



ICIMOD



Summary of Proceedings

National Workshop on

Development & Harmonization of Land Cover Classification
and
District-wise Forest Cover Assessment of Pakistan



Organized by WWF – Pakistan in collaboration with ICIMOD

31st May to 4th June, 2010 - Islamabad, Pakistan,



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List of Acronyms

AJ&K	Azad Jammu and Kashmir
FSMP	Forestry Sector Master Plan
GIS	Geographic Information System
GPS	Global Positioning System
HKKH	Hindu Kush-Karakoram-Himalaya
ICIMOD	International Centre for Integrated Mountain Development
IUCN	The World Conservation Union
NGO	Non-Governmental Organization
SPOT	Système Pour l'Observation de la Terre (French remote sensing satellite)
WWF	World Wide Fund for Nature (a.k.a. World Wildlife Fund)
RS	Remote Sensing
PFI	Pakistan Forest Institute
FAO	Food and Agriculture Organization of United Nations
LCCS	Land Cover Classification System
UNEP	United Nations Environmental Programme
NRM	Natural Resource Management
IFAP	Indus for All Programme
RDP	Rural Development Project
SEED	Social Economic Environmental Development Project
ha	Hectare
m	Meter
km ²	Kilometer Square
SUPARCO	Space and Upper Atmosphere Research Commission
SLMP	Sustainable Land Management Project
FATA	Federally Administered Tribal Areas
PARC	Pakistan Agriculture Research Council
PPAF	Pakistan Poverty Alleviation Fund
WMC	Water Management Center
MENRIS	Mountain Environment and Natural Resources' Information System
IGIS	Institute of Geographic Information System
NUST	National University of Science and Technology

1 Workshop introduction

Natural resources (e.g., water, forest, agriculture), which are used jointly by many, continue to deteriorate at an alarming rate. Comprehensive knowledge is essential for their sustainable use. In Pakistan, the data necessary for informed decision-making are unavailable, incomplete, or unreliable. Due to a lack of standardization and harmonization the data are not presented in a format that policy-makers and managers can use effectively.

Pakistan has an area of 3.3 million ha covered by forests and planted trees, which is equivalent to 4.1% of the total land area. The forest resources of Pakistan are deteriorating both qualitatively and quantitatively due to anthropogenic, climatic and loose institutional arrangements. Annual change rate during 1990-2000 was -1.8% and during 2000-2005 was -2.1%. GIS and Remote Sensing based tools and technologies have been in use to assess forest cover for the last two decades in Pakistan. The national level forest cover studies based upon satellite images include the Forestry Sector Master Plan (1992) and National Forest & Range Resources Study (2004). Aim of these mapping activities conducted at 1:250,000 scale was to estimate national forest cover disintegrated at province level. The results of such, relatively coarser detail studies provide concise baseline information for policy level awareness and decision making. However, no systematic baseline data disintegrated at local administration boundaries (e.g., District and Tehsil), is available to accurately measure either the current extent of forest cover or the deforestation rate of a particular district.

During the last Pakistan Environmental Protection Committee (PEPC) meeting, chaired by the Prime Minister of Pakistan, held on 29 March 2010, it was agreed that WWF – Pakistan will assist the government in making an assessment of the state of natural forests in the country. Priority will be given to the districts with a natural forest cover greater than 5% of land area. The Pakistan Forest Institute (PFI) has already undertaken such forest cover assessments for many parts of the country which will be incorporated in this study.

Land Cover is an important component of the biosphere that is critical to the continued existence of all terrestrial life. At the regional level a combined effort has been made by ICIMOD and FAO to map the land cover and generate harmonized land cover database. ICIMOD being a regional and intergovernmental organization, which has a regional mandate, will help the national organization, responsible for the assessment and management of natural resources within their countries, to carry out the land cover classification at national level by following the Land Cover Classification System (LCCS) developed by FAO/UNEP. LCCS is a comprehensive and standardized priori classification system based software, designed to meet specific user requirements and created for mapping exercises independent of scales or means, in the world.

The International Centre for Integrated Mountain Development (ICIMOD), and World Wide Fund for Nature Pakistan (WWF – P) are collaborating in activities related to promoting sustainable mountain environment and development. To complement the mutually beneficial initiative, a joint training cum workshop has been organized at Envoy Hotel, Blue Area, Islamabad from 31st May to 4th June, 2010.

2 Workshop Objectives

The main objectives of the workshop include the development of a national legend which is harmonized at regional level; building the capacity of national institutions on the use of classification software; and to refine the methodology for District-wise forest cover assessment of Pakistan. Specific objectives of the workshop are:

- to assess the current status on forest cover / land cover mapping in Pakistan.
- to refine methodology, identify resources, and establish workplan for the assessment of forest cover in Pakistan.
- to prepare a national land cover legend, which is harmonized at regional level.
- to train provincial representatives on the use of classification software.

3 Participating institutions

1. Pakistan Forest Institute (PFI)
2. Planning Commission (Government of Pakistan)
3. Pakistan Space & Upper Atmosphere Research Commission (SUPARCO)
4. AJK Planning and Development Department
5. Punjab Planning and Development Department (Urban Unit)
6. IUCN - Quetta
7. Gilgit-Baltistan Forest Department
8. Punjab Forest Department
9. Balochistan Forest Department
10. Sindh Forest Department
11. Rural Development Project - FATA
12. Pakistan Agricultural Research Council (PARC)
13. Pakistan Wetlands Programme
14. Indus for All Programme
15. SLMP (A GEF-assisted Project of Ministry of Environment)
16. Water Management Center (WMC) - PPAF
17. IGIS – NUST

4 Workshop sessions

4.1 Opening Session

Dr. Ejaz Ahmed, Deputy Director General, WWF – P, welcomed the participants from all the provinces and the resource persons from Nepal. He gave a brief introduction to the workshop and explained its objectives. Later on, Birendra Bajracharya, GIS Specialist, ICIMOD, formally welcomed the participants on behalf of ICIMOD and introduced the activities of ICIMOD in general and MENRIS in particular.

Afterwards, Faisal Mueen explained in detail the objectives of the workshop and gave an overview of the National Forest Cover Assessment Initiative and standardization of national level legend for the land cover of Pakistan.

4.2 Stake holder presentations summaries

4.2.1 Land Cover Mapping Activities of Pakistan Forest Institute (PFI)

Presented by: Ali Haider, Director GIS, PFI

Pakistan Forest Institute (PFI) was established in 1947 to conduct research and impart education and training in forestry sciences to the nominees of the Provincial Forest Departments. The PFI is the second largest centre in forestry sciences in South Asia after the Dera Dun Forest Institute in India.

The GIS / Remote Sensing Centre of the PFI is responsible for conducting satellite image based forest cover assessment studies at the national level. Previously the centre remained engaged in Forestry Sector Master Plan and facilitated the forest cover assessment, using satellite images of 1990, conducted by the Swiss consultants. Later in 2004, the centre conducted National Forest & Range Resources Study using satellite images of 2000 -2001.

Currently the centre is conducting national level land cover mapping, using SPOT5 2.5 meter spatial resolution images acquired in 2007, under the Forestry Sector Research and Development Project (FRR&DP). The study aims to prepare an Atlas of Pakistan districts, indicating the present distribution of various, natural resources; to monitor the changes in forests; and capacity building of the professionals of Provincial Forest Departments in GIS & RS techniques for NRM. So far, the preliminary classification of Azad Jammu & Kashmir and Khyber Pashtunkhwa has been completed and Satellite images of Sindh province are being processed.

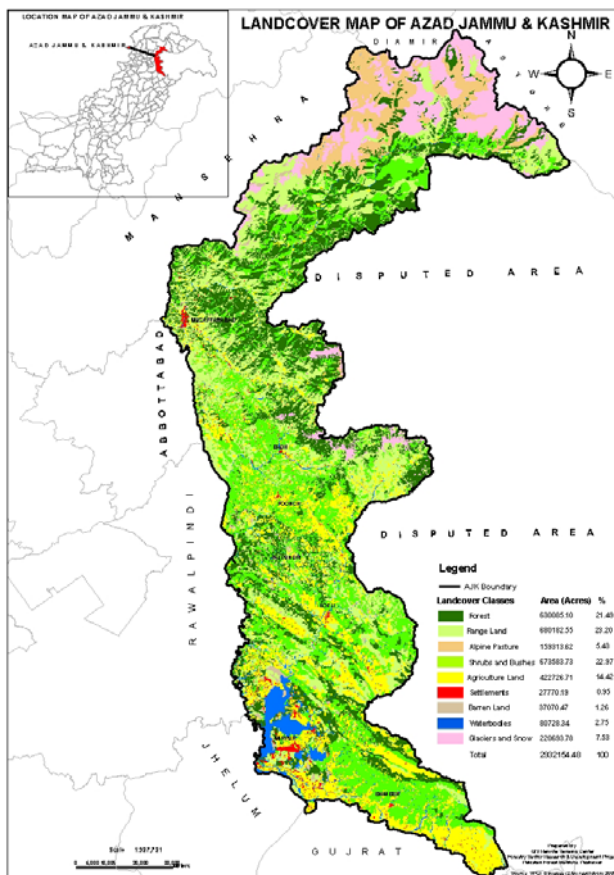
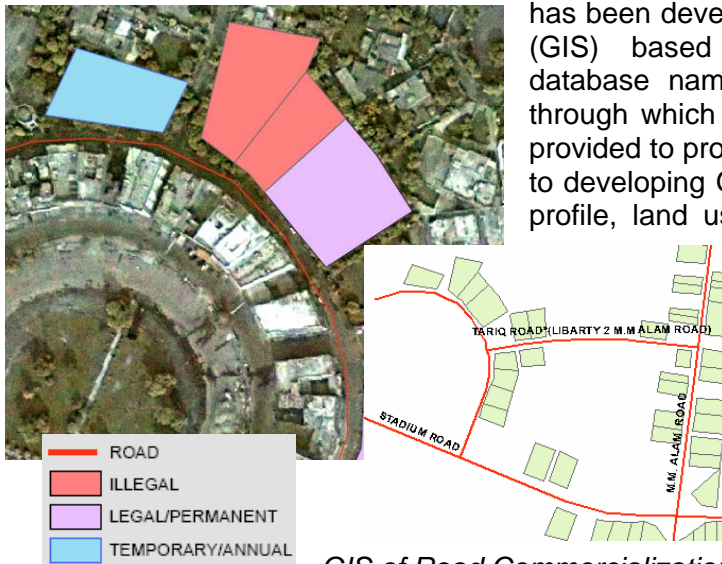


Figure: Preliminary land cover classification map of AJ&K conducted by PFI

4.2.2 THE URBAN UNIT, Urban Sector Policy & Management Unit Planning and Development Department, Punjab

Presented by: Abubakar, GIS Analyst, Urban Unit, Planning and Development Department, Lahore.

The sector of Geographic Information System (GIS) at the Urban Unit is committed to contributing towards the Government of the Punjab's vision 2020, which envisages developing the urban areas of Punjab as the engines of growth and sustainable development. The sector has been developing a Geographic Information System (GIS) based multi-user enterprise level, spatial database named "IRIS" as a decision support tool, through which quality and updated information can be provided to provincial and local governments. IRIS aims to developing GIS enabled spatial database with urban profile, land use mapping, infrastructure, and service delivery profile for the entire Punjab, starting with five big cities.

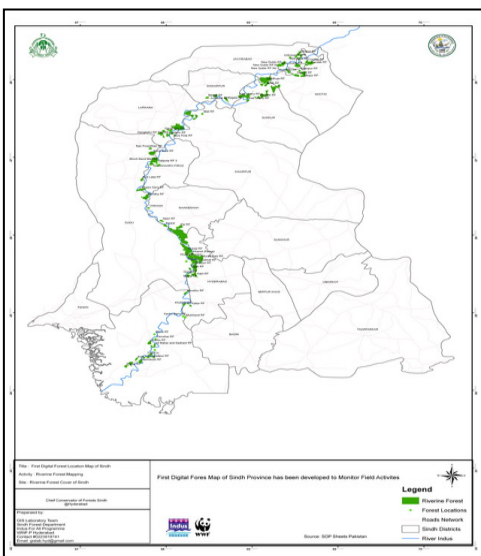


GIS of Road Commercialization in Lahore

4.2.3 Sindh Forest Department GIS Laboratory Hyderabad

Presented by: Abdul Sattar Khatri, DFO, Sindh Forest Department, and Farooq Ahmed Laghari, GIS Analyst, IFAP, WWF - P

The GIS Laboratory of Sindh Forest Department was revived through a MoU between Indus for All Programme, WWF - Pakistan and Sind Forest Department. The aim of this MoU was to build capacity of Forest Officials / Field Staff in using GIS; Development of Base Map for Sindh Forest Department, and to collect data (Maps, Forest Maps, Deh Maps and Notifications of Forest) from all district offices.



4.2.4 Pakistan Space & Upper Atmosphere Research Commission

Presented by: Zafar Jamil, Technical Officer, SUPARCO

Pakistan Space & Upper Atmosphere Research Commission (SUPARCO) is mandated to facilitate peaceful uses of space and space technologies. SUPARCO acquires high resolution satellite data from Landsat and Spot platforms at its Satellite Ground Stations at Karachi and Islamabad. SUPARCO is the leading supplier of remote sensing data to researchers, and other organizations. SUPARCO has established Satellite Remote Sensing (SRS) & Geographic Information System (GIS) facilities 30 years ago.

Assessment of Mangrove Forests along the Coast of Pakistan

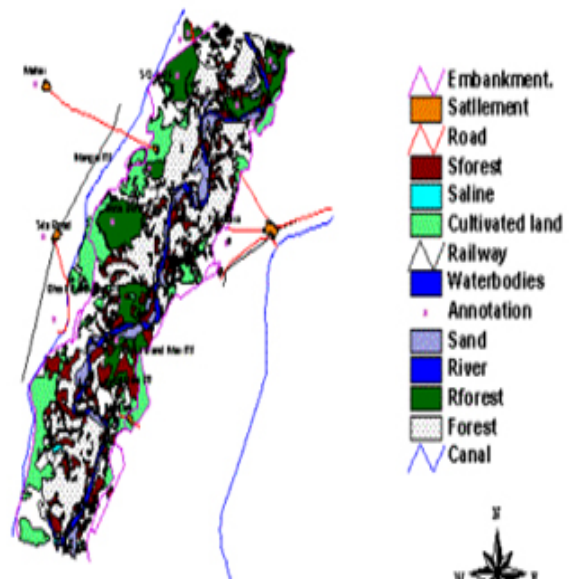
This project has been executed by the IUCN and the Coastal Forest Division, Government of Sindh. SUPARCO provided remote sensing services for the assessment of mangrove forests along the coasts of Sindh and Balochistan. Scope of the project included:

- Identification and delineation of mangrove forests along the coast of Pakistan at Indus Delta, Karachi, Sonmiani, Kalmat and Gwadar Bay
- Mapping and classification of the forest based on canopy density along with other terrain categories
- Generation of thematic map at 1:25, 000 scale

Baseline Survey of Kacho Areas in Sindh

SUPARCO is working for Sindh Forest Department for assessment of riverine (riparian) forests located in the flood plains along the Indus River. The objectives of this project include:

- Survey of Kacho areas (flood plain) of Indus river from Jacobabad to Indus Delta to assess existing natural resources for devising a poverty alleviation plan
- Image analysis performed at 1:50,000 scale to delineate forestry, agriculture, barren land, water ponds, settlements and other infrastructure
- Field verification of image analysis and generation of thematic maps



Assessment of Riverine forests in Sindh

SUPARCO has also conducted resource assessment and mapping, including forests, in some projects of Water & Development Authority (WAPDA) to facilitate development of hydro electric power plants and development of irrigation networks like Bunji Hydro Electric Power Project and Environmental Impacts Assessment of Left Bank Outfall Drainage (LBOD).

4.2.5 IUCN – Pakistan: Juniper Conservation Project, Ziarat, Balochistan

Presented by: Ghulam Qadir Shah, Project Manager, IUCN

Established in 1948, IUCN - The World Conservation Union brings together 82 States, 111 government agencies, 800 plus NGOs, and some 10,000 scientists and experts from 181 countries in a unique worldwide partnership. IUCN's mission is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable. IUCN Pakistan (IUCNP) is part of the global Union, with its country office located in Karachi and provincial/project offices at 05 locations in Pakistan.

The Project, Mainstreaming Biodiversity Conservation into Production Systems in the Juniper Forest Ecosystem, aims to make production activities in the Juniper forest ecosystem biodiversity friendly. The project will focus on reducing the negative impacts of production activities in the livestock grazing and energy production sub-sectors, while exploring opportunities for biodiversity benefits from sustainable tourism, controlled hunting and watershed and ecosystem services.

The project plans to conduct Remote Sensing based assessment of forests in the Ziarat district in particular and other forested districts of Balochistan in general.



Juniper Tree, Balochistan

4.3 Case Studies

4.3.1 Land – Forest Cover Classification Methodologies

Presented by: Urooj Saeed, Coordinator GIS, WWF – P

Image analysis algorithms have the ability to identify similarities and distinguish between different surface objects. They carefully filter off the data written on imageries and thus bring about the sorting out of surface objects. Success and elaboration in distinguishing between different surface objects, which may be attained by these “classification algorithms” forms one of the limiting factors in the effective use of remote sensing products. There are many classification techniques that have been developed to classify digital images for landcover/landuse mapping. However, two broad categories of classification approaches are: Pixel-based approach and Object-based approach.

A pixel-based algorithm utilizes spectral pattern value combinations associated with different feature types, each assigned a unique Digital Number (DN), evaluating spectral reflectance and emittance values present within each pixel to find meaningful patterns. A pixel's class is evaluated from statistical analysis of spectral characteristics of pixels in the whole data set.

The recently emerged, “Object-Based Image Analysis” is a promising methodology. Unlike conventional “pixel-based methods”, which only use layer pixel values, object-based techniques can also use shape, texture and context information of the image objects. These extra features associated with image objects can be very useful for surface objects recognition. Typically; an “Object-Based Image Analysis” starts with the crucial step of Image Segmentation in which meaningful image objects are generated, then these image objects are classified in the later step of classification. It is a good alternative to manual digitizing of satellite images. However, manually digitized maps are rich in information content but the mapping process is very time consuming.

4.3.2 Forest cover change assessment using satellite images in Swat and Shangla districts

Presented by: Sawaid Abbas, Remote Sensing Analyst, WWF – P

In context of recent conflict in NWFP, there have been numerous media stories that specifically implied that extensive forest degradation occurred in Swat, Shangla and Lower Dir districts. The study examined the spatial and temporal land cover changes in Swat and Shangla to understand the deforestation pattern and extent, using satellite images. The study assessed particular damage made to the forest during October 2007 and October 2008 and also evaluated the forest degradation rate of Swat and Shangla districts using satellite images of 2001 and 2009.

Based on the temporal (2001-2009) land cover mapping using Landsat satellite images (30m spatial resolution), eight years of forest damage was assessed for the entire Swat and Shangla districts. Currently in 2009, Shangla District has 42.8% while Swat has 20.4 % of the forests of the area. The results showed that in Swat district ~ 7,300 ha of forest was damaged between 2001 and 2009, which is 13% of the forest cover present in 2001 and in Shangla district ~ 2860 ha of forest was damaged which is 11% of the forest cover present in 2001.

To assess the degradation in context of the conflict period, suitable temporal images (October 2007 and October 2008) were only available for lower Swat and Shangla districts. This area covered approximately 68% of the forests of Shangla and Swat. Based on the visual

interpretation of the two SPOT 5 pan-sharpened images, six localities, covering an area of 56 ha, were identified as areas of deforestation. Of these six localities, four were in Swat and two in Shangla.

The results highlight that the extent of deforestation in Swat and Shangla during the conflict period of October 2007 and October 2008 is not as significant when compared with the degradation from 2001 to 2009. Overall, Swat has higher degradation, which in some studies has been attributed to institutional failure and lack of law enforcement leading to exploitation of forest by local communities and timber smugglers.

4.3.3 Land cover classification of CKNP - Case Study

Presented by: Hassan Ali, GIS Analyst, WWF – P

Previously there was no comprehensive information available on the Land Cover of the CKNP. The Park was not covered even under the national level Land Cover mapping initiatives in 1992 and 2004. To accomplish the Land Cover mapping of the area, ASTER satellite images of 15m spatial resolution captured during the year-2006 were acquired. Land Cover classification scheme following the LCCS standard was developed in a consultative workshop. Extensive field surveys were carried out to collect ground samples and to further improve the classification scheme. 57 sample plots and 209 GPS-linked descriptive data points, along with their photographs were collected from the field.

Object based Image analysis method was adopted for satellite image based Land Cover mapping of the CKNP. Recently emerged, "Object-Based Image Analysis" (OBIA) is a promising methodology. Unlike the conventional "pixel-based methods" which only use the pixel values, the object-based techniques also use shape, texture and contextual information of the image objects. This was the first ever application of OBIA in Pakistan and was found to be very efficient and highly reliable.

17 valleys/watersheds covering an area of 19,197 km² were classified into 13 Land Cover Classes. The Land Cover has seven vegetation classes including Shrubs, Grasses, Juniper, Conifer, Broadleave, Plantation and Agriculture. Valley-wise cover statistics were computed and thematic maps were produced for each valley. The study primarily focused on vegetation and in this respect most of the area can be characterized as dry alpine scrub type vegetation with species like *Artemesia spp.*, *Juniper spp.*, *Rosa webbiana* and *Polygonum spp.* on the dry slopes and *Myricaria germanica* and *Hippophae rhamnoides*, along the stream beds. Broadleaves mainly consists of *Salix spp.* and *Betula utilis* which can be found in moist places. Conifer mainly includes *Pinus wallichiana* and Junipers were found mixed with grasses at high altitude while *Pinus wallichiana* was less common in the area and was mostly found in the western end of the CKNP.

Further in continuation of this study, large scale mapping of Bagrot and Shigar valleys were carried out as a part of multi-scale approach towards using remote sensing data for land cover mapping of CKNP. Current analysis was performed on SPOT-5 high resolution data which also lead to refinement of the LCCS legend which has 22 land cover classes. An additional field survey was carried out to collect the sample data and to verify the LCCS legend on ground. Current land cover comprises of 12 vegetation classes and distribution of major vegetation classes along elevation and aspect were also analyzed.

4.3.4 Remote Sensing for sustainable forest management-a case study of Pai Forest

Presented by: Naeem Rana, Remote Sensing Analyst, WWF – P

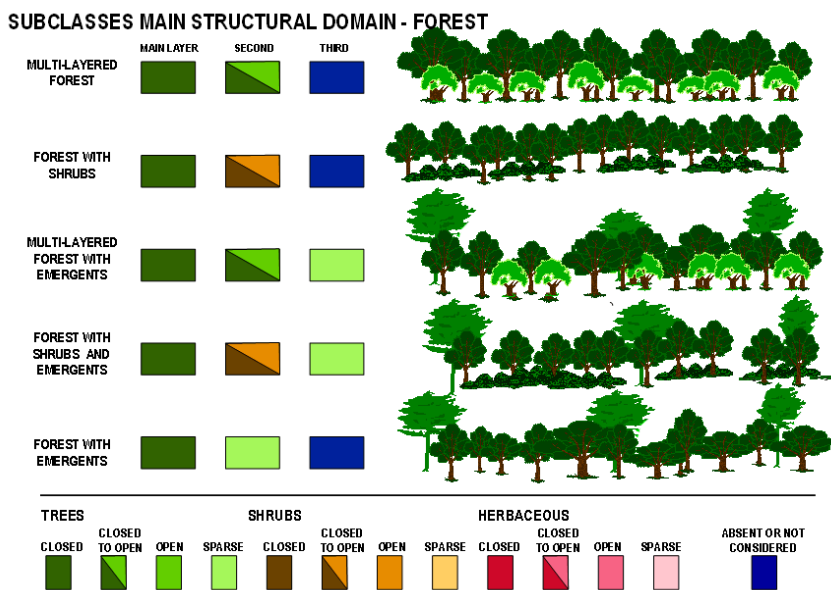
The study aims to analyze the temporal variations in the Pai Forest, irrigated plantation situated in district Nawabshah, Sindh, by using Object based Image Classification Technique. A standardized legend was developed by using Land Cover Classification System (LCCS)

designed by Food and Agriculture Organization (FAO) and United Nations Environment Programme (UNEP). The study reveals a significant decrease of 40.57% in the 'mixed forest class' i.e. *Acacia spp.*, *Prosopis cinerea*, *Salvadora spp.* and *Prosspis juliflora*. from 2003 to 2008. This decline could be attributed to the extraction of forest for fuel wood. On the other hand an increase of 55 hectares in Eucalyptus spp. class has been observed which seems to be due to the plantation activities in the area. The spread of exotic vegetation i.e. *Prosopis juliflora* is 128% and it is critical to eradicate some of the Forest compartments. *Prosopis spp.*, an exotic species of vegetation has increased by 128%. It is recommended to study and halt any impact of *Prosopis spp.* on indigenous flora and fauna. It will help the foresters to develop forest products in a sustainable manner that can diversify and support livelihoods of local communities. The study can be effectively used as a baseline to strengthen the National level vegetation mapping projects. The developed thematic maps can be effectively merged with other land cover maps at a regional and global scale.

4.4 Harmonized and Standardized National Land Cover Legend

4.4.1 Principles and Concepts of Land Cover Classification System

Presented by: Salman Asif, Remote Sensing Specialist, ICIMOD



The LCCS design (Di Gregorio and Jansen, 2000) is based on the following unique concept: instead of pre-defining the land cover classes, a set of universally valid classification criteria, that uniquely identify the land cover classes worldwide, was selected. This presumes that any land cover class, regardless of its type and geographic location, can be defined by a set of pre-selected independent diagnostic attributes, the "classifiers". The number of classifiers used determines the level at which the land

cover is classified. Thus, a larger number of classifiers is needed when more detailed classification of land cover is required.

The advantages of the FAO/UNEP Land Cover Classification System are manifold. It is a highly flexible system in which each land cover class is mutually exclusive and clearly defined, thus providing internal consistency. These characteristics are independent of the classification level. The classification can be stopped at any desired level and will still result in clearly defined land cover classes corresponding to that level. Any land cover type can be readily accommodated. The system is truly hierarchical and applicable to a variety of mapping scales and in any geographic location. It can be used as a reference standard system because its diagnostic criteria allows correlation with existing classifications and legends.

4.4.2 Overview of Regional Legend

Salman Asif explained in detail the LCCS legend developed for the KHK region. Each class was explained by giving detailed class description, criteria used to interpret that class on the satellite image. For each class the corresponding area on Landsat ETM+ satellite image was compared with the high resolution data from Google Earth. It helped the participants to understand the interpretation criteria being used for the preliminary classification. For Example;

Closed to Open Needle-leaved Trees – 2TCOne

Needle-leaved Evergreen Closed to Open Trees

LCCS CLASSIFIERS:

A3 = Trees

A20 = Closed to Open (15-100%)

B2 = Height >30 - 3 m

D2 = Needle-leaved

E1 = Evergreen

Class description: This class is constituted by a layer of open to closed trees with a generic height ranging from 3 to 30 meters. Needle-leaved refers to botanical group Gimnospermae, while evergreen stands for perennial plants that are never entirely without green foliage. For this class, to be applicable, there must be a whole layer that is more than 75 % of Needle-leaved evergreen trees.

Interpretation criteria used: The typical features to recognize this class are: the dark red reflectance and the coarse texture. It usually shows homogenous pattern and covers most extended zones. Sometimes this class could be confused with 2TCObc.

4.4.3 Development of National Land Cover Legend (Group Work)

On completion of formal lectures and hands on exercises in using LCCS software, the participants were divided into three groups to work on the definition of land cover classes of terrestrial natural vegetations (Forest), terrestrial agriculture and other non-vegetated covers. On completion of group work followed by a discussion session, the following land cover classes were defined by using LCCS software.

Terrestrial natural vegetations:

1. Closed to Open Broadleaved Evergreen Low Trees On Permanently Flooded Land
2. Broadleaved Evergreen Sparse Low Trees On Permanently Flooded Land
3. Closed to Open Herbaceous Vegetation On Permanently Flooded Land
4. Closed to Open Closed to Open Broadleaved Low Woodland On Temporarily Flooded Land.
5. Mixed Shrub-land with Herbaceous
6. Mixed Sparse Shrubs// Sparse Trees
7. Irrigated Broadleaved Tree Crop(s) Crop Cover: Plantation(s)
8. Broadleaved Closed to Open Thicket // Broadleaved Woodland

9. Broadleaved Closed to Open Trees // Needle-leaved Evergreen Closed to Open Trees
10. Needle-leaved Evergreen Trees Floristic Aspect: Pinus roxburghii
11. Needle-leaved Evergreen Trees Floristic Aspect: Blue Pine, Fir, Spruce
12. Needle-leaved Evergreen Trees Floristic Aspect: Deodar, Spruce
13. Needle-leaved Evergreen Thicket
14. Needle-leaved Evergreen Woodland // Sparse Shrubs
15. Closed Grassland Altitude: 3500-5000 m
16. Sparse Grassland Altitude: 3000-3500 m

Agriculture:

1. Tree Crop(s)
2. Irrigated Graminoid Crop(s)
3. Rainfed Graminoid Crop(s)
4. "Rainfed Non-Graminoid Crop(s)
5. Major Landclass: Sloping Land
6. Monoculture Of Continuous Medium Sized Field(s) Of Graminoid Crop(s)
7. Major Landclass: Sloping Land
8. Rainfed Non-Graminoid Crop(s) (Two Additional Crops) .
9. Irrigated Non-Graminoid Crop(s) (Two Additional Crops) .
10. Rainfed Tree Crop(s) (Two Additional Crops) .
11. Irrigated Tree Crop(s) (Two Additional Crops) .
12. Small Sized Field(s) Of Irrigated Tree Crop(s) (One Additional Crop) (Herbaceous Terrestrial Crop With Simultaneous Period) .
13. Permanently Cropped Area With Irrigated Herbaceous Crop(s)

Other non-vegetated:

1. Perennial Ice (Moving)
2. Perennial Snow
3. Seasonal Snow
4. Perennial Natural Waterbodies (Flowing)
5. Shallow Perennial Natural Waterbodies (Flowing)// Shallow Non-Perennial Natural Waterbodies (Flowing)
6. Perennial Natural Waterbodies (Standing)
7. Non-Perennial Natural Waterbodies (Standing)
8. Non-Perennial Natural Waterbodies (Standing) (Surface Aspect: Bare Soil) (Water presence 3-1 months)

9. Bare Soil And/Or Other Unconsolidated Material(s)
10. Bare Rock And/Or Coarse Fragments
11. Shifting Sands / Dune(s)
12. Artificial Perennial Waterbodies
13. Artificial Non-Perennial Waterbodies (Flowing)
14. Non-Linear Built Up Area(s)
15. Linear Built Up Area(s)

4.5 Framework for District-wise Forest Cover Assessment of Pakistan

The second last day of the workshop was dedicated to working out the framework for the District-wise Forest Cover Assessment which mainly includes the setting of technical specification, preparation of workplan and identification of responsibility at activity level.

4.5.1 Recommendations on technical specification for the forest cover assessment

Options for Satellite Images: There are almost one hundred Remote Sensing satellites orbiting around the planet Earth and providing substantial data for monitoring and observing earth systems. These data sets are of different resolutions with different acquisition intervals and dates. Based on their suitability for national level assessment, the following satellite images were considered.

Table: List of Moderate resolution satellite images

Satellite/ Sensor	Resolutions		
	Spatial	Temporal	Spectral
Landsat / TM	30 m	16 Days	Blue, Green, Red, NIR, SWIR
TERRA / ASTER	15m, 30m	16 Days	Green, Red, NIR, SWIR
SPOT 5	10m; 2.5m	2-3 Days	Green, Red, NIR, SWIR; Panchromatic
ALOS	10m; 2.5m	46 Days	Green, Red, NIR, SWIR

It was agreed with the group that the satellite images with spatial resolution not less than 30m and acquired not older than 2007 will be used for the study.

Minimum Mapping Unit: A polygon defined as a group of adjacent (i.e., connected) pixels (polygons) with the same thematic class value. The MMU allows reducing the visual and spatial complexity of the information contained in the map.

<i>Working Scale</i>	<i>Typical MMU</i>
1:1,000,000	1 km ²
1:500,000	64 ha
1:250,000	16 ha
1:100,000	4 ha
1:50,000	1 ha

Suggested MMU for different scale

While considering the suggested minimum spatial resolution (30m) and expected scale of output maps (1:100,000 – 1:50,000), it was suggested to use 1 ha as Minimum mapping Unit for the study.

Image Classification Method: The possible methods for forest cover mapping could be, manual digitization, automatic pixel based classification or semi-automatic object based image analysis. Although the techniques are different but the definition of MMU will abridge the harmonization of the scale of the study. Priori classification will be further improved with field verification and accuracy of the land cover maps will also be assessed.

Projection System: Commonly, three types of projection systems are being used in Pakistan; Lambert Conformal Conic Projection, Universal Transverse Mercator System (UTM) and Geographic Coordinate System. Considering the integration with regional and global studies and restrictions on using Lambert Conformal Projection it was agreed that the UTM projection system would be used for the study.

Field Data Collection and Validation Process: It was agreed to use a standardized data encoding form for the field data collection. At least one preliminary classification map will be developed which will be verified/improved through field visit. It was also agreed that in some cases the maps can also be improved/verified in consultation with forest department field staff.

Deliverables: At the end of the project a comprehensive report on forest cover assessment will be compiled along with District-wise Forest Atlas both in digital and paper format. A fully operational land covers assessment methodology will be published to assist with conducting a similar study every five years.

4.5.2 Workplan and activity responsibility

Based on the formal and informal discussions during the workshop following interest groups were in each province.

Azad Jammu & Kashmir

PFI
Forest department
AJ&K PDD
WWF

Balochistan

IUCN
PWP / NCCW (WWF)
Forest department

FATA

PFI
Rural Development Project
WWF

Punjab

WWF, Forest department, PFI

Khyber Pakhtunkhwa

PFI
Forest department
WWF

Sindh

PFI
IFAP (WWF)
Forest department

Gilgit-Baltistan

SEED(WWF)
Forest department
PFI

1st June 2010 is agreed as the start date of the project and it was also agreed to complete the work within the nine months period. Each group worked on a standard template and compiled a tentative work plan and also identified responsibilities at activity level.

4.5.2.1 Draft Workplan for Forest Cover Assessment of AJK

No.	Activity/Sub-activity	Months									Focal Institution	Supporting Institution	Technique	Data
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th				
1	Data acquisition/Topo cadastral base layers and maps in GIS format										PFI			
2	Satellite images acquisition & pre-processing										PFI			Landsat TM, SPOT 5
3	Legend definition and existing field data compilation										PFI,FD, P&DD	WWF	LCCS	
4	Preliminary Classification										PFI		On Screen Digitization	
5	Field Verification										P& DD, FD	WWF,PFI	Field visits	Maps, Data encoding forms
6	Final Classification										PFI, P&DD	Forest Dept., WWF	On Screen Digitization	
7	Result review and accuracy assessment										PFI, WWF	Forest Dept., PDD		
8	Draft Report compilation										PFI, FD, PDD	WWF		
9	Partners Workshop										WWF, FD	PFI, P&DD		
10	Final report compilation										WWF	PFI, P&DD, FD		
11	District-wise Atlas compilation										WWF,PFI	FD, P&DD		
12	Midterm review										WWF	PFI, P&DD, FD		

	Already accomplished
	Partially accomplished
	To be done

4.5.2.2 Workplan for Forest Cover Assessment of Balochistan

No.	Activity/Sub-activity	Months									Focal Institution	Supporting Institution	Technique	Data
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th				
1	Data acquisition/Topo cadastral base layers and maps in GIS format	Yellow	Yellow								PWP	PFI, BFWD,IUCN	DIGITIZING	SOP 50K
2	Satellite images acquisition & pre-processing	Green	Green	Green	Green	Green	Green	Green	Green	Green	WWF/PWP	PFI, PPAF, PWP		Landsat TM, SPOT 5
3	Legend definition and existing field data compilation	Yellow	Yellow	Yellow							PWP	IUCN/BFWD	LCCS	
4	Preliminary Classification		Red	Red							PWP/IUCN	IUCN/BFWD	Supervised Classification	
5	Field Verification			Red	Red						IUCN/BFWD	PWP		
6	Final Classification				Red	Red					PWP/IUCN	BFWD	Supervised Classification	
7	Result review and accuracy assessment					Red	Red				PFI	WWF		
8	Draft Report compilation						Red				IUCN/PWP	BFWD, PFI		
9	Partners Workshop							Red			WWF	PFI, BFWD,IUCN		
10	Final report compilation							Red	Red		WWF	PFI, BFWD,IUCN		
11	District-wise Atlas compilation								Red	Red	PWP/WWF	PFI, BFWD,IUCN		
12	Midterm review					Red					WWF	PFI, BFWD,IUCN		

	Already Accomplished
	Partially Accomplished
	To be done

4.5.2.3 Workplan for Forest Cover Assessment of Gilgit-Baltistan

No.	Activity/Sub-activity	Months									Focal Institution	Supporting Institution	Technique	Data
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th				
1	Data acquisition/Topo cadastral base layers and maps in GIS format	Yellow	Yellow								WWF	SEED, FD, PFI	Digitization	SOP 50K
2	Satellite images acquisition & pre-processing	Green	Green	Green	Green	Green	Green	Green	Green	Green	WWF	SEED, FD, PFI		Landsat TM
3	Legend definition and existing field data compilation	Yellow	Yellow	Yellow							WWF	SEED, FD, PFI	LCCS	
4	Preliminary Classification		Red	Red	Red						WWF	SEED, FD, PFI	Pixel-based Supervised Classification	
5	Field Verification			Red	Red	Red					SEED, FD	SEED, FD, PFI		
6	Final Classification				Red	Red	Red				WWF	SEED, FD, PFI	Pixel-based Supervised Classification	
7	Result review and accuracy assessment						Red	Red			PFI	WWF		
8	Draft Report compilation							Red	Red		WWF, PFI	SEED, FD		
9	Partners Workshop								Red		WWF	SEED, FD, PFI		
10	Final report compilation									Red	WWF, PFI	SEED, FD		
11	District-wise Atlas compilation								Red	Red	WWF, PFI	SEED, FD		
12	Midterm review					Red					WWF, PFI	SEED, FD		

Green	Already Accomplished
Yellow	Partially Accomplished
Red	To be done

4.5.2.4 Workplan for Forest Cover Assessment of Punjab

No.	Activity/Sub-activity	Months									Focal Institution	Supporting Institution	Technique	Data
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th				
1	Data acquisition/Topo cadastral base layers and maps in GIS format	■	■								WWF	PFI, Forest Dept	DIGITIZING	SOP 50K
2	Satellite images acquisition & pre-processing	■	■	■	■	■	■	■	■	■	WWF	PFI		Landsat TM
3	Legend definition and existing field data compilation	■	■	■							WWF	PFI	LCCS	
4	Preliminary Classification				■	■	■				WWF	PFI, Forest Dept	Supervised Classification	
5	Field Verification					■	■	■			Forest Dep	PFI, WWF		
6	Final Classification						■	■			WWF, PFI	Forest Dept		
7	Result review and accuracy assessment							■	■		PFI	WWF, Forest Dept		
8	Draft Report compilation								■		WWF, PFI	Forest Dept		
9	Partners Workshop								■	■	WWF	PFI, Forest Dept		
10	Final report compilation									■	WWF, PFI	Forest Dept		
11	District-wise Atlas compilation									■	WWF, PFI	Forest Dept		
12	Midterm review					■					WWF	PFI, Forest Dept		

■	Already Accomplished
■	Partially Accomplished
■	To be done

4.5.2.5 Workplan for Forest Cover Assessment of Sindh

No.	Activity/Sub-activity	Months									Focal Institution	Supporting Institution	Technique	Data
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th				
1	Data acquisition/Topo cadastral base layers and maps in GIS format	Yellow									IFAP/WWF	PFI,SFD, SUPARCO, IFAP / WWF		Landsat TM, SPOT 5
2	Satellite images acquisition & pre-processing	Green	Green	Green	Green	Green	Green	Green	Green	PFI				
3	Legend definition and existing field data compilation	Yellow	Yellow							IFAP/WWF	LCCS			
4	Preliminary Classification	Green	Green	Green	Green	Green	Green	Green	Green	PFI	Onscreen Digitization			
5	Field Verification		Red	Red						SFD				
6	Final Classification				Red	Red	Red	Red		IFAP/WWF,PFI	Supervised Classification			
7	Result review and accuracy assessment						Red	Red		IFAP/WWF,PFI				
8	Draft Report compilation							Red	Red	IFAP/WWF,PFI				
9	Partners Workshop								Red	WWF				
10	Final report compilation							Red	Red	WWF,PFI				
11	District-wise Atlas compilation							Red	Red	WWF,PFI				
12	Midterm review				Red					WWF				

	Already Accomplished
	Partially Accomplished
	To be done

4.5.2.6 Workplan for Forest Cover Assessment of Khyber Pakhtunkhwa and FATA

No.	Activity/Sub-activity	Months									Focal Institution (s)	Supporting Institution (s)	Technique	Data
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th				
1	Data acquisition/Topo cadastral base layers and maps in GIS format										PFI			
2	Satellite images acquisition & pre-processing										PFI			Landsat TM, SPOT 5
3	Legend definition and existing field data compilation										PFI	WWF, FD	LCCS	
4	Preliminary Classification										PFI		On Screen Digitization	
5	Field Verification										FD	WWF,PFI	Forest official consultation	Maps, Data encoding forms
6	Final Classification										PFI	FD, WWF	On Screen Digitization	
7	Result review and accuracy assessment										PFI, WWF	FD		
8	Draft Report compilation										PFI, FD	WWF		
9	Partners Workshop										WWF	PFI, FD		
10	Final report compilation										WWF	PFI, FD		
11	District-wise Atlas compilation										WWF,PFI	FD, P&DD		
12	Midterm review										WWF	PFI, FD		

	Already accomplished
	Partially accomplished
	To be done

4.6 Closing Session

Dr. Ejaz Ahmed welcomed the participants of the closing session. Later on, Bairendra Bajracharaya gave a brief presentation on the National Level Legend developed during the workshop. Afterwards, Faisal Mueen briefed the participants on the National Forest Assessment Initiative and also presented framework for assessment prepared during the workshop.

In his closing remarks Mr. Muhammad Javed Malik, Federal Secretary, Ministry of Environment, highlighted the importance of maintenance of good forest cover in a country. He said that in the Millennium Development Goals (MDG) we have a set target to increase the forest cover of Pakistan from 4.8 % in 1990-91 to 6.0 % by 2015. To set the direction, it is essential to assess the current state of forest cover in Pakistan. Mr. Javed underscored the timely completion of the work, utilizing this assessment in policy development and continuity in forest cover assessment activities in future.

Mr. Syed Mahmood Nasir, Inspector General Forest, commended the participants for their contributions in this important initiative. He hoped that the exercise would be successful and urged participants to fully utilize the government institution in completing this work in time.

Annexure 1: Workshop Programme

31 May 2010	Items	Presenter	Time
Inaugural Session	<ul style="list-style-type: none"> • Welcome address <ul style="list-style-type: none"> ○ MoEnv., WWF, ICIMOD • Introduction to workshop & objectives • Introduction of participants • Group photo 	Dr. Ejaz Ahmed Birendra Bajracharaya Faisal Mueen Qamer	09:30 – 10:30
Tea break		10:30 – 11:00	
Session 2	<ul style="list-style-type: none"> • Introduction to Land cover initiatives of ICIMOD • Introduction to NFA Initiative • Presentations on land cover / forest cover activities by the participating institutions <ul style="list-style-type: none"> ○ AJ&K – Planning & Development ○ Sindh Forest Department ○ Punjab – Planning & Development (Urban Unit) ○ Gilgit-Baltistan Forest Department ○ 	Birendra Bajracharaya Faisal Mueen Qamer	11:00 – 01:00
Lunch – Prayer break			01:00 – 02:00
	<ul style="list-style-type: none"> ○ PFI ○ Punjab Forest Department ○ Quetta - IUCN 		02:00 – 02:45
	<ul style="list-style-type: none"> • Case Study: Swat and Shangla district Forest Cover Assessment • Case Study: Land cover classification of CKNP - Case Study 	Sawaid Abbas Hassan Ali	02:45 – 03:30
	Tea Break		3:30 - 03:45
	Discussions – (Group exercises) <ul style="list-style-type: none"> • State of Land cover database in Pakistan • Lessons from past initiative • Institutions roles 		3:45 – 05:00
1 June 2010			
Session 1	Introduction & Overview of LCCS	Salman Asif	9:30 – 11:00
Tea break			11:00 – 11:30
	<ul style="list-style-type: none"> • Introduction & Overview of LCCS (Contd.) • Case Study: Pai Forest Change Analysis 	Salman Asif Naeem Rana	11:30 – 01:00
Lunch – Prayer break			01:00 – 02:00
Session 2	<ul style="list-style-type: none"> • Hands on exercise – LCCS 		02:00 – 03:30
Tea Break			03:30 - 03:45
	Continue.... <ul style="list-style-type: none"> • Land – Forest cover classification methodologies 	Urooj Saeed	

2 June 2010			
Session 1	<ul style="list-style-type: none"> • Overview of Regional Legend • Group formation • Working Group on National Legend Formation 	Salman Asif	09:30-11:00
	Tea Break		11:00 – 11:30
	Continue....		11:30 – 01:00
Lunch – Prayer break			01:00 – 02:00
Session 2	<ul style="list-style-type: none"> • Group Presentations 		02:00-3:30
Tea Break			3:30- 3:45
	<ul style="list-style-type: none"> • Comparing with national legends from the region (Nepal, Bhutan, Pakistan, Myanmar) • Finalization of national legend 	Birendra Bajracharaya	3:45-5:00
3 June 2010			
Session 1	<ul style="list-style-type: none"> • Developing a framework for Assessment and monitoring of Forest cover of Pakistan • Resource Identification and Workplan (group work) 	Faisal Mueen Qamer	09:30-11:00
	Tea break		11:00 – 11:30
	Continue		
Lunch – Prayer break			01:00 – 02:00
Session 2	<ul style="list-style-type: none"> • Group Presentations and finalization of Workplan 		02:00-3:30
	Tea Break		03:30- 3:45
	Continue....		

4th June, 2010, Closing Session

10:00 - 10:05 AM	Recitation from Holy Quran
10:05 - 10:10 AM	Welcome by Dr. Ejaz Ahmad, WWF - Pakistan
10:10 – 10:25 AM	Brief about the Workshop Concept by Mr. Brindera, ICIMOD
10:25 - 11:05 AM	Presentation on workshop output and way forward by Faisal Mueen Qamer, WWF - Pakistan
11:05 - 11:30 AM	Feedback from participants
11:30 - 11:45 AM	Remarks by Mr. Muhammad Javed Malik, Federal Secretary, Ministry of Environment, Government of Pakistan
11:45 - 12:00 PM	Certificate distribution
12:00 - 12:05 PM	Vote of thanks by Syed Mahmood Nasir, IGF
12:05 – 12:10 PM	Group Photograph
Lunch	

Annexure 2: List of Participants

Sr.#	Name	Organization	Email
1	Aamir Imran	SUPARCO	aamir_spacian@yahoo.com
2	Abdul Sattar Khatri	Sindh Forest	abdulsattarkhatri2000@yahoo.com
3	Abdul Wahid	P&DD GOAJK P&DD,Urban Unit,	gislabajk@gmail.com
4	Abu Bakar	Punjab	uu_gis@gmail.com
5	Ahmed Khan	WWF - PWP	akhan@wwf.org.pk
6	Ali Haider	PFI	
7	Birendra Bajracharya	ICIMOD	bbajracharya@icimod.org
8	Dr. Shaujat Ali	ERRA	ch.shujat.ali@gmail.com
9	Dr. Zaker Hussain	AJK Forest Deptt	zaker_nrm@yahoo.com
10	Faisal Mueen	WWF - P, Lahore	fmueen@wwf.org.pk
11	Farooq Ahmed Iaghari	WWF	falaghari@wwf.org.pk
12	Garee Khan	WWF	gareekhan@yahoo.com
13	Ghulam Qadir Shah	IUCN Pakistan	ghulam.qadir@iucn.org
14	Hassan Ali	WWF - P, Lahore	hali@wwf.org.pk
15	Iftikhar Abbas	SLMP MoE	
16	Kiaf Gill	WWF - P, Lahore	kgill@wwf.org.pk
17	Kifayat Ullah Baloch	FRDP, FATA	balochitee@gmail.com
18	Muhammad Afra Siyab	IGIS/NUST	afrasiyab08@igis.edu.pk
19	Muhammad Bilal Iqbal Muhammad Ibrahim	NARC	
20	Khan	WWF	iblr65@yahoo.com
21	Muhammad Ismail Zafar	Forest Dept. GB	
22	Muhammad Latif	BFWLD	
23	Mumtaz Haider Khan	IUCN Quetta	
24	Naeem Abbas Malik	NUST	naeem08@igis.nust.edu.pk
25	Naeem Shehzad Rana	WWF - P, Lahore	nrana@wwf.org.pk
26	Niaz Ali Khan	Planning Commission	niazalikhanpk@hotmail.com
27	Raja Khalid Hussain	Govt. of Punjab	
28	Salman Siddique	ICIMOD	
29	Sawaid Abbas	WWF - P, Lahore	sawaid.abbas@gmail.com
30	Shaukat Bashir	Planning Commission	shaukat.sbft1979@hotmail.com
31	Syed M. Faisal Zaidi	WMC-PPAF	saiFIans@gmail.com
32	Syed Mahmood Nasir	MoE	mnasirn@yahoo.com
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34	Zafar Jamil	SUPARCO	zafarc14@yahoo.com

Annexure 3: Concept Paper

Project Title	District-wise Forest Cover Assessment of Pakistan
Concept Originator	WWF-Pakistan
Contact Persons	Syed Mahmood Nasir, Inspector General Forests, MoE mnasirn@yahoo.com Faisal M. Qamer, GIS Manager, WWF- P fmueen@wwf.org.pk
Project Duration	1 Year

Introduction

Pakistan has 3.3 million ha. covered with forests and planted trees, which is equivalent to 4.1% of the total land area. Eighty-five percent of this forest is public forests (NFRRAS 2004). The forest resources of Pakistan are deteriorating both qualitatively and quantitatively due to anthropogenic, climatic and loose institutional arrangements. Annual change rate during 1990-2000 was -1.8% and during 2000-2005 was -2.1% (FAO, 2009).

GIS and Remote Sensing based tools and technologies have been in use to assess forest cover for the last two decades in Pakistan. The national level forest cover studies based upon satellite images include the Forestry Sector Master Plan (1992) and National Forest & Range Resources Study (2004). Aim of these mapping activities conducted at 1:250,000 scale was to estimate national forest cover disintegrated at province level. The results of such, relatively coarser detail, studies provide concise baseline information for policy level awareness and decision making. However, no systematic baseline data disintegrated at local administration boundaries (e.g., District and Tehsil), is available to accurately measure either the current extent of forest cover or the deforestation rate of a particular district (Qamer et al., 2010).

In this context, it is realized to develop a comprehensive forest cover inventory primarily focused at district level, ultimately leading towards national scale mapping of forest resources in Pakistan. Also, the information generated through the study should be readily available and easily replicable for the future monitoring of the forest resources.

Objectives

This Project will contribute towards the overall goal of increasing forest cover in Pakistan according to the targets set in the Medium Term Development Framework (MTDF, 2005).

Specific objectives will be:

1. To assess the current status of forest cover in forested districts of Pakistan.
2. To devise a mechanism to assess district-wise historic deforestation rate and regular monitoring of the forest resources in future with a particular focus on monitoring and verification system to report on REDD.

Project Areas

The study areas include all the districts of Pakistan with more than 5% forest cover of its total area. In total, there are 49 districts; 15 in NWFP, 9 in FATA, 6 in Sindh, 6 in Balochistan, 5 in Punjab, 4 in Gilgit-Baltistan, 3 in AJK, and 1 in Islamabad (Figure 1, Annexure 1).

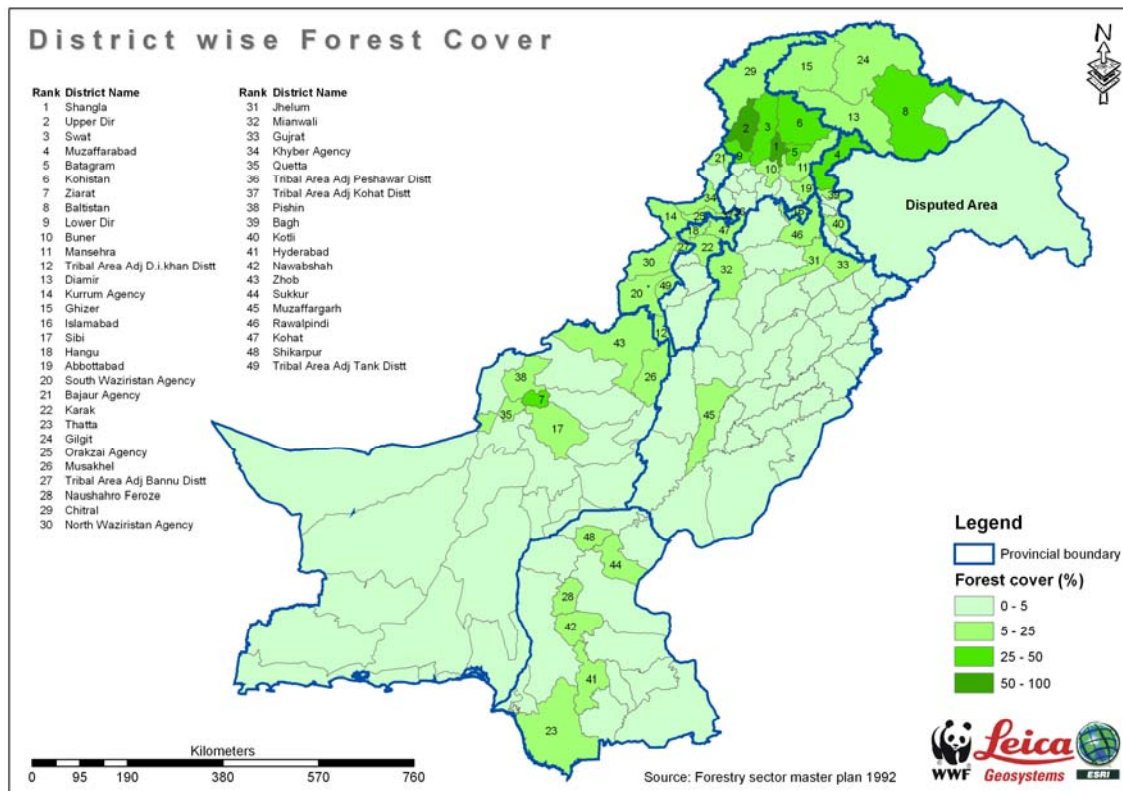


Figure 1: Map showing districts qualifying for forest cover assessment.

Specific Project Outputs:

The following outputs will be achieved through this project implementation:

▪ Outputs relating specific objective 1

1. A fully operational land cover assessment methodology, with normative components, database management system software & tools developed;
2. Newly acquired (2009-2010) Landsat satellite images made available for all the districts under the study;
3. Report on National Forest Resource Assessment and an atlas of Forest Resource Inventory developed and disseminated to the relevant authorities and stakeholders.

▪ **Outputs relating specific objective 2**

4. A method to update the inventory and analyze change at appropriate intervals is developed.
5. Capacity of the Forest Department to use the GIS and Satellite data in their management and planning activities is built.

Proposed Methods

At the start of the project, a consultative workshop with professionals of the Forest Department and key stakeholders will be held to understand the issues and refine the methodology of the project. A draft standardized legend based on the FAO's Land Cover Classification System (LCCS) will be developed for the study.

The study will be primarily based on remote sensing and GIS technologies. The satellite data proposed in the research includes 30m spatial resolution Landsat Thematic Mapper (TM) images acquired in 2009-2010. TM images are being recommended because of their good geographic and temporal coverage of Pakistan. In addition, the pixel size of TM images is 30X30m and a block of 3x3 pixels can be used to achieve ~ 1ha Minimum Mapping Unit (MMU) for forest mapping. The Landsat images can be accessed freely from GLCF, University of Maryland, USA <http://glcf.umiacs.umd.edu/> and USGS data portal.

Extensive ground reference data will be collected for image interpretation and a post processing accuracy assessment will also be performed and documented. Ancillary information on forest compartments and their relevant statistics will be provided by the Forest Department to correlate the results of the study.

Of all the available ways of extracting information from the remote sensing data, image classification in particular can be considered a prime candidate for a standard methodology with the potential to be distilled into a protocol that can be extended spatially and temporally (Lillesand et al., 2004).

In each forest area the relevant Forest Officer will be closely engaged in the study. This close engagement will contribute in two ways. First, the Officer will provide ancillary information on forest conditions such as tree species of the forest, number of compartments and their extents. Secondly, this interaction will enhance officers' capacity in using advance technologies such as Global Positioning System (GPS) and Satellite Images in forest management.

Guiding documents:

- FAO's Land Cover Classification System (LCCS): Classification Concepts and User Manual (Gregorio A. and Jansen L., 2005).
- GOFC-GOLD REDD Sourcebook of methods and procedures for monitoring and reporting anthropogenic greenhouse gas emissions and removals caused by deforestation, gains and losses of carbon stocks in forests remaining forests, and forestation (Archard et al., 2009).
- Evaluation of Forest Monitoring, Assessment & Reporting Systems in Pakistan (Jehangir et al., 2007).
- Forest cover change assessment using satellite images in Swat and Shangla districts, NWFP, Pakistan (Qamer et al., 2010).

Annexure**List of districts qualifying for Forest Cover Assessment**

Sr. No	District	Province/Territory
1	Muzaffarabad	AJK
2	Bagh	AJK
3	Kotli	AJK
4	Ziarat	Balochistan
5	Sibi	Balochistan
6	Musakhel	Balochistan
7	Quetta	Balochistan
8	Pishin	Balochistan
9	Zhob	Balochistan
10	Baltistan(Skardu-Ghanche)	Gilgit Baltistan
11	Diamir (Astor)	Gilgit Baltistan
12	Ghizer	Gilgit Baltistan
13	Gilgit (Hunza Nagar)	Gilgit Baltistan
14	Islamabad	Islamabad
15	Shangla	NWFP
16	Upper Dir	NWFP
17	Swat	NWFP
18	Batagram	NWFP
19	Kohistan	NWFP
20	Lower Dir	NWFP
21	Buner	NWFP
22	Mansehra	NWFP
23	Abbottabad	NWFP
24	Bajaur Agency	NWFP
25	Karak	NWFP
26	Orakzai Agency	NWFP
27	Chitral	NWFP
28	Tribal Area Adj Kohat Distt	NWFP
29	Kohat	NWFP
30	Tribal Area Adj D.i.khan Distt	FATA

31	Kurrum Agency	FATA
32	Hangu	FATA
33	South Waziristan Agency	FATA
34	Tribal Area Adj Bannu Distt	FATA
35	North Waziristan Agency	FATA
36	Khyber Agency	FATA
37	Tribal Area Adj Peshawar Distt	FATA
38	Tribal Area Adj Tank Distt	FATA
39	Jhelum	PUNJAB
40	Mianwali	PUNJAB
41	Gujrat	PUNJAB
42	Muzaffargarh	PUNJAB
43	Rawalpindi	PUNJAB
44	Thatta	SINDH
45	Naushahro Feroze	SINDH
46	Hyderabad	SINDH
47	Nawabshah	SINDH
48	Sukkur	SINDH
49	Shikarpur	SINDH

*District list is based on 1998 Census Report

References:

FAO (2009). State of the World's Forests 2009, Food and Agriculture Organization, Rome.

Lillesand, T. M., Kiefer, R. W., Chipman, J. W., (2004). Remote sensing and image interpretation, fifth ed. John Wiley and Sons (Asia) Pte. Ltd., Singapore.

NFRRAS (2004). National Forest & Range Resources Assessment, Pakistan Forest Institute, Peshawar.

Qamer F.M., S. Abbas, R. Saleem, K. Shehzad, A. Iqbal (2010). Forest cover change assessment using satellite images in Swat and Shangla districts, NWFP, Pakistan. WWF – Pakistan, Lahore.

Annexure 3: Workshop photographs



