)	
	1992	1997	2001	5Yr Rate	10Yr Rate
Conifer	940	805	858	2.87(-)	0.87(-)
Scrub	539	709	628	6.31(+)	1.65(+)
Riverain	13	7	8	9.23(-)	3.85(-)
Total	1492	1521	1494	0.39(+)	0.01 (+)

Source: PFI, 2004

Table 4. Estimates of Deforestation by different studies

Study	Period	Data used	Annual Deforestation (ha)
NFRRAS	1992-2001	Landsat (30m)	8,200
ICIMOD	1990-2000	Landsat (30m)	4,332
ICIMOD	2000-2010	Landsat (30m)	5,081
THBS	1996-2008	Landsat (30m)	8,231
CSA	2007-2012	Spot-5 (2.5 m)	8,792

5. Emission Factors

Local emission factors were developed through a terrestrial carbon inventory conducted in all forest types of Khyber Pakhtunkhwa. Local allometric equations were developed through destructive sampling of more than 300 trees covering 10 major tree species of the province. Thus, these emissions factors represent Tier 3 approach. The aboveground and belowground carbon stocks were multiplied with 3.66 to develop emission factors for different forest types.

The emission factors are listed in the following table 6. In combination with activity data, these factors have been used to estimate emissions from deforestation and forest degradation.

Table 6. Emissions Factors for different forest types

Forest Type	AGC (t/ha)	BGC (t/ha)	Total C (t/ha)	Emission Factor for deforestation (CO ₂ t/ha)
Subalpine	34.27	9.94	44.21	162
Dry Temperate (conifer)	99.41	18.10	117.51	430
Dry Temperate (oak)	34.58	10.37	44.95	165
Moist Temperate	85.04	18.10	103.14	378
Subtropical Pine	24.77	6.44	31.21	114
Subtropical Broad-Leaved	4.52	1.24	5.76	21
Dry Tropical Thorn	4.48	2.51	6.99	26

Source: Ali, 2017

6. Development of FREL/FRL

The FREL/FRL is based on historical average of deforestation and forest degradation with adjustment for some key policy decisions. Stock difference approach is used to calculate emissions from deforestation and forest degradation. Historically there are two different phases of forest management in Khyber Pakhtunkhwa. Before 1993, forests were used for commercial timber harvesting. The total forest area under the custody of the Forest Department and properly covered by forest Working Plans for management purposes is 841,517 ha. Of the total area, 7.6% (63,915 ha) are state-owned Reserved forests, 29.7% (250,106 ha) are Guzara forests owned either by community or private individuals and 62.7% (527,496 ha) are Protected forests. Thus 92% of the forests are encumbered with rights of local communities. Traditionally forests have been harvested to provide revenue to the state and the private owners. In 1993, the Government of Pakistan imposed a complete ban on felling of green trees in the aftermath of a catastrophic flood in the country which was attributed to large scale deforestation in the upland catchment areas. Thus harvesting of green trees has been

under suspension since 1993. Thus, there are two distinct periods of forest management which yield varied amount of carbon emissions i.e Pre-Ban Period (Before 1993) and Post-Ban Period (after 1993).

6.1 Carbon Emission in the Pre-Ban Period

No proper assessment has been carried out to determine the magnitude of deforestation before 1993. However, the record of Forest Development Corporation (FDC) shows that 62.684 m³ timber was harvested in the period 1980-1993 with an average outtake of 4.477 million m³ per year. This timber data is converted into CO₂ emissions as follows:

$$\text{Emission ton CO}_2 = V \times \text{BWD} \times \text{BEF} \times \text{CF} \times 3.66$$

Where

V= volume of timber

BWD= Basic Wood Density (0.5 for conifers)

BEF= Biomass Expansion Factor (1.3 for conifers)

CF= Conversion factor (0.47)

Thus the timber estimates were converted into emissions on the basis of above formula. The average annual emissions for the period 19981-1993 was estimated at 6.458 million tCO₂. Year-wise detail is presented in the Table 7.

Table 7. Year-wise detail of emissions from timber extraction

Year	Timber (million m ³)	AGB (million ton)	AGC (million ton)	BGC (million ton)	Total C (million ton)	CO ₂ (million ton)
1980	1.634	1.0621	0.499187	0.144764	0.643951	2.356862
1981	1.978	1.2857	0.604279	0.175241	0.77952	2.853043
1982	2.911	1.89215	0.889311	0.2579	1.147211	4.198791
1983	5.301	3.44565	1.619456	0.469642	2.089098	7.646097
1984	5.176	3.3644	1.581268	0.458568	2.039836	7.465799
1985	4.405	2.86325	1.345728	0.390261	1.735988	6.353718
1986	3.221	2.09365	0.984016	0.285364	1.26938	4.645931
1987	4.309	2.80085	1.3164	0.381756	1.698155	6.215249
1988	4.778	3.1057	1.459679	0.423307	1.882986	6.891728
1989	4.97	3.2305	1.518335	0.440317	1.958652	7.168667
1990	4.65	3.0225	1.420575	0.411967	1.832542	6.707103
1991	5.94	3.861	1.81467	0.526254	2.340924	8.567783
1992	6.801	4.42065	2.077706	0.602535	2.68024	9.809679
1993	6.61	4.2965	2.019355	0.585613	2.604968	9.534183
Average	4.477429	2.910329	1.367854	0.396678	1.764532	6.458188

Illegal harvesting and removal of trees under the rights of local communities may also have a huge quantum which could not be assessed from the FDC data. However, after 1992 the outtake of legal timber has been drastically reduced as per the record of FDC and Forest Department.

Recently the government of Khyber Pakhtunkhwa has decided to lift the ban on timber harvesting and resume scientific management under the approved working plans. Thus the quantum of wood harvesting will be increased in future. This will result an increase in emissions from deforestation and degradation. Therefore, it is essential to consider these policy decisions while preparing FREL/FRL for Khyber Pakhtunkhwa.

6.2 Carbon Emission in the Post-Ban Period

In the post-ban period, several datasets are available on deforestation which were used to calculate emissions. The detail is given in the following sections.

6.2.1 Calculation of Emissions from Deforestation

If the deforestation rate is considered as 8000 ha per year for the period 1992-2012 as reported by CSA Project, NFRRAS and THBS, the total carbon emissions will be 2.128 million ton as calculated below:

$$\begin{aligned}\text{Annual emissions from deforestation (Aboveground Biomass)} &= \text{Activity Data} \times \text{Emission Factor} \\ &= 8000 \times 220 = 1,760,000 \text{ tonnes CO}_2\end{aligned}$$

$$\text{Annual emissions from deforestation (Belowground Biomass)} = 8000 \times 46 = 368,000 \text{ tonnes CO}_2$$

$$\text{Total Annual emissions from deforestation} = 1,760,000 + 368,000 = 2,128,000 \text{ tonnes CO}_2$$

6.2.2 Calculation of Emissions from Forest Degradation

According to Provincial Forest Resource Inventory (2000) the average growing stock in the forests of Khyber Pakhtunkhwa was 228 m³/ha in 1995/96. If this is converted into aboveground carbon stock, we get 69.65 t/ha as calculated below:

$$\text{Carbon Stock} = \text{Volume} \times \text{BWD} \times \text{BEF} \times \text{CF}$$

$$\text{Carbon Stock} = 228 \times 0.5 \times 1.3 \times 0.47 = 69.65 \text{ t/ha}$$

According to the Carbon Stock Assessment of Forests of Khyber Pakhtunkhwa, the current aboveground carbon stock is 60 t/ha (Ali, 2017). Thus forest degradation is calculated through stock difference approach as follows:

$$\text{Annual carbon Stock Degradation} = (\text{Carbon Stock in time 1} - \text{Carbon Stock in time 2}) / \text{time interval}$$

$$\text{Annual carbon Stock Degradation} = (69.65 - 60.00) / 20 = 0.482 \text{ C t/ha}$$

$$\text{Emission Factor for Forest Degradation} = 0.482 \times 3.66 = 1.76 \text{ CO}_2\text{t/ha}$$

$$\begin{aligned}\text{Total Annual Emissions from Forest Degradation} &= \text{Forest area} \times \text{Emission Factor} \\ &= 1133560 \times 1.76 = 1,995,065 \text{ ton CO}_2\end{aligned}$$

$$\text{Total Annual Emissions} = \text{Emissions from Deforestation} + \text{Emissions from Forest Degradation}$$

$$\text{Total Annual Emissions} = 2,128,000 + 1,995,065 = 4,123,065 \text{ ton CO}_2$$

6.3 Summary of Total Emissions

In the Pre-Ban period, the average annual emissions were 6.458 million ton CO₂ whereas in the Post-Ban Period, the average annual emissions are 4.123 million tonnes of CO₂. FREL of Khyber Pakhtunkhwa is constructed on the basis of the historical average emissions in the Pre-Ban Period as shown Figure 5.

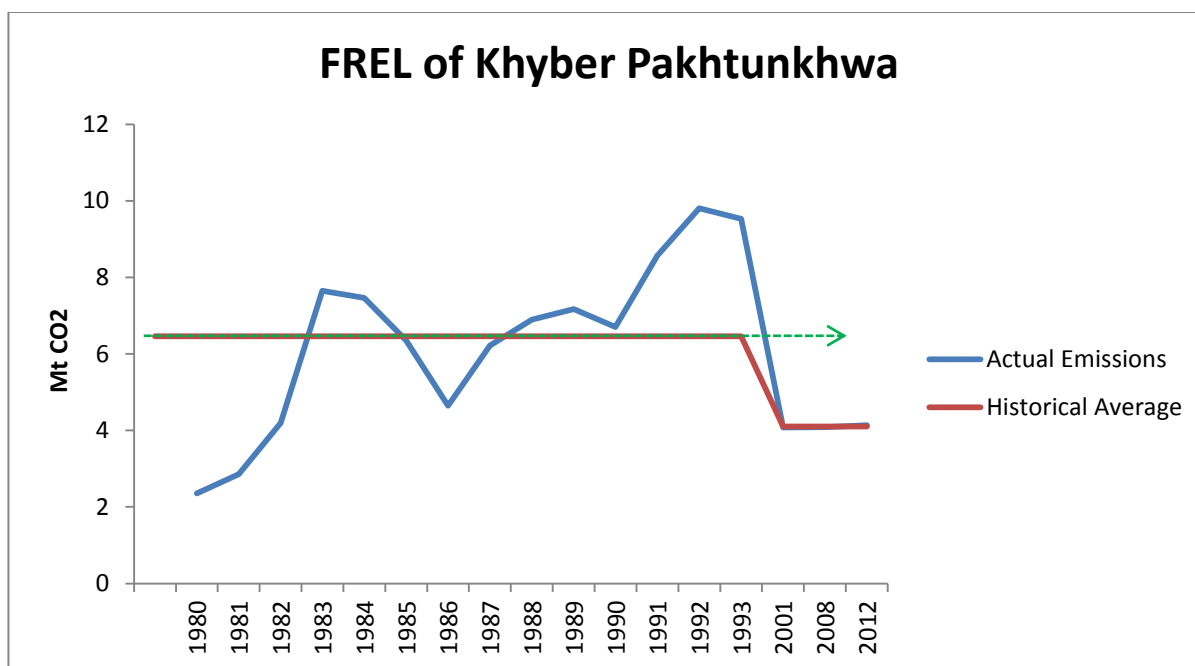


Figure 5. FREL of Khyber Pakhtunkhwa

7. Calculation of carbon sequestration

Total annual carbon sequestration by the forests of Khyber Pakhtunkhwa is 5.968 million tonnes as given in the following Table 8.

Table8. Annual CO₂ sequestration in different Forest Types

Forest Type	Area (ha)	Annual Growth Rate (t/ha)	CO2 sequestration (t/ha)	AGC annual Sequestration (ton)	BGC annual Sequestration (ton)	Total annual Sequestration (ton)
Sub-alpine	48,782	3	5.15	251,227	72,856	324,083
Temperate	654,277	3	5.15	3,369,527	977,163	4,346,689
Dry Temperate (oak)	77,491	3	5.15	399,079	115,733	514,811
Subtropical pine	144,424	1	1.72	248,409	72,039	320,448
Subtropical Broad-Leaved	206,810	1	1.72	355,713	103,157	458,870
Dry Tropical Thorn	1,776	1	1.72	3,055	885	3,940
Total	1,133,560			4,627,009	1,341,833	5,968,843

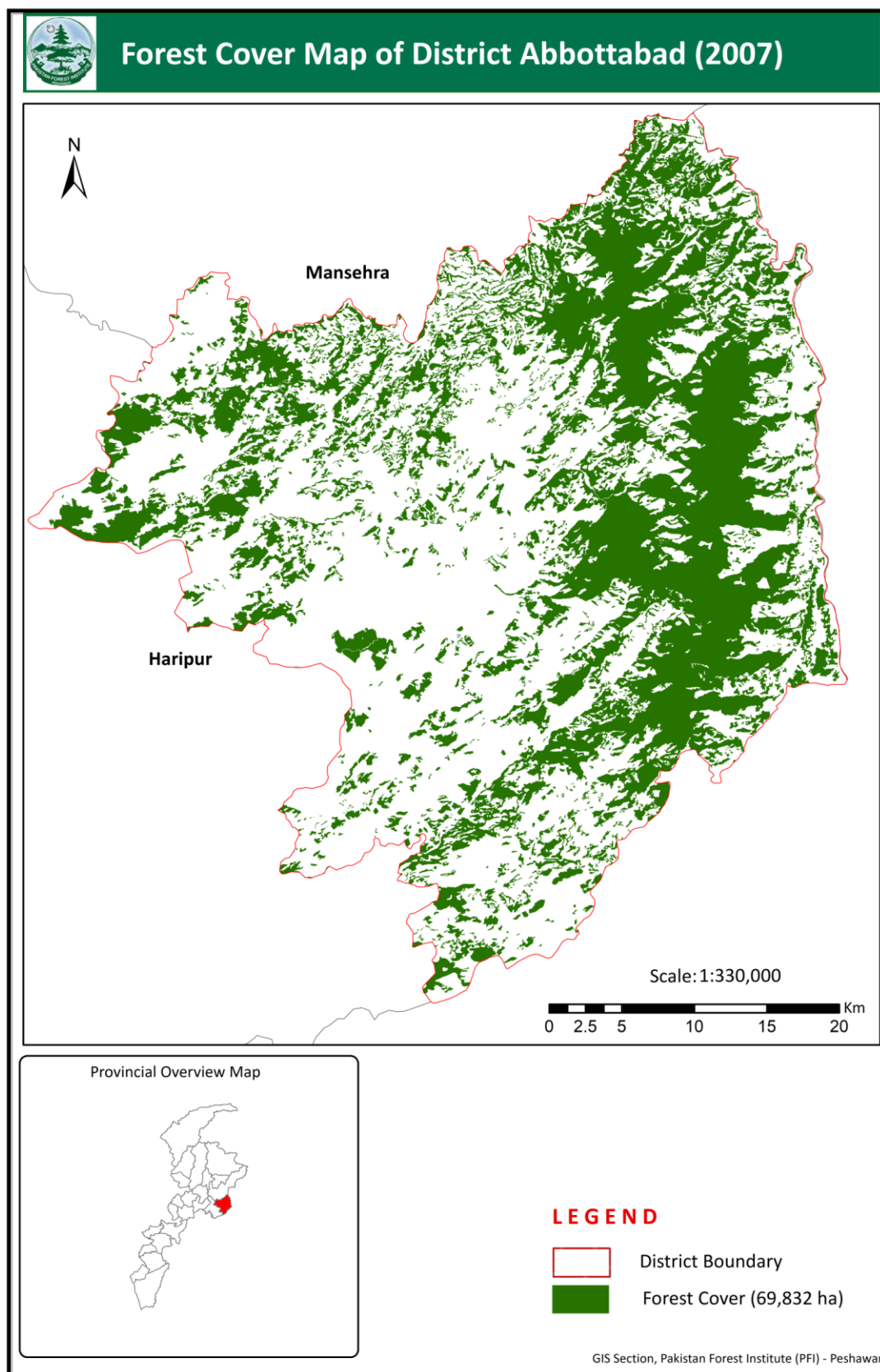
Source: Ali, 2017

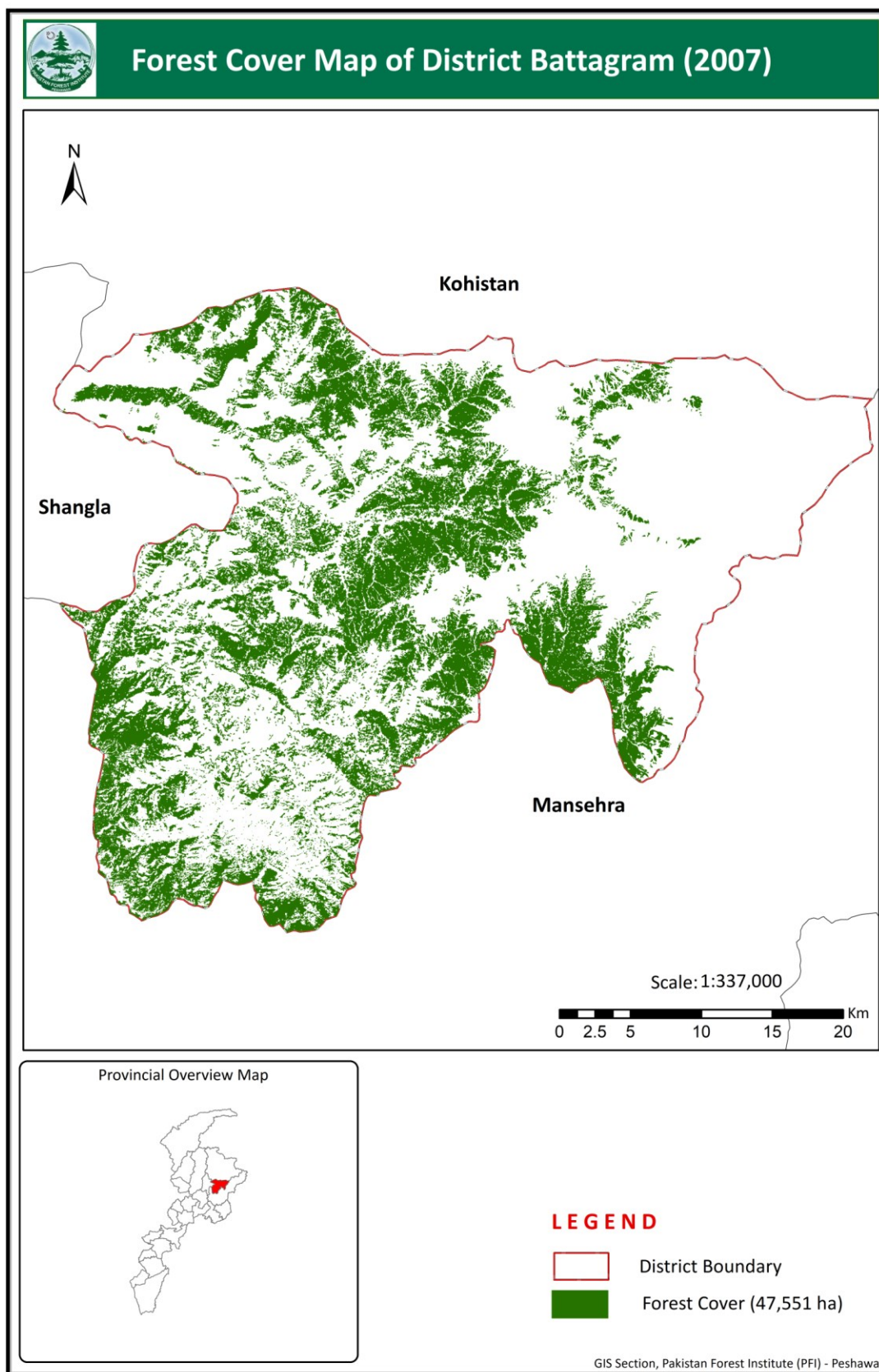
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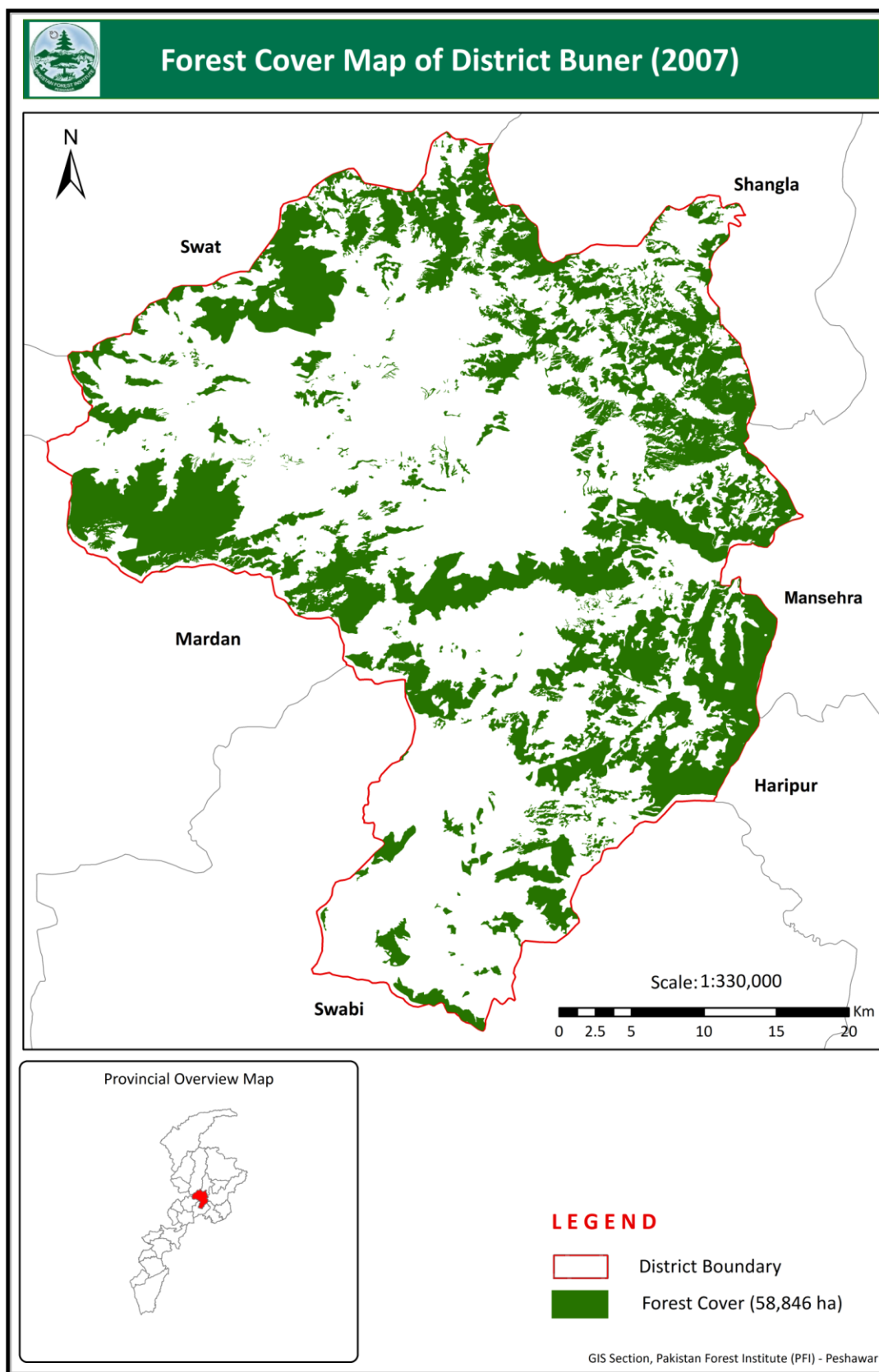
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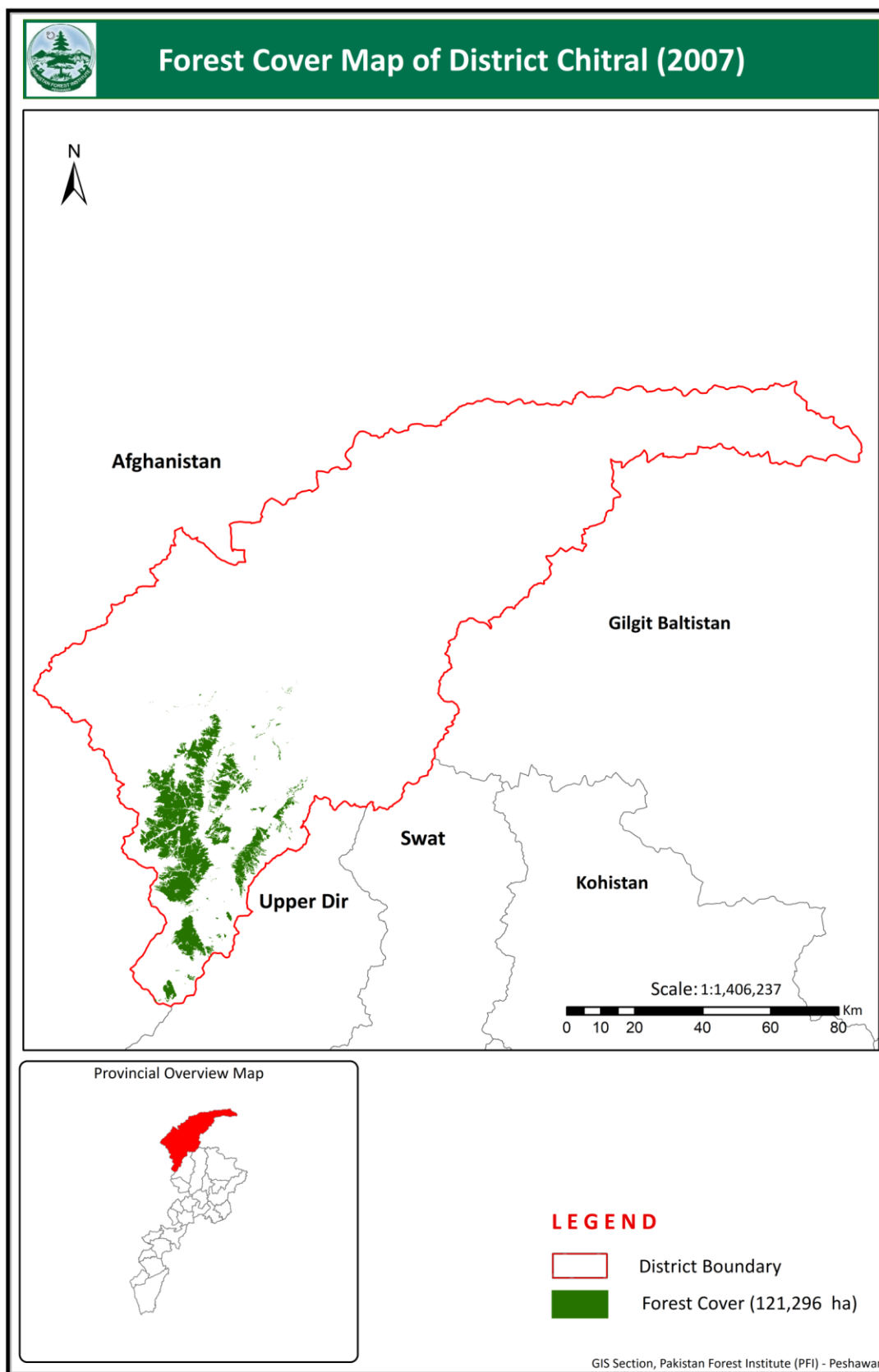
ANNEX-I

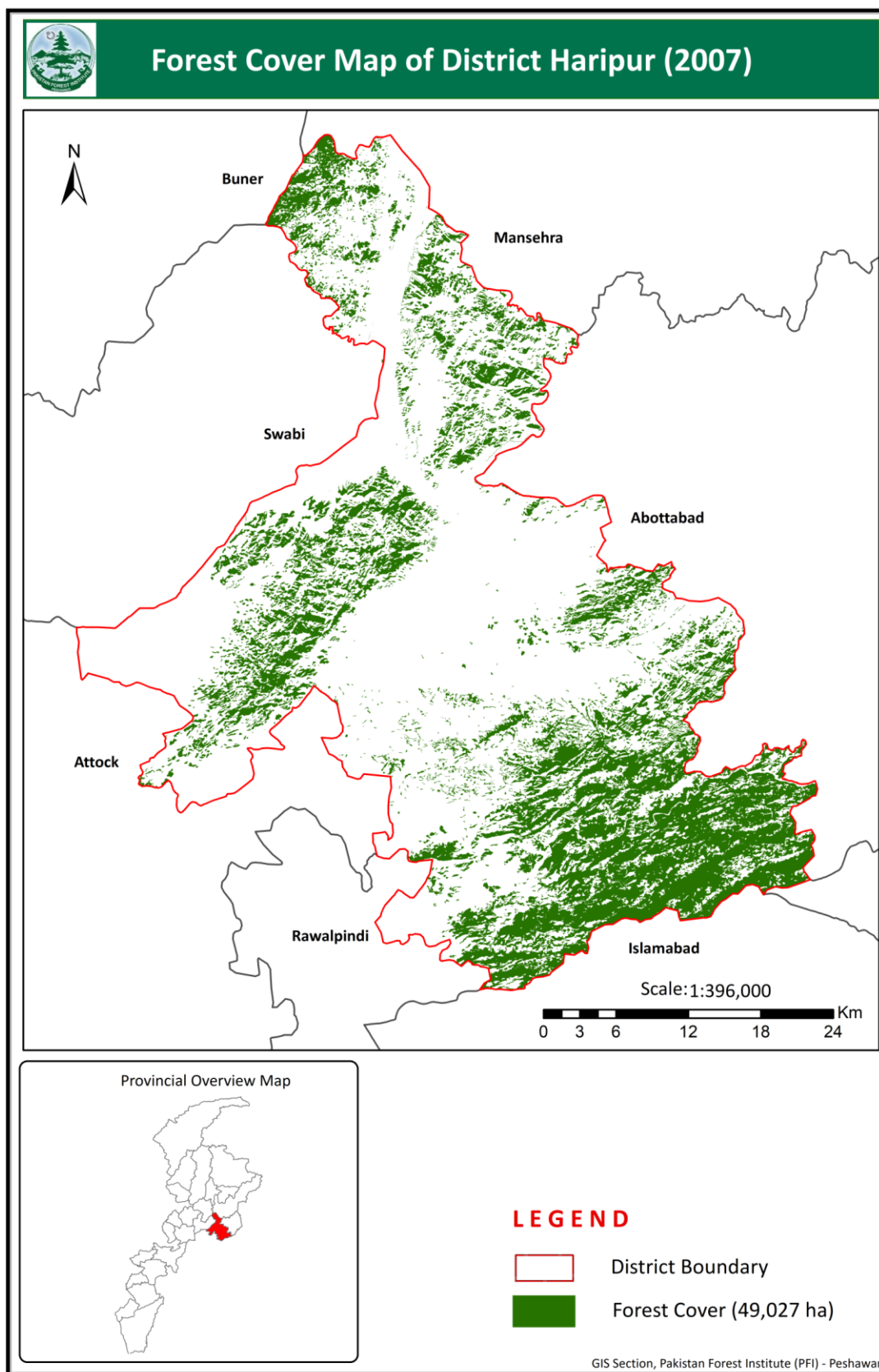
FOREST COVER MAPS OF FORESTED DISTRICTS 2007

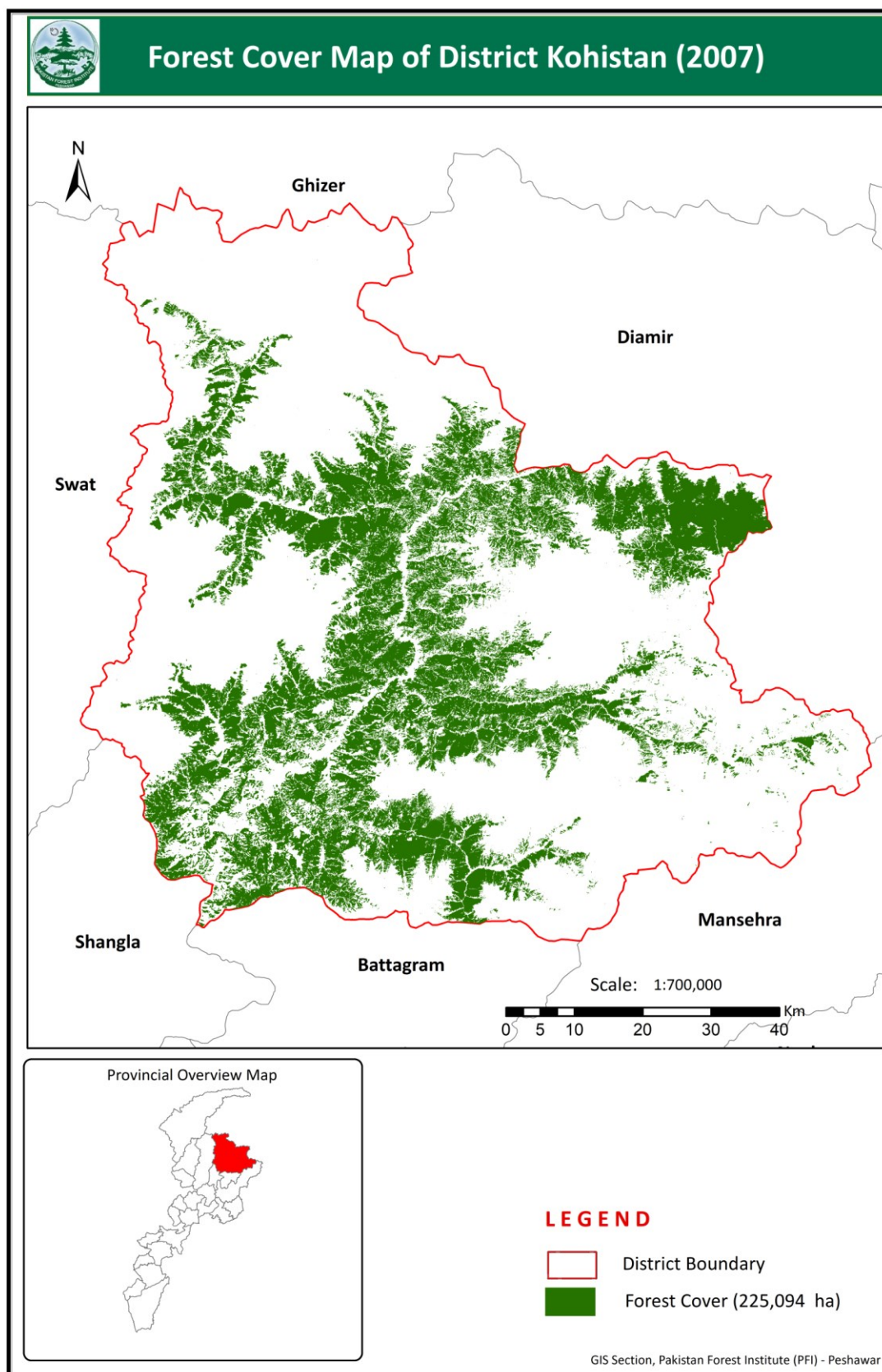


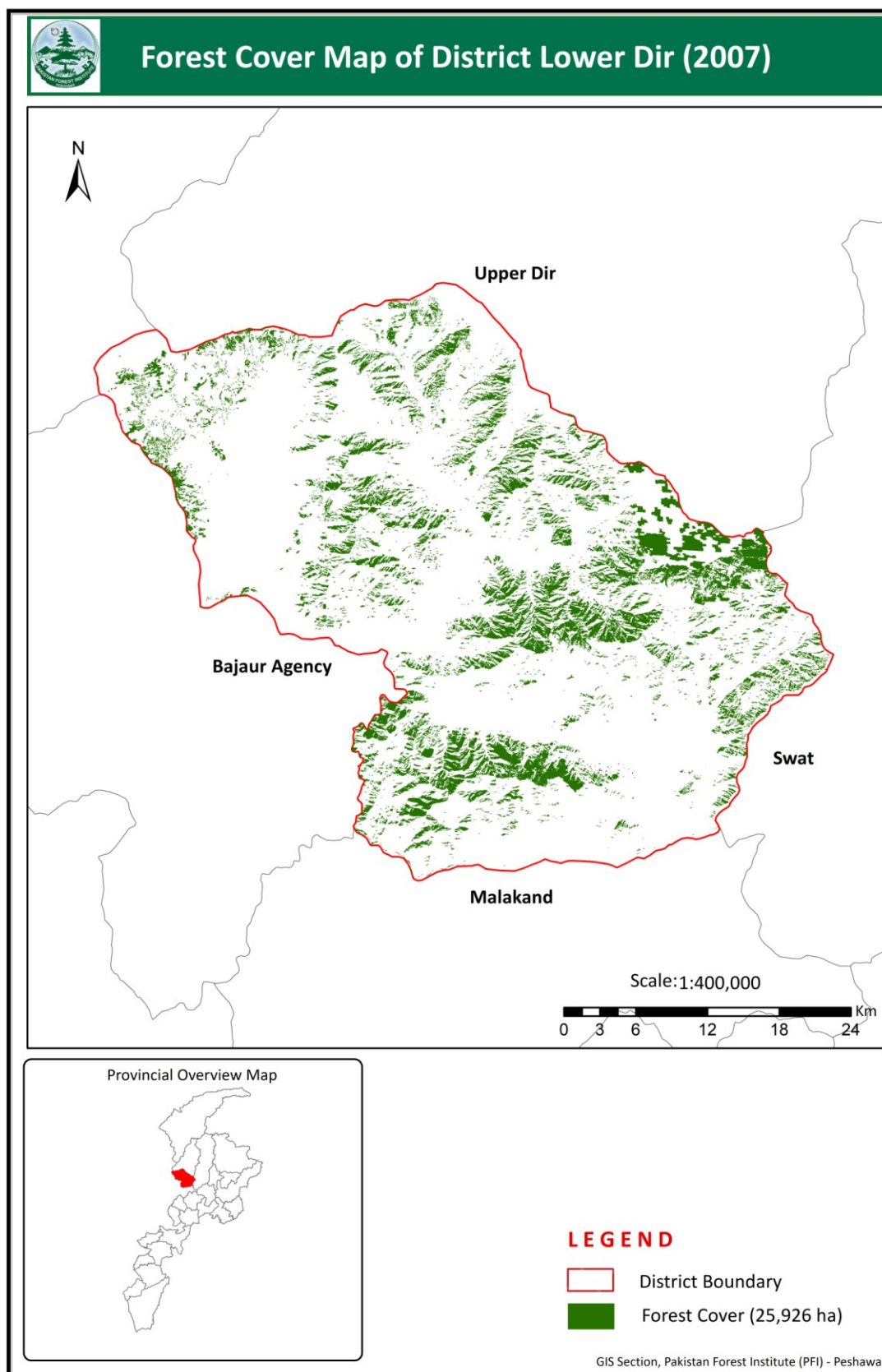


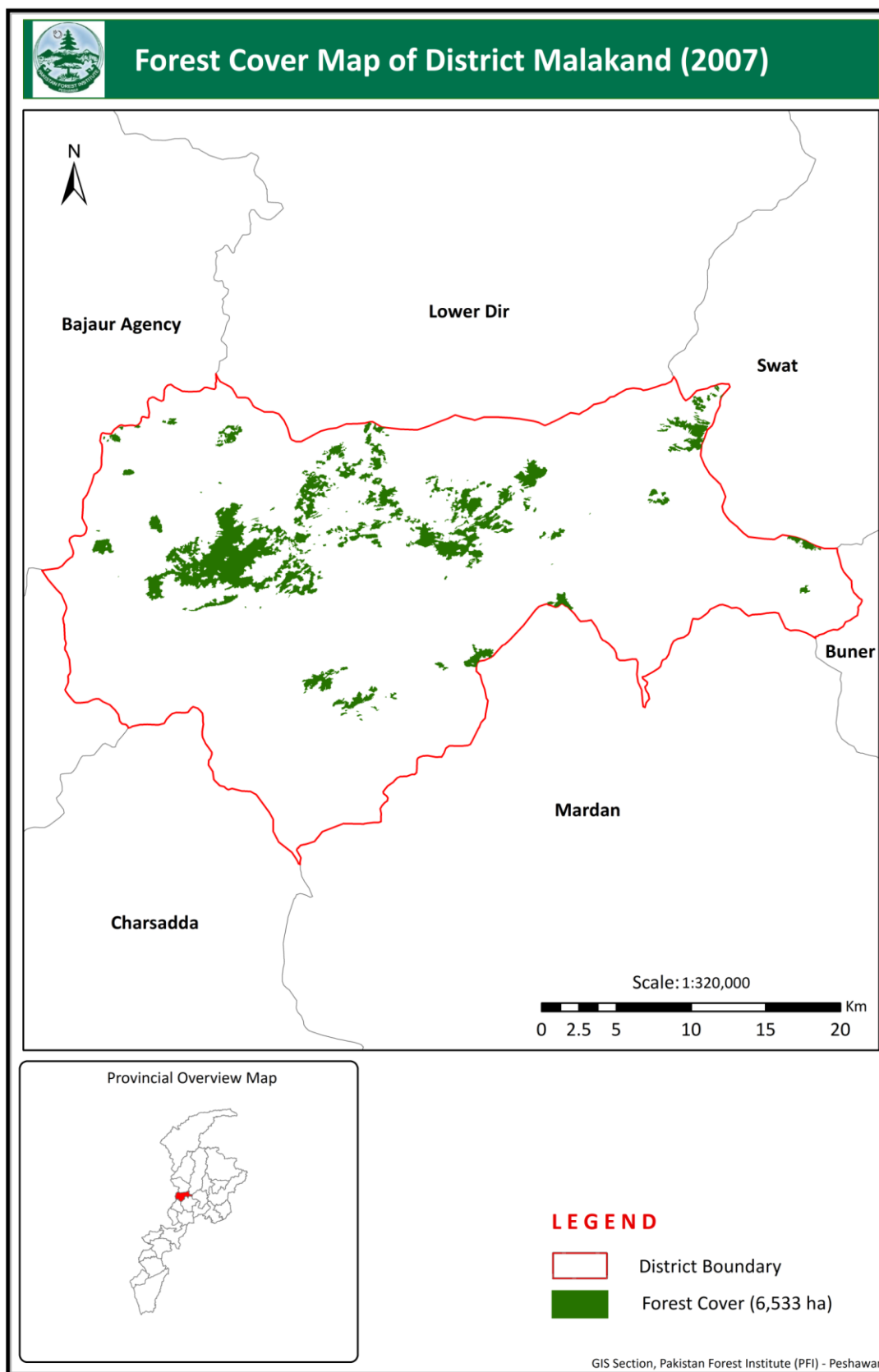


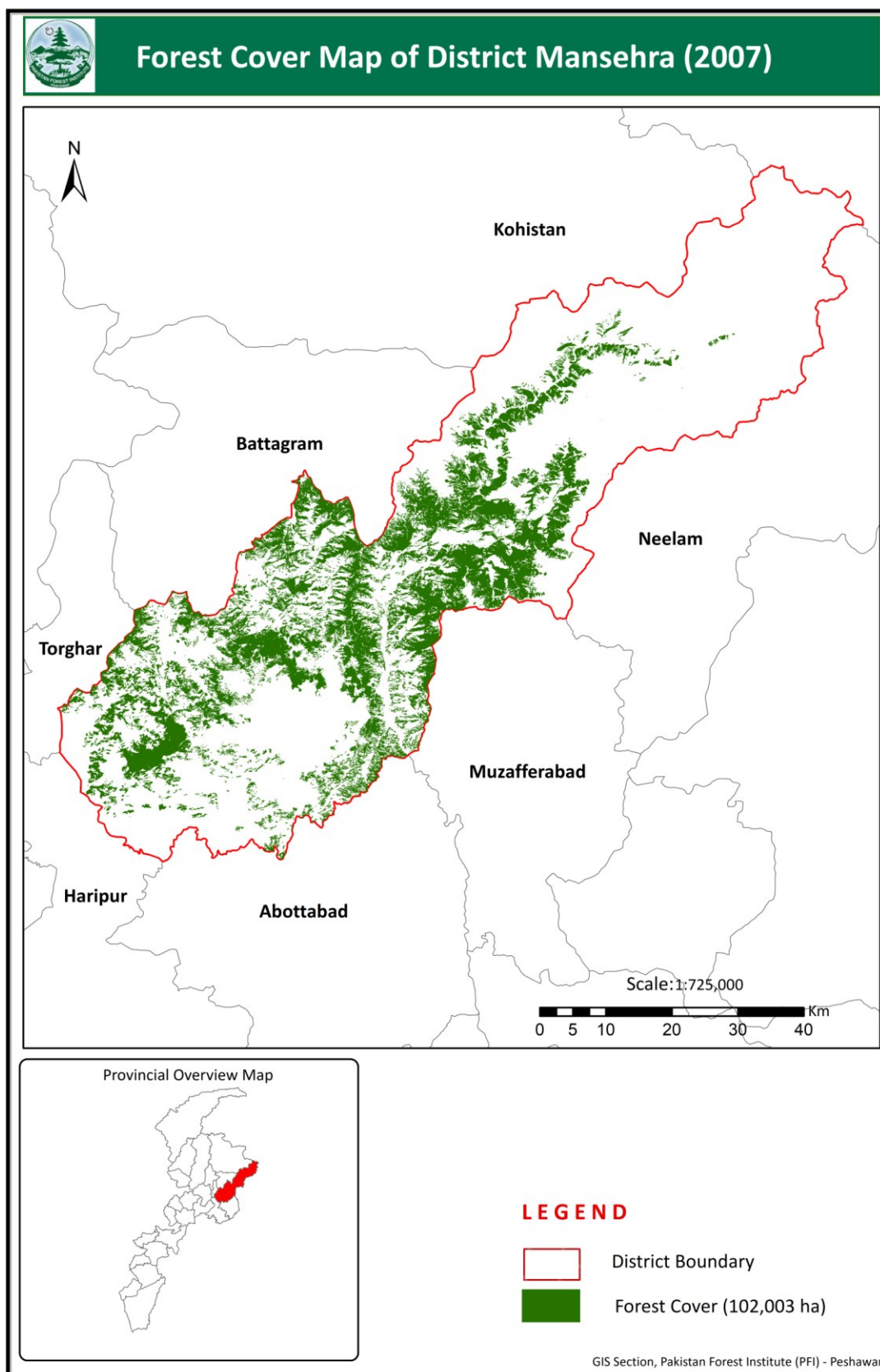


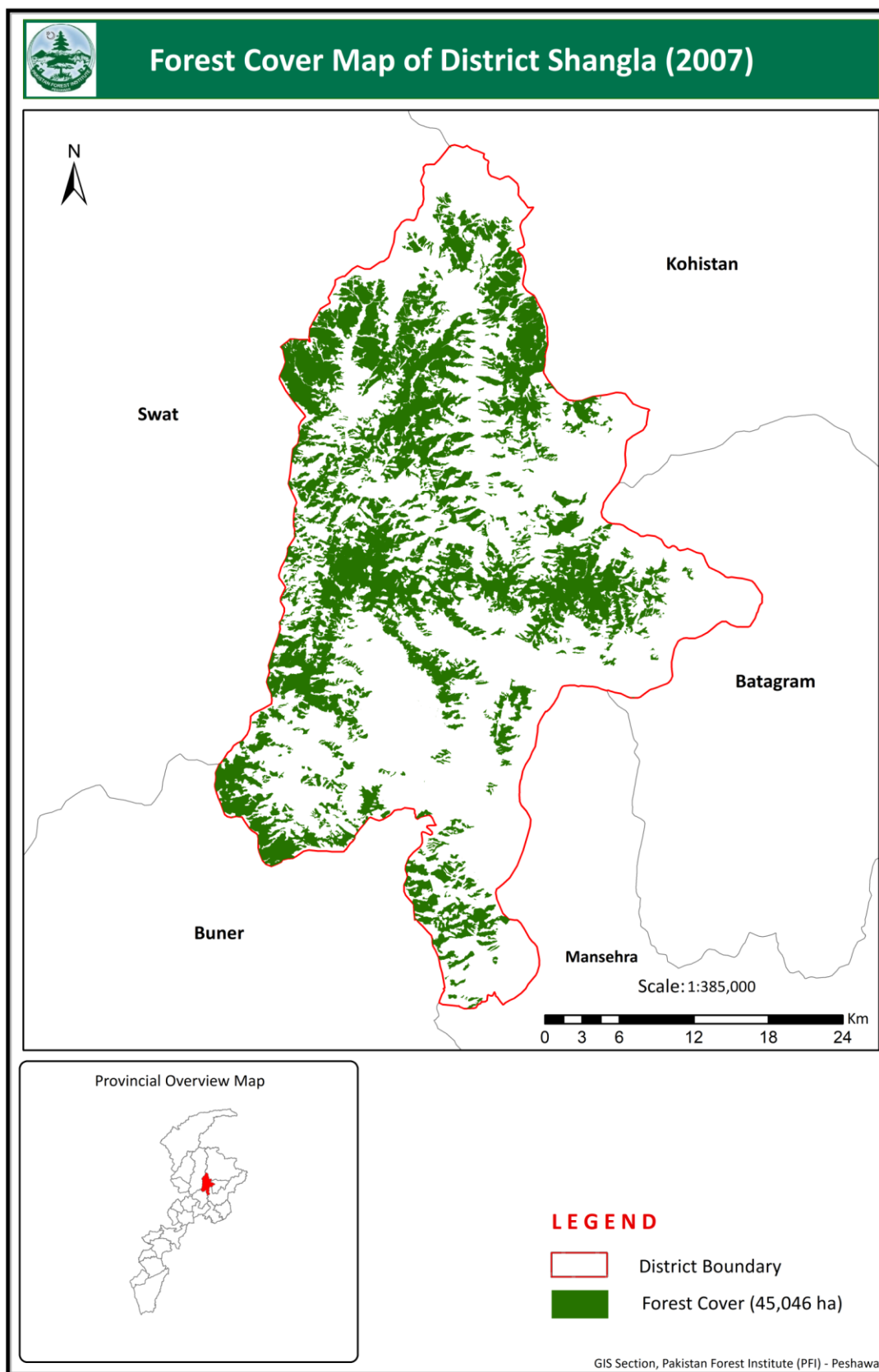


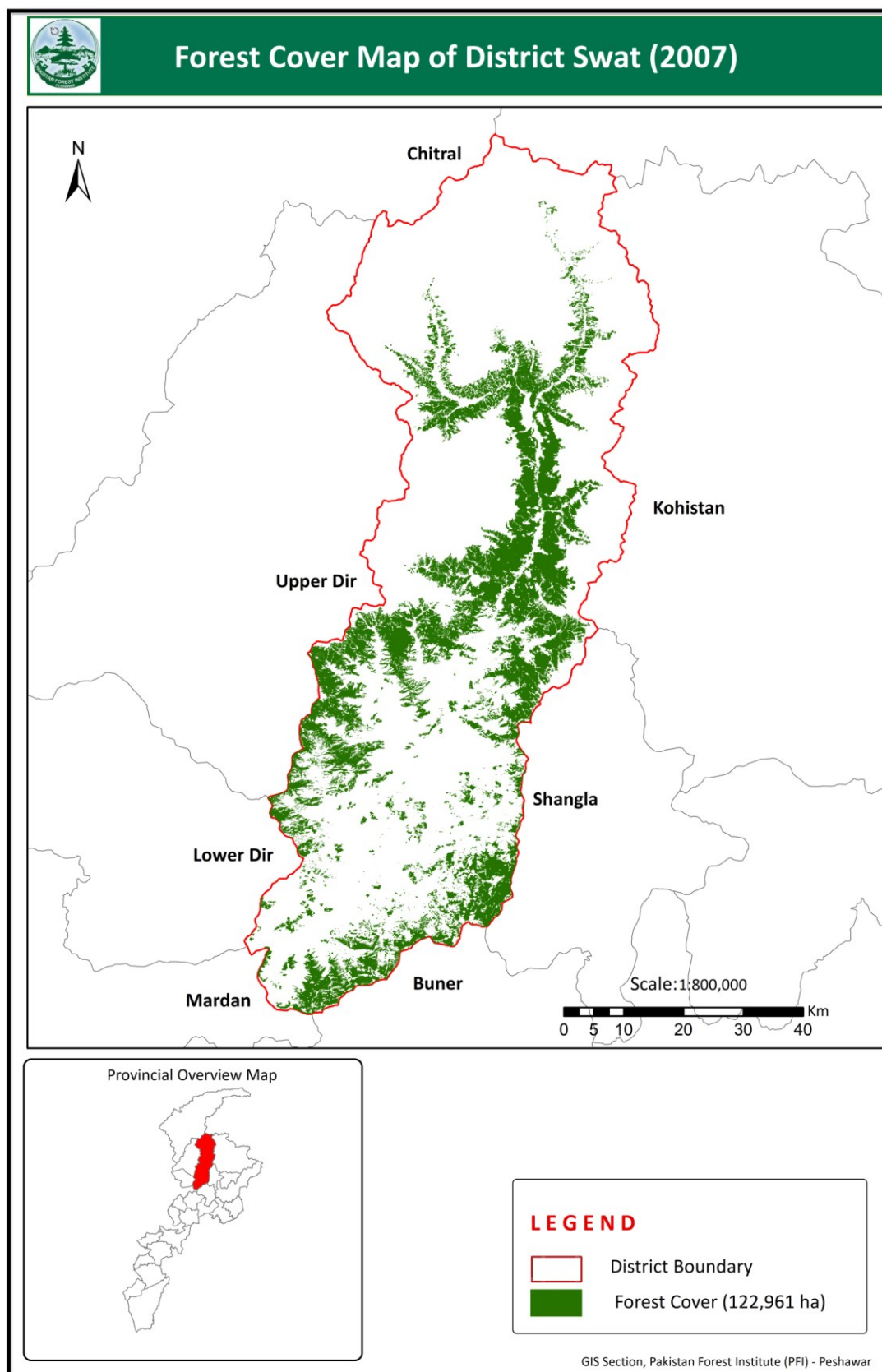


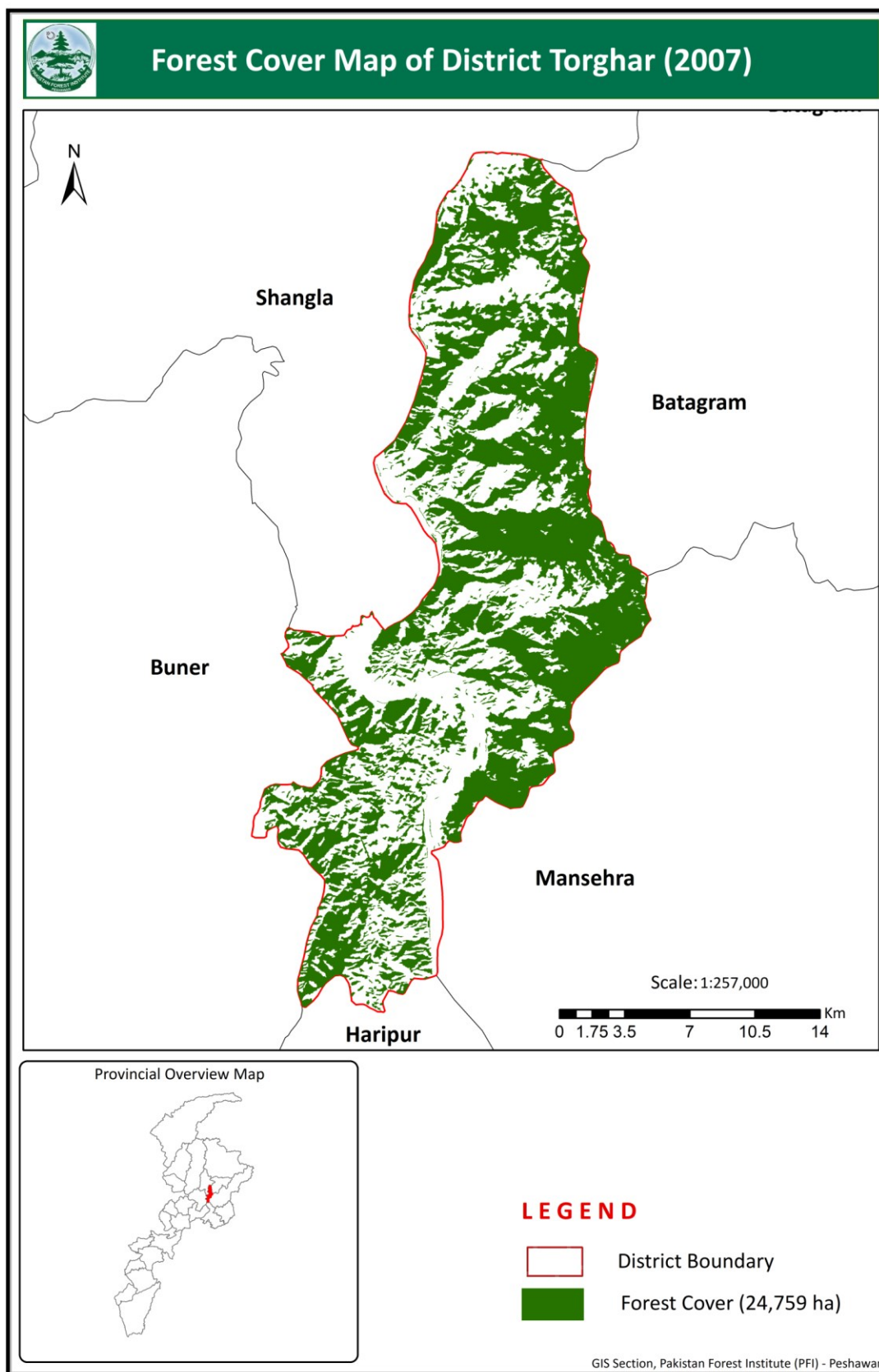


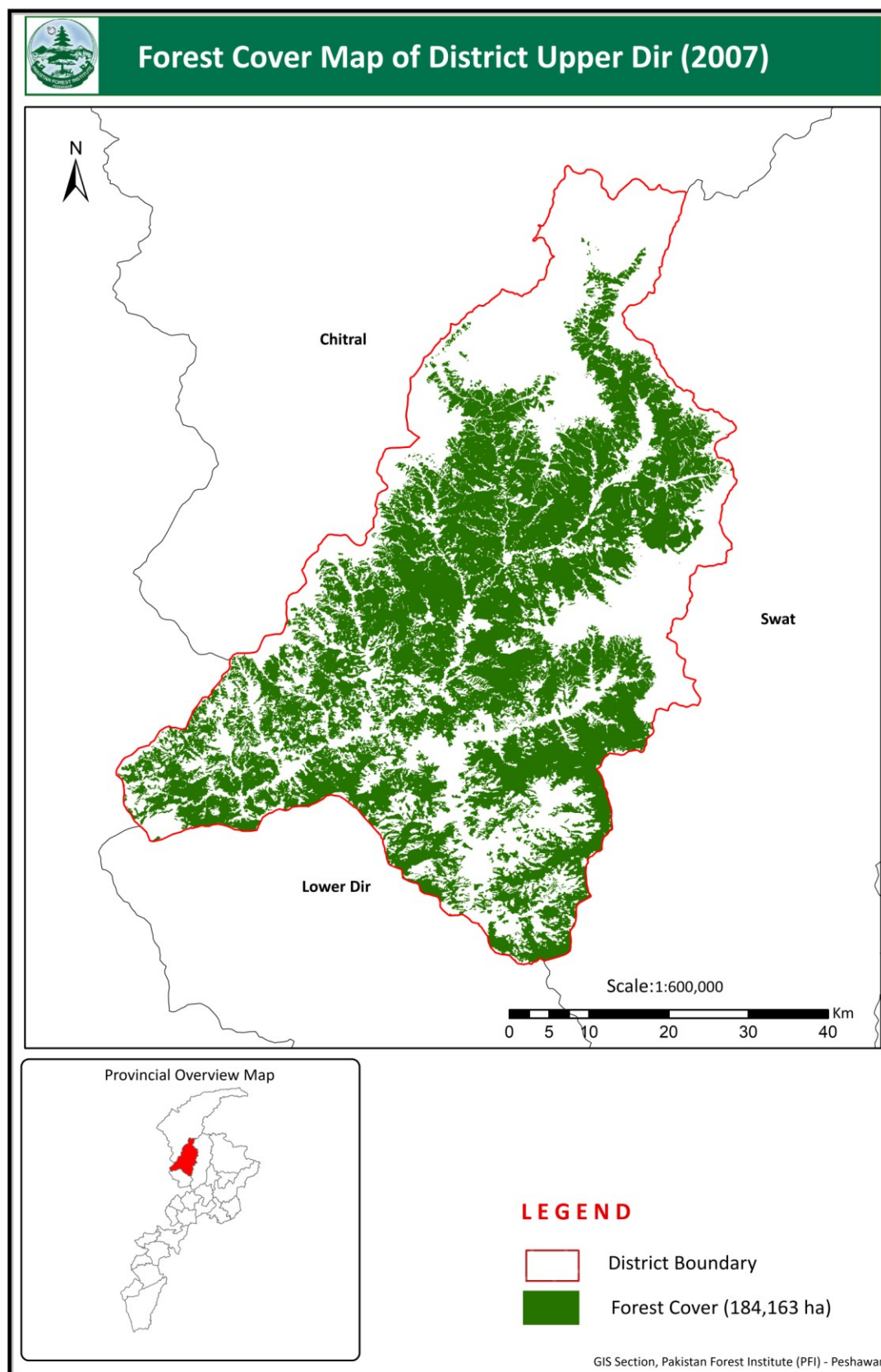












ANNEX-II

FOREST COVER MAPS OF FORESTED DISTRICTS 2012

