Forestry Department
Food and Agriculture Organization of the United Nations

FOREST RESOURCES ASSESSMENT

NATIONAL FOREST AND TREE RESOURCES ASSESSMENT 2003-05
(TCP/LEB/2903)

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The Forest Resources Assessment Programme

Forests are crucial for the well being of humanity. They provide foundations for life on earth through ecological functions, by regulating the climate and water resources and by serving as habitats for plants and animals. Forests also furnish a wide range of essential goods such as wood, food, fodder and medicines, in addition to opportunities for recreation, spiritual renewal and other services.

Today, forests are under pressure from increasing demands of land-based products and services, which frequently leads to the conversion or degradation of forests into unsustainable forms of land use. When forests are lost or severely degraded, their capacity to function as regulators of the environment is also lost, increasing flood and erosion hazards, reducing soil fertility and contributing to the loss of plant and animal life. As a result, the sustainable provision of goods and services from forests is jeopardized.

In response to the growing demand for reliable information on forest and tree resources at country and global levels, FAO initiated a programme to provide support to national forest assessments (NFA). The programme includes developing a harmonized approach to NFAs, information management and support to policy impact analysis for national level decision-making.

The purpose of the initiative is to introduce countries to an alternative approach designed to generate cost-effective information on forests and trees outside forests, including all benefits, uses and users of the resources and their management. Special attention is placed on monitoring the state and changes of forests, and on their social, economic and environmental functions. Another main objective is to build national capacities and harmonize methods, forest related definitions and classification systems among countries.

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III. LIST OF ACRONYMS AND ABREVIATIONS{ TC "III. LIST OF ACRONYMS AND ABREVIATIONS" \f C \l "1" }

AFDC	Association for Forest Development and Conservation
CI	Climatic Index
COFO	Committee on Forestry
DRDNR	Directorate of Rural Development and Natural Resources
DSC	Directorate of Studies and Coordination
FAO	Food and Agriculture Organization of the United Nations
FD	Forest Department
FORM	Forest Resources Development Service
FRA	Forest Resources Assessment
GIS	Geographic Information System
GPS	Global Positioning System
IC	International Consultant
LCCS	Land Cover Classification System
LCLU	Land Cover / Land Use
LCLUP	Land Cover / Land Use Project
LNU	Lebanese National University
MOA	Ministry of Agriculture
MOE	Ministry of Environment
MoU	Memorandum of Understanding
NC-FI	National Consultant Forest Inventory
NC-ID	National Consultant Institutional Development
NC-RSM	National Consultant Remote Sensing and Mapping
NCSR	National Council of Scientific Research
NFA	National Forest Assessment
NGO	Non Governmental Organization
NPC	National Project Coordinator
NRRDD	Natural Resources and Rural Development Department
NWFPS	Non-wood Forest Products and Services
OL	Other Land
OLWT	Other Land With Trees
OWL	Other Wooded Land
RDS	Regional Development Services
SC	Steering Committee
TCDC	Technical Cooperation Between Developing Countries
TCP	Technical Cooperation Programme
TOF	Trees Outside the Forest
TOR	Terms of Reference
USJ	Université St. Joseph

IV EXECUTIVE SUMMARY{ TC "**IV EXECUTIVE SUMMARY**" \f C \l "1" **}**

1. Introduction

{ TC "1. Introduction" \f C \l "1" **}**

The Food and Agriculture Organization of the United Nations (FAO), at the request of member nations and the world community, regularly monitors the world's forests through the FRA Programme.

The *FRA Programme* has observed in the past GFRA that national forest definition vary among countries and the survey method used in data collection also differ. The differences in definitions and measurement methodologies have resulted to problems of comparability of national data and reliability of aggregated results. Likewise, many countries still lack reliable primary technical information at the country level.

To help address the issue the *FRA Programme,* following the 2001 meeting of the *Committee on Forestry* (COFO), launched a new approach to support *national forest assessment* (NFA) through in-country capacity building activities. The long-term objective of the FAO-NFA approach is "*to contribute to the sustainable management of forests and trees outside forest by providing decision makers and stakeholders with the best possible, most relevant and cost effective information for their purposes at local, national and international levels*."

The FAO-NFA approach was first pilot-implemented in Costa Rica and later replicated in Guatemala, Cameroon, the Philippines, and then Lebanon through TCP/LEB/2903 (CONSOLACION, C.P., 2004, FAO 2001).

TCP/LEB/2903 National Forest and Tree Inventory and Assessment of Lebanon became active in July 2003. The main objective of the project was to reinforce the capacity of the Directorate of Rural Development and Natural Resources (DRDNR) in collecting, compiling, analyzing and disseminating reliable and up–to-date information on the forest and trees outside the forest (TOF) resources of Lebanon through training of the national staff on forest and tree inventory (MOA/FAO 2003).

During the project, a systematic grid of permanent sample plots was established in accordance with the forest inventory component of the FAO-NFA approach. Tracts (1 km x 1km) were established at every 4 minutes longitude and latitude (every 6-7 km) across Lebanon. On the systematic grid of tracts, data on the forest and trees outside forest (TOF), information on the resources (wood and non-wood-forest products and Services (NWFPS) were measured, registered and analyzed in accordance with the specifications of the FAO-FORM support to National Forest Assessments and the additional national requirements for accurate statistics on the state of the resources.

Information on the supply and demand trend of wood and NWFPS, and the uses of such resources was collected through interviews with the local forest users who extract forest products from the sites measured and/or who have information about the forest products extracted. The interviews provide valuable information which are difficult, if not impossible, to acquire through direct observations of the forest resources (CONSOLACION, C.P., 2004).

TCP/LEB/2903 provides the first experiences with systematic field sampling of the forest and TOF resources of Lebanon.

The current report is produced for the Workshop on project findings for TCP/LEB/2903 Forest and Tree Inventory and Assessment of Lebanon, December 2004

The report summarizes the work undertaken during TCP/LEB/2903 and the findings, structured in accordance with the reporting requirements for the meeting of the FRA Advisory Committee. The report therefore doubles as the submission of the country report for Lebanon for the February 2005 meeting of the FRA Advisory Committee.

The strategy adopted by DRDNR for the formulation of recommendations and priority areas in chapter 18 was to hold a workshop on project findings in late 2004/early 2005 and to consider the feedback provided from the workshop participants during this workshop in the formulation of recommendations and priority areas allowing for the completion of chapter 18 so the current report can be completed and submitted to FORM in time for the February 2005 meeting of the FRA Advisory Group.

During the first quarter of 2005, the report will be fine polished, based on comments and recommendations and possibly suggestions for further data analysis provided by the workshop on project findings. The final report on the project findings and the final version of the derived map of forest and TOF resources of Lebanon will be presented to the public on a final workshop during the first quarter of 2005

2. Background and justification{ TC "2. Background and justification" \f C \l "1" }

2.1. General background{ TC "2.1 General background" \f C \l "2" }

The Republic of Lebanon is situated on the Eastern shores of the Mediterranean Sea, approximately between 35.2 - 36.6 E and 33.1 – 34.7 N.

Lebanon covers a total of 10452 km^2. The topography is characterized by the Mount Lebanon and the Anti-Lebanon mountain chains that run parallel to the coast and are separated by the Beqaa Valley. [1] Please refer to figure 3 for a topographic map of Lebanon.

The ecological conditions of Lebanon are determined largely by topography and vary with altitude and exposition. The climatic conditions vary from Mediterranean climate along the coast and the mid altitudes of the mountain ranges, via sub alpine or mountain Mediterranean climate on the highest slopes to arid / sub-desertic in the northern plains.

Figure 1: Location map of Lebanon

Most rainfall falls between November and March.
The mean annual rainfall on the coast ranges between 700 – 1000 mm. The central part of the Mount Lebanon coastal range receives up to 1600 mm annually. In the Beqaa Valley the rainfall ranges from 200 mm in the north east to 800 mm in the south. The Anti Lebanon receives between 600 mm in the north to 1000 mm on Mount Hermon.

Based on the climatic index (CI = Precipitation / evapotranspiration) Lebanon can divided into the following Zones (MOA 2003).

Arid	0.10 < CI < 0.25
Dry Subhumid	0.25 < CI < 0.65
Semi Arid	0.65 < CI < 1
Subhumid and humid	CI > 1

The zonation of Lebanon according to the Climatic index is indicated in figure 2 below.

The main forest and OWL species of Lebanon are *Quercus calliprinos, Q. infectoria, Q. cerris, Juniperus excelsea, Cedrus libani, Abies cilicica, Pinus pinea, Pinus halepensis, Pinus brutia,* and *Cypressus sempervirens*. The bulk of the forest area consists of oak and pine stands (ASMAR, F.R., 2003).

[1] FAOSTAT area of Lebanon is 10400 km^2

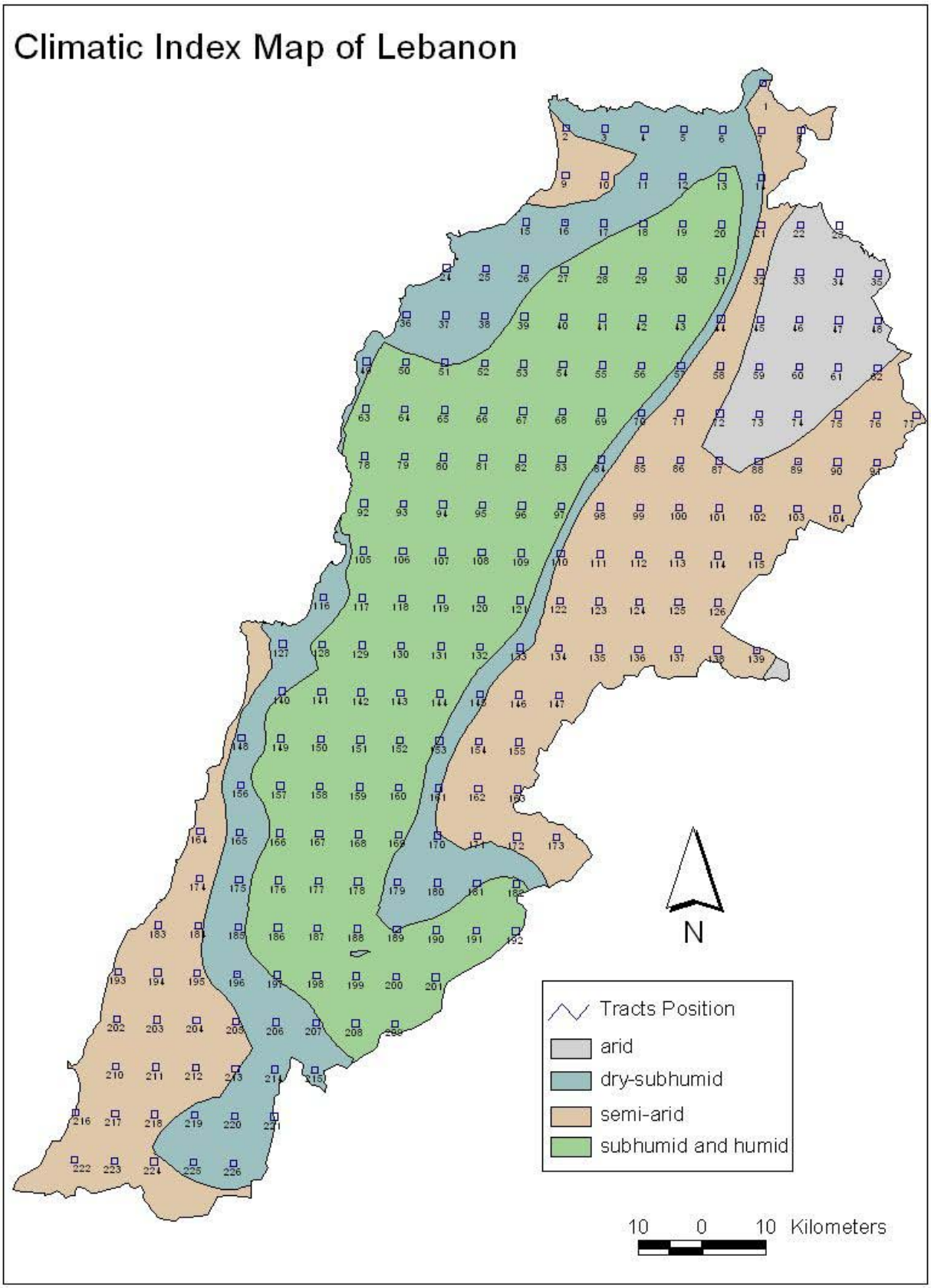


Figure 2: Climatic indices of Lebanon according to (MOA 2003) with permanent sample sites of TCP/LEB/2903 indicated.

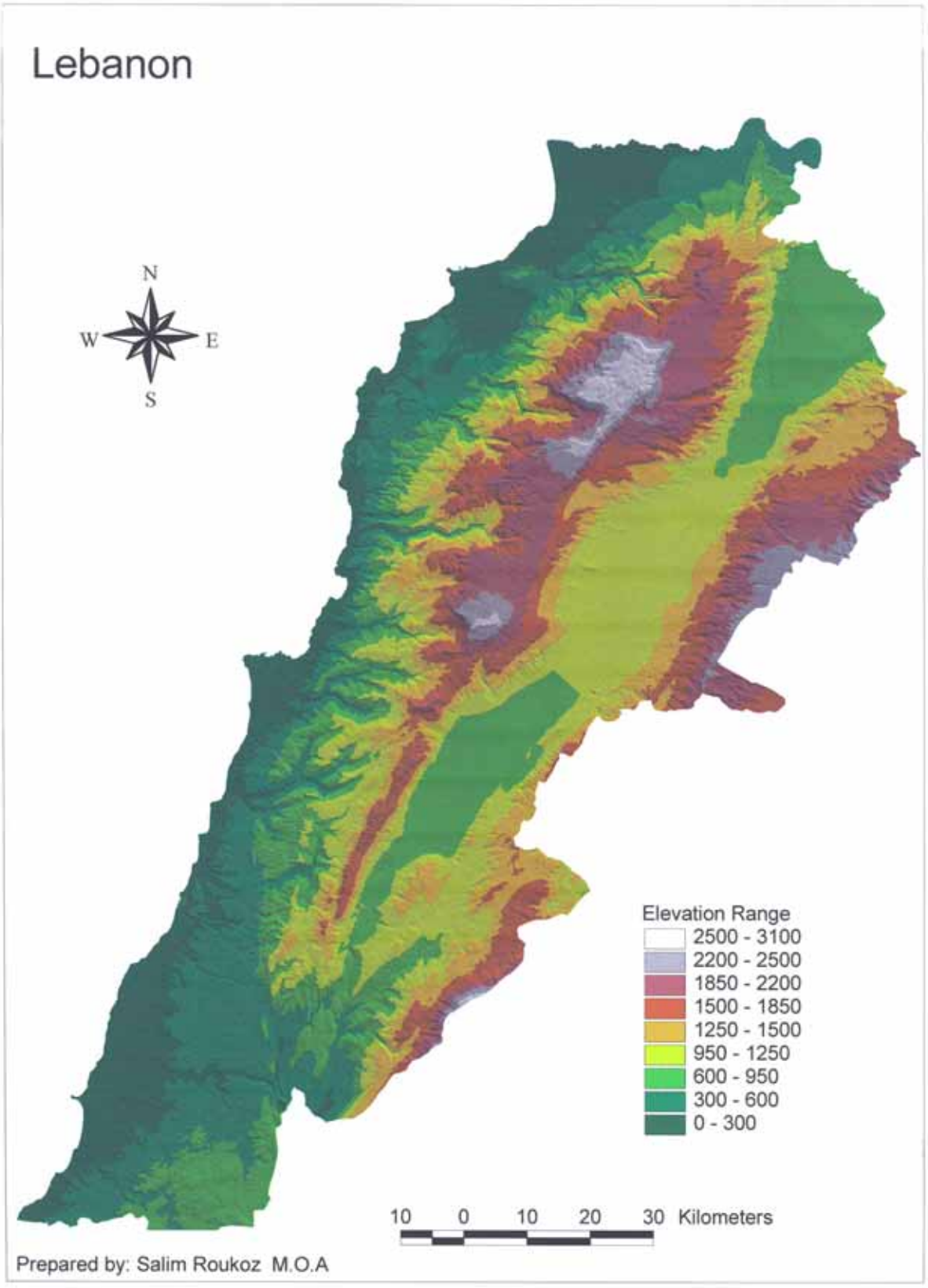


Figure 3: Topography of Lebanon based on Topographic Map of Lebanon 1:20.000 (MINISTÉRE DE LA DEFENSE NATIONALE, 1963)

2.2. Existing datasets{ TC "2.2 Existing datasets" \f C \l "2" }

Prior to TCP/LEB/2903 two datasets existed (MOA/FAO 2003):

2.2.1 The 1962-1965 1:50.000 Forest Type Map of Lebanon.

{ TC "2.2.1 The 1962-1965 1:50.000 Forest Type Map of Lebanon." \f C \l "3" **}**This data set is prepared from 1962 aerial photography at 1:25.000 with substantial ground checking. (Directorate of Geographic Affairs, Lebanese Army, 1965).

The dataset is of very high quality but as the last 4 decades have seen major changes in the land cover of Lebanon, the 1962-1965 dataset is somewhat outdated. The dataset distinguishes between the following forest types:

Forest Type	Crown closure	Species
Oak coppice – open	10 – 30 %	*Quercus calliprinos, Q. infectoria,* with or without some *Pinus brutia, Juniperus* and Maquis *spp*. in varying proportions.
Oak coppice – closed	> 30%	
Oak standards – open	10 – 30 %	*Quercus calliprinos, Q. infectoria, Q. brantii, Q. cerris*
Oak standards – closed	> 30%	
Pinus brutia – open	10 – 40 %	*Pinus brutia*
Pinus brutia – closed	> 40%	
Pinus pinea –	predominantly regeneration or pole stands	*Pinus pinea*
Pinus pinea – open	10 – 40 %	
Pinus pinea – closed	> 40%	
Cedar – open	10 – 40 %	*Cedrus libani* with or without some *Quercus spp., Juniperus spp.* and *Abies silicica* in varying proportions
Cedar – closed	> 40%	
Fir – open	10 – 40%	*Abies cilicica* and *Juniperus spp*. with or without *Cedrus Libani*, *P. brutia and Quercus spp*. in varying proportions.
Juniper – open	10 – 30 %	*Juniperus excelsea, J. foetidissima* with or without *Quercus calliprinos and Q. infectoria* in varying proportions
Juniper – closed	> 30%	
Cypress		*Cypressus sempervirens,* usually in mixture with *P. brutia.*
Areas of mean crown closure <10% i.e. scattered trees and / or dispersed stands too small to map individually are also indicated in the forest type map.		

Source: DIRECTORATE OF GEOGRAPHIC AFFAIRS, LEBANESE ARMY, 1965.

2.2.2 The 2000-2002 mapping of the Land Cover / Land Use (LCLU) under TCP/LEB/2801{ TC "2.2.2 The 2000-2002 mapping of the Landcover / Landuse (LCLU) under TCP/LEB/2801" \f C \l "3" }.

The mapping of the land cover was designed for agricultural census and is based on FAO's Land Cover Classification System (LCCS). The mapping is very accurate and employs minimum polygon-areas of 2000 m^2. The merged set of Landsat 5 and IRS-1D described in Chapter 4 were used to produce the map supported by extensive ground validation. The resolution of the merged images is about 5 meters.

As far as the areas of forest and OWL are concerned the LCCS does not translate readily into the global classes employed by FRA because different threshold levels for stand height and crown cover are employed to distinguish forests and OWL from other land. The minimum area employed for the LCLUP is 0.2 ha, while it is 0.5 ha for FRA. Being based on remote sensing with some ground verification, the LCLU map does not contain stand parameters, related to standing volume, uses and management (DALSGAARD, S., 2003A).

By combining the information on classification of the LCLU classes used for Forest and OWL in the Land Use Land Cover Project (LULCP) (EL-KHOURY, D. & BAKHOS, W., 2002), with the Standard Description of the FAO Land Cover Classification (FAO 2000). The LCLUP classes used for areas of Forest and OWL as defined by FRA can be summarized as below:

Summary of criteria for species composition, height and density of LCLU classes containing Forest and OWL					
Level 1	**Level 2**	**Level 3**	**Level 4**	**Height**	**Crown cover**
300 Woodland Homogeneous zone with a dominant tree or shrub type	**310** Dense Woodland The crown cover exceeds 60%	**311** Dense Coniferous Woodland	**311a** Dense Pines. *Pinus spp*. mainly *P. pinea* and *P. brutia* **311b** Dense Cedars. *Cedrus libani* **311d** Dense Fir **311e** Dense Cypress. *Cupressus spp.*	3 – 30 m	> 60-70%
		312 Dense Broadleaved Woodland	**312a** Dense Oaks. *Quercus spp* **312b** Dense - other types of broadleaved trees (poplar, willow)		
		313 Dense Mixed Woodland			
	310/ 112c Urban Sprawl on Dense Woodland				
	320 Open Woodland The crown cover is less than 60%	**321** Open Coniferous Woodland	**321a** Open Pines **321b** Open Cedars **321c** Open Juniper *Juniperus spp* **321d** Open Fir. *Abies cilicica* **321e** Open Cypress	3 – 30 meter	> 10-20% < 60-70%
		322 Open Broadleaved Woodland	**322a** Open Oaks **322b** Open - other types of broadleaved trees		
		323 Open Mixed Woodland			
	320/112c Urban Sprawl on Open Woodland				
	330 Scrubland includes scrubs and other types of degenerated woodland and maquis	**331** Scrubland		0.3 – 5 meter	> 10-20% < 60-70%
		332 Scrubland with some dispersed bigger trees			
	330/112c Urban Sprawl on Scrubland				
	340 Burnt woodland				

(**Source:** LICHAA, EL-KHOURY, D. & BAKHOS, W., 2002; FAO 2000).

In addition to the classes containing Forest and OWL, the following classes from LCLUP contain woody species and can be defined as Other Land with Trees in accordance with FRA Working Paper 82 (FAO 2004B)

Summary of classes from LCLUP that contain Other Land with Trees			
Level 1	**Level 2**	**Level 3**	**Level 4**
200 Agricultural area	**220** Permanent Crops	**221** Olives, include both monocultures of dense olive plantations and open olive trees incorporated with arable crops.	
		223 Fruit Trees include irrigated and dry deciduous fruit trees, main apples, almonds, pears and peaches.	
		223/ 221 Permanent crops on field crops.	
		224 Citrus Fruit Trees, lemon trees, orange trees.	

(**Source:** LICHAA, EL-KHOURY, D. & BAKHOS, W., 2002; FAO 2000

2.3. Justification{ TC "2.3 Justification" \f C \l "2" }

As a consequence of the 1975 - 1992 civil war developmental programmes were brought to a stand still for 2 decades, the environmental and natural resource base of Lebanon has been badly damaged and is under serious treat from causing factors such as urban sprawl, overgrazing, quarrying etc. Following the end of hostilities the resource depletion has been fuelled by the growth in economy and population.

The Government of Lebanon is increasingly concerned about the deep social, economic and environmental consequences of the depletion of the natural resources. The government requested the assistance of FAO in order to build the local capacity to monitor and report these changes in land cover with special focus on the woody resource thus enhancing the ability of the national institutions to plan for and respond to this dynamic situation.

Timely, easily available and accurate information on forest and TOF resources and their utilization is a precondition for sustainable management of these resources based on an environmentally, socially and economically balanced forest policy. The pre-TCP/LEB/2903 level (extent and quality) of information on the forest and TOF resource of Lebanon was perceived inadequate to support national policy decisions and to monitor and counteract resources depletion and environmental degradation.

A broad knowledge on the forest and TOF resources is critically needed for redefining the policy and strategy of the Forest Department as well as for developing a comprehensive national forestry action plan. The Government considers the formulation of its forestry action plan as a first priority once the results of the current inventory are analyzed and reported upon.

The Government therefore requested the technical assistance of FAO under the Technical Cooperation Programme to assist the Directorate of Rural Development and Natural Resources (DRDNR) to develop capabilities to survey the country’s resources to monitor trends and changes, to describe their nature and localities and to advise on protective measures where required for resources at risk (MOA/FAO 2003).

3. Objectives of the Study{ TC "3. Objectives of the Study" \f C \l "1" }.

According to the Project Document of TCP/LEB/2903, the main objective was to reinforce the capacity of the Directorate of Rural Development and Natural Resources (DRDNR) in collecting, compiling, analyzing and disseminating reliable and up–to-date information on the forest and trees outside the forest (TOF) resources of Lebanon through training of the national staff on forest and tree inventory.

To meet this target six main project outputs are described in the Project Document (MOA/FAO 2003):

Output 1 The capacity of the Forestry Department of the DRDNR to plan and implement forest inventories, monitor the resources, manage the related information, and contribute to advance sustainable forest and tree management by enabling an increased use of forestry knowledge in forest policy development and implementation enhanced and strengthened. (*For the capacity building aspects of TCP/LEB/2903 please refer to chapter 15*)

Output 2 The national team within the Forestry Department and the Regional Development Services adequately trained in forest inventory and assessments techniques and project management through on-the-job training, workshops and study tours. (*For the training aspects of TCP/LEB/2903 please refer to section 7.2*)

Output 3 As part of the training programme, a forest and tree cover map produced at appropriate scale on the basis of harmonised and standardised vegetation classification system according to national and international requirements. The satellite Landsat TM data available with the UTF/LEB/016 within the Ministry of Agriculture will be used. (*For the mapping aspects of TCP/LEB/2903 please refer to section 7.3*)

Output 4 Methodology of forest and tree assessment defined on the basis of the approach developed by FRA and taking into account the information needs for national use and international reporting, pilot assessment carried out in selected and representative field sample sites in the country with focus on the multiple functions (environmental, social and economic) of the forest and tree resources, their management, uses and users, health and monitoring of the forest and tree resources set up and a register of permanent observation sites for future surveys established. *(For aspects related to development of methodology of TCP/LEB/2903 please refer to section 7.1*)

Output 5 A data base based on the pilot assessment on the forestry resources established and the results disseminated to users. (*For aspects related to establishing the database for TCP/LEB/2903 please refer to Chapter 9*)

Output 6 Priority areas identified and recommendations given to the trained national team from the Forestry Department to build on the project findings in order to develop a forestry action plan, reformulate forestry policy/strategies if needed, identify specific projects for detailed forest inventories, forest and tree resources development and/or conservation, etc. (*For the identification of priority areas please refer to chapter 18*)

4. Resources for the implementation of the NFA{ TC "4. Resources for the implementation of the NFA" \f C \l "1" }.

4.1. Institutions{ TC "4.1 Institutions" \f C \l "2" }

TCP/LEB/2903 is undertaken by the *Directorate of Rural Development and Natural Resources* (DRDNR) and is implemented in the field by the *Rural Development Service* (RDS), in collabouration with the Forestry Department of the *Food and Agriculture Organization of the United Nations* (FAO). It is implemented under the *Technical Cooperation Programme* (TCP).

The organization of the project and the allocation of responsibilities is described in Chapter 6 – Project Management.

Among the other institutions and organizations that have contributed significantly to the progress of the NFA specifically the following should be mentioned:

The *Ministry of Defence Cartographic Department* provided the project with georeferenced colour topographic maps (1:20.000) allowing for the production of accurately georeferenced field maps for the field teams. The Cartographic office also assisted with the scanning and georeferencing of the 1962-1965 map of forest types.

The *Ministry of Defence, Demining Office* provided the maps of the known mined areas – to be used along with the field maps and to identify inaccessible areas (mined areas or areas that for other military reasons are inaccessible).

A formalised collabouration between the DRDNR and the *Directorate of Studies and Coordination* (DSC) within the Ministry of Agriculture concerning the use of and access to data and equipment was encouraged by the Project Document. Although a formal Memorandum of Understanding was not signed, there was full access for TCP/LEB/2903 to use the merged satellite images, the LCLU map and the A0 plotter of the DSC that were products of the Land Cover Land Use (LCLU) Mapping Project (TCP/LEB/2801).

The *National Council of Scientific Research* (NCSR) has made recent satellite images available to the project and been supportive in the original analysis of the LCLU map.

The following institutions and organizations contribute to the project through their appointment of professionals and scholars to the Project Steering Committee: *Université St. Joseph, National Council of Scientific Research, Lebanese National University, Directorate of Studies and Coordination, Ministry of Environment, Association for Forest Development and Conservation* (AFDC - an environmental NGO).

4.2. Infrastructure{ TC "4.2 Infrastructure" \f C \l "2" }

In accordance with the Project Document, the DRDNR provided all physical facilities for the project (office facilities for staff and information system, training space, local transportation including for the fieldwork, communications means, etc.).

Lebanon is composed of 6 administrative subnational units - the Mohafazas i.e.: Beirut, Mt. Lebanon, North Lebanon, Beqaa, South Lebanon and Nabatiyeh. As no tracts fell in Beirut, the fieldwork was performed in the 5 latter Mohafazas. In each Mohafaza, the staff of the Natural Resources and Rural Development Department (NRRDD) under the Regional Development Services (RDS) under MOA/Regional Services undertook the fieldwork. Each RDS is equipped with several vehicles as is the Central Office of the Ministry of Agriculture – transportation therefore went smoothly.

The infrastructure of Lebanon is good. Communications have been possible almost throughout the country via cellular phones. The rugged topography causes the coverage poor in a few areas of very steep slopes and can also cause poor reception for the GPS receivers.

The small size of the country combined with a dense network of roads has made it possible for the field crews to return home after each day in the field. In most tracts it has been possible to drive into the tract. In spite of this easy access, the fieldwork in the tracts could still be rather time consuming, and in some plots even impossible, due to the topography and dense vegetation.

4.3. Staff{ TC "4.3 Staff" \f C \l "2" }

4.3.1 MOA Staff{ TC "*4.3.1 MOA Staff*" \f C \l "3" ***}***

In accordance with the Project Document, the DRDNR provided all the needed national counterpart staff at secretariat and professional level. The DRDNR through the RDS provided all the national personnel for the field work. All the staff involved in the project are mentioned in Appendix 9:

The Government appointed a National Project Coordinator, who held the overall responsibility for all aspects of the project activities, with direct reference to the Director General of MOA. Below the national staff at secretariat and professional level are mentioned:

Ministry of Agriculture

National Project Coordinator:	Mr. Ghattas Akl, Director DRDNR.

Project Team:

- Supervision and Control:	Mr Michel Bassil, forest engineer, DRDNR
- Coordination and Assistance:	Ms Zeina Tamim, agricultural engineer, DRDNR
- GIS and mapping:	Mr. Selim Roukoz, agricultural Engineer, DRDNR

Regional Development Services (RDS) / Natural Resources and Rural Development Department (NRRDD)

5 field teams were established, equipped and trained during the first phase of the project. Each field team is headed by the Team leader who is normally the Chief of the NRRDD under MOA/Regional Services in the respective Mohafazas.

There is a team leader responsible for all aspects related to data collection in Mt. Lebanon and North Lebanon Mohafaza. Beqaa Mohafaza was split into a northern and a southern part due to the

large size and a field team was established for each. The data collection in the two Southern Mohafazas was undertaken by one field team as they are small. On an average this setup implied that each field team had to measure around 45 tracts.

A field team would normally consist of 1 team leader and 3 forest guards. In Appendix 9, the number of trained persons that are listed under each Mohafaza exceed this figure. This is because an extra number forest guards were trained in the field work – to increase the flexibility, and decrease the vulnerability of the field crews. Since many were trained it was always possible to assemble complete field teams (DALSGAARD, S. 2004A).

4.3.1 External Staff{ TC "4.3.2 External Staff" \f C \l "3" }.

In accordance with the Project Document, the following consultants / FAO Staff support was attached to the Project. For their respective TORs, please refer to the Project Document:

Consultant	Duration of consultancy
International Consultant Forest inventory and Mapping	3 months
TCDC Forest Inventory Consultant	4 months
National Consultant Forest Inventory	7 months
National Consultant Remote Sensing	3 months total
National Consultant Institutional Development	4 months
FAO backstopping	1,5 months

In addition to the TORs contained in the Project document, the following additional assistance was recruited during the third and final project phase to assist in the final phases of data entry and the data-processing and statistical analysis.

Title	Duration of consultancy
Data Entry Service	2 months total
Specialist Data Analysis and Statistics	3 months

At the start of the third phase of the project, the recruitment of a specialist in data analysis and statistics was unanimously recommended by the NPC, the IC, the FAO technical backstopping officer and FAO Lebanon to ensure high quality data processing and statistical analysis on the large quantity of detailed field data collected during the field work phase. The specialist has through the data-processing and analysis work ensured that the staff of the DRDNR was adequately trained in data processing and statistical analysis so that the staff of the Directorate can perform the tasks related to data processing and analysis in future repetitions of the inventory. Thus the recruitment of the specialist has implied a substantial capacity building component for the DRDNR.

Please refer to Chapter 5 – Project Management for the organization of the project and the allocation of responsibilities.

4.4. Equipment{ TC "4.4. Equipment" \f C \l "2" }

Wherever possible, equipment was purchased locally to ease any future servicing. The forest measuring equipment however had to be purchased from international suppliers, as it was not available from Lebanese suppliers. Each field team was provided with the following equipment (appendix 6 of DALSGAARD 2003A contains the full technical specifications). An extra set of field equipment was purchased for the supervisory function of the NC-FI and the TCDC expert:

4.4.1 Field equipment{ TC "4.4.1 Field equipment" \f C \l "3" }

Items that were purchased from international suppliers of forestry equipment:

- Fibreglass diameter measuring tape 5 meters
- Forest measuring tapes 50 m on V-frame
- Measuring tapes 10 m
- Prismatic Pocket Compass Model *Suuntto*
- Flagging Tags (rolls) biodegradable
- Altimeter *Haga*
- Loggers measuring tape, length 30 m. *Spencer*
- Measuring tape holder
- Laser rangefinder. *Yardage Pro 1000*
- Metal locator *Fisher FX-3*

Items available for purchasing locally:

- GPS receiver 12 parallel channel receiver band receiver *Carmin Etrex VISTA*
- Digital Camera *Nikon 3100 Coolpix*
- Extra storage media for Digital camera *Compact flash ™ (256 MB)*
- Back pack
- Galvanized iron poles for marking plot starting point
- Binoculars *Nikon Standard Action Series 8x40 CF*
- Slasher and hammers
- 4 m poles and flags
- Belt
- Target wooden plate mounted on pole for Laser rangefinder

The field teams were already sufficiently equipped with uniforms and boots, therefore these items were not purchased by the project. The purchase of increment-borers was omitted, as none of the parameters that were included in the survey, after all national recommendations had been added to the FAO base requirements, called for the use of increment borers.

4.4.2 Hardware - Forest Information System{ TC "4.4.2 Hardware - Forest Information System" \f C \l "3" }:

All hardware items were purchased locally:

- 1 workstation.
- 21” monitor for workstation
- DVD-RW External
- USB memory stick for data transfer
- A3/A4 printer
- Photocopier A3/A4 with page sorter, stand and printer card.

- 2 UPS's

3 upgraded used PCs were donated to the project from FAO Lebanon in connection with routine upgrading of the hardware at the FAO representation in Lebanon. The PCs were installed at the Rural Development Services and used for decentralised data entry.
An A0 plotter was available to the project through the Memorandum of Understanding with DSC and therefore it was not necessary to purchase one for TCP/LEB/2903.

4.4.1 Software - Forest Information System{ TC "4.4.3 Software - Forest Information System" \f C \l "3" }:

- Windows Xp,
- Map Source version 3.02

The following software was already available in the Ministry of Agriculture and therefore not purchased: MS Xp Office Pack Pro, Arc view 3.2.

4.4.2 Digital Maps and satellite images{ TC "4.4.4 Digital Maps and satellite images" \f C \l "3" }:

The Ministry of Defence provided the project with:

- Digital georeferenced topographic map 1:20000 of Lebanon (1962) for use in the field maps[2].
- Digital maps of all registered mines and unexploded ordnance for use with the field maps.
- Scanned and georeferenced version of the 1962-1965 map of Forest Types of Lebanon.

The Directorate of Studies and Coordination MOA provided the project with:

- The digital Land Use Land Cover Map from TCP/2801
- The satellite images available through TCP/LEB/2801 are a merged set of Landsat 5 and IRS-1D. The resolution of the merged images is about 5 meters. Data on the images are presented below:

Table 1: Satellite images available through TCP/LEB/2801

Sensor	***Date***	***Band***	***Spatial Resolution***	***Radiometric Resolution***
Landsat TM 5	October 15, 1998	7	30 m	8 bit
		4	30 m	8 bit
		2	30 m	8 bit
IRS-1D	October 15, 1998	Pan	5 m	6 bit

Source: Lichaa, El-Khoury, D. & Bakhos, W., 2002.

As auxiliary data used for the production of the derived forest cover map. The following maps were used:

- Map of the forest types of Lebanon 1965 (DIRECTORATE OF GEOGRAPHIC AFFAIRS, LEBANESE ARMY, 1965).
- Map of climatic indices of Lebanon (MOA 2003)
- Merged Satellite image of high resolution (Landsat-IRS)

[2] While the project was active in 2003 and 2004 the Cartographic Department of the Ministry of Defence was in the process of producing an updated set of topographic maps covering the whole of Lebanon. However the maps were not finished and available for use during the active period of TCP/LEB/2903

- Recent road maps

5. Project Management{ TC "5. Project Management" \f C \l "1" }.

TCP/LEB/2903 is based in the DRDNR in MOA. The overall responsibility for the project implementation was allocated to the Department of Forests within DRDNR with the assistance of international and national consultants as well as technical support from FAO-FORM.

The organisational diagram for TCP/LEB/2903 is indicated below

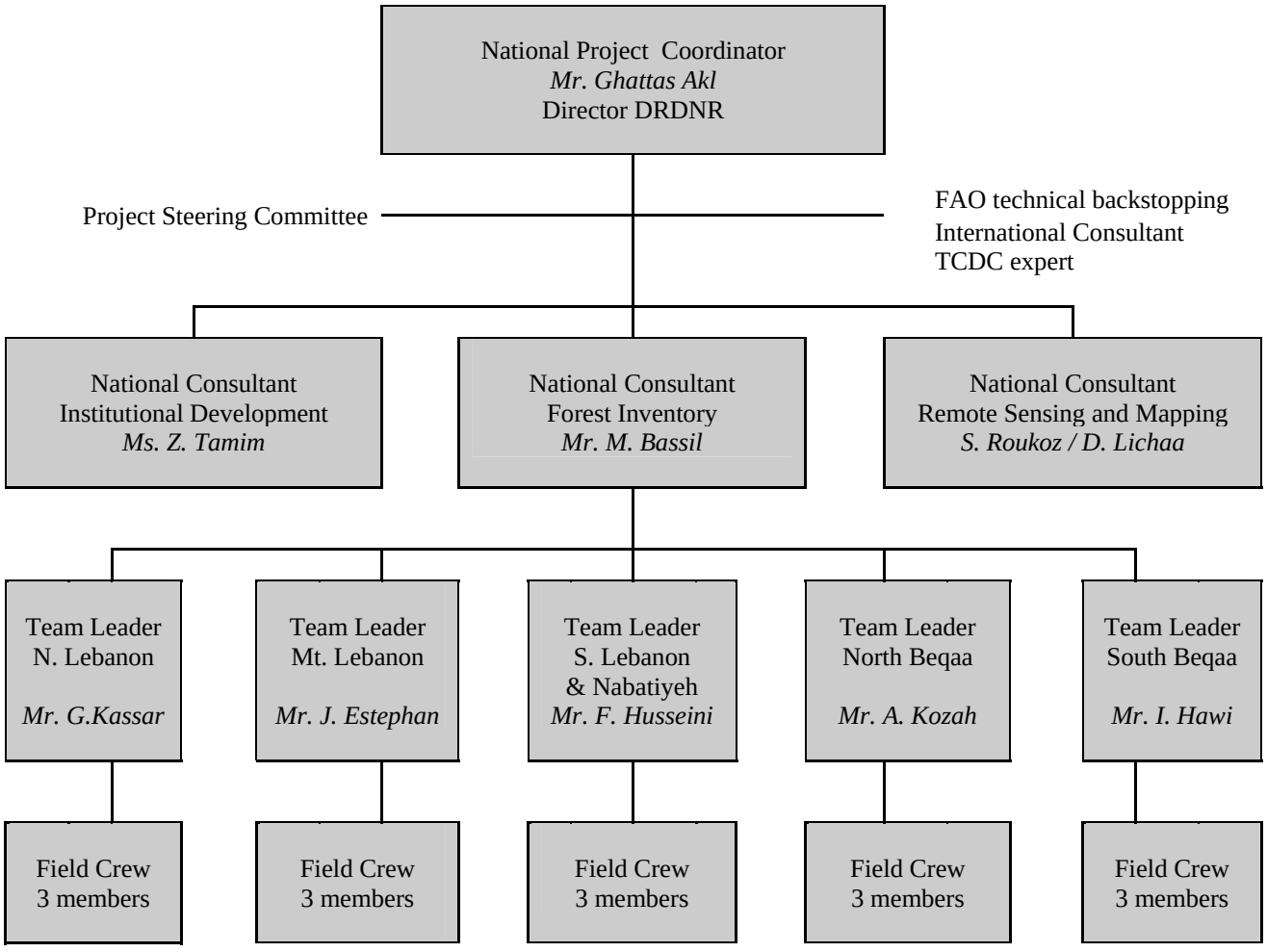


Figure 3: Organisational Diagram for TCP/LEB/2903

5.1. National Project Coordinator{ TC "5.1 National Project Coordinator" \f C \l "2" }

As *National Project Coordinator* to the Project, the Government of Lebanon appointed the Director of DRDNR Mr. Ghattas Akl. With direct reference to the Director General of MOA the NPC supervised the overall coordination of all project activities including training of national personnel, the forest mapping activities and organizing the field crews making use of the staff in the Regional Development Services.

The NPC with the assistance of the staff of the FD and the national and international consultants supervised the project activities and organized the field crews in making use of the staff in the Regional Services. The NPC held the overall responsibility for:

- Coordinated interventions of the national institutions and individuals involved in the project
- Facilitation of training of field crew members
- Overseeing the fieldwork and securing the timely deployment of the necessary logistical support of the field crews
- Overseeing the design and development of the forest information system and processing field data and reporting of project findings.

5.2. National Consultants and Team Leaders{ TC "5.2 National Consultants and Team Leaders" \f C \l "2" }

The main tasks of the National Consultants are mentioned below. For complete TORs please refer to Project Document.

The *National Consultant Forest Inventory* (NC-FI) was responsible for:

- the training of team leaders and field teams.
- the coordination of the fieldwork activities in order to ensure the daily smooth running of the project.
- planning project activities, supervision the field teams and provision of technical guidance as to homogenise data collection and best interpretation of variables and definitions.
- in collabouration with the TCDC expert, to double check all submitted field forms and correcting any errors before clearing the field forms for entry into the Forest Information system by the team leaders.
- double checking the structures and contents of the secondary databases filled out by the teamleaders before merging and processing the data.
- participation in developing the forest information system and preparing functions for data-processing
- and assist in data analysis and reporting of project findings
- prepare project progress report and terminal statement.

The main responsibilities of the *National Consultant Institutional Development* (NC-ID) were:

- assist in reviewing the mandates of the FD and the RDS as to extend to resources monitoring and periodic assessments, under the direct supervision of the NPC/Director DRDNR
- assist in proposing a new organization of the FD within DRDNR and strengthening of the RDS encompassing the new mission regarding forest and tree monitoring and assessment
- assist in defining human and financial resources needed by the FD and the RDS to implement resources monitoring programme and carry out periodic assessments.
- assist DRDNR in defining implementation procedures for the recommendations of the consultancy and to prepare a report for discussion during the workshop on project findings.

The main tasks of the *National Consultant Remote Sensing and Mapping* (NC-RS) were to:

- Production of field maps for the field teams.
- Production of derived forest cover map, based on the interpretation of satellite imagery, georeferenced maps of forest types and climatic data and the ground verification provided by the field work and the subsequent ground validation of the draft map.
- Assist in purchasing, installing and using project equipment
- In collabouration with the IC and the DRDNR staff to review and adjust the vegetation classification system, taking into account the national requirements and the FAO terminology and requirements.
- Ensuring that DRDNR's capacity for conducting reinterpretation of images, aided by all relevant existing data was built.
- In collabouration with the IC to prepare a work plan of the mapping activities and to identify timely inputs from the project and the Government.
- Report on mapping results.

The Team Leaders were responsible for all aspects related to the practical field measurements (logistics, quality, safety etc.). The team leaders were responsible for the correct data capture through measurements and interviews and the correct registration of the data in the field forms. The team leaders were also responsible for entering the data in the secondary databases at the RDS and the timely submission of reports and databases.

5.3. International Consultants and FAO Support{ TC "5.3 International Consultants and FAO Support" \f C \l "2" }

The *International Consultant* (IC) functioned under the direct supervision of the FRA Programme/RNER and the technical supervision of the FRA Technical Backstopping Officer. Through periodic fieldings the IC provided technical assistance and support to the FD of DRDNR in training of national personnel, planning and implementing the NFA and setting up the information system. The main tasks were related to:

- assist in setting up training of national staff through workshops and courses
- in collabouration with national counterparts of the DF at DRDNR to review and adjust when necessary inventory methodology, vegetation classification and variables
- assist in supervising the reinterpretation of existing geographic information to construct the derived forest cover map.
- Preparing and updating a plan of project activities with inputs from the project and Government
- Assist in data analysis, reporting of findings and outline follow-up plan of action.

The *TCDC Forest Inventory Consultant* (IC) functioned under the direct supervision of the FRA Programme/RNER and the technical supervision of the FRA Technical Backstopping Officer. Through periodic fieldings the IC provided technical assistance and support to the FD of DRDNR in training of national personnel, planning and implementing the NFA and setting up the information system. The main tasks were related to:

- Providing continual supervision of field crews on technical issues as to homogenise data collection and best interpretation of variables.
- Reviewing and adjusting when necessary inventory methodology, vegetation classification and variables in collabouration with national counterparts of the DF at DRDNR
- Assisting in preparing and updating a plan of project activities with inputs from the project and Government
- Assisting in organizing collection of field crews outputs, double-checking of field data before clearing for entry in information system by team leaders.
- Assisting in developing the national forest database.
- Assisting in data analysis, reporting of findings and outline follow up plan of action.

The *FAO/FRA Backstopping Officer* undertook periodic missions in support of the project as foreseen in the workplan and provided technical assistance and guidance on aspects of:

- Forest and tree inventory methodology development including sampling design, classification system harmonization and variables.
- Forest and land use type mapping
- Training of national personnel in forest mapping, forest inventory and information management
- Field survey
- Data processing, information system development and reporting
- Overall technical supervision of project implementation
- Technical editing and clearance of project reports including terminal statement.

The *FAO representation of Lebanon* was throughout the project helpful and supportive in all aspects related to the implementation of the various project phases. All Steering Committee Meetings were held at the FAO Representation

5.4. Project Steering Committee{ TC "5.4 Project Steering Comittee" \f C \l "2" }

In accordance with the Project Document, the Steering Committee provided the overall supervision of implementation of project activities, facilitated inputs to the project at all phases and functioned to ensure a wider dissemination of results. The Steering Committee was composed of representatives from:

- Directorate of Studies and Coordination, MOA
- Ministry of Environment, MOE
- National Council of Scientific Research, NCSR
- Association for Forest Development and Conservation, AFDC
- Lebanese National University, LNU
- Université St. Joseph, USJ
- FAO representation of Lebanon

Minutes of the meetings of the Steering Committee are contained in Appendix 5.

6. Preparations{ TC "6. Preparations" \f C \l "1" }

According to the Project Document TCP/LEB/2903 is characterized by 3 well defined phases:

Phase I	July 2003-November 2003: Preparation, Training and Mapping;
Phase II	November 2003-July 2004: Field Survey;
Phase III	July 2004-December 2004: Data Processing and Reporting.

The workplan of TCP/LEB/2903 was revised a couple of times as the project progressed, the final version of the workplan is attached in appendix 6

Phase I includes all preliminary arrangements and preparatory work related to acquisition of equipment, recruitment of staff production of field manuals and field forms, production of working maps and signing a letter of understanding with DSC promoting inter-Directorate collabouration concerning access to geographic data and use of mapping equipment from an earlier TCP Project, Land Use Land Cover Mapping Project (TCP/LEB/2801).

In accordance with the Project Document Phase I also included training sessions for staff, adjustment of methodology and harmonizing classification system and variables according to national requirements. These 1st Project Phase activities are dealt with in chapter 7 in accordance with the reporting requirements of FAO-FORM for the FRA Advisory Group Meeting in February 2005.

The main preparatory activities were as follows:

6.1. Recruitment of national and international consultants{ TC "6.1. Recruitment of national and international consultants" \f C \l "2" }

The International Consultant was recruited for entry on duty on the 06.07.2003 for a total of 3 months split on 4 separate fieldings at strategic times during the lifespan of the project. Prior to the first fielding the IC was briefed by FORM in the inventory methodology during a stopover in Rome.

The National Consultants were identified during the first phase of the project. However due to unforeseen delays concerning the recruitment procedure they were not formally recruited before early 2004. Although not yet formally recruited, all National Consultants worked hard for the project throughout the first phase of the project. In accordance with the Project Document the National Consultants were initially recruited for the following periods.

National Consultant Forest Inventory	7 months
National Consultant Remote Sensing	3 months
National Consultant Institutional Development	4 months

The TCDC Forest Inventory Consultant, who was supposed to be fielded during the first phase of the project, was eventually fielded during the second project phase. The delay was caused by unavailability of the first candidate and later, a delay due to the climatic conditions of the winter. Due to this delay, the TCDC Forest Inventory Consultant was fielded for a 4 months period (March - July) during the Phase II of the project – the fieldwork phase, i.e. for a shorter total period than the seven months prescribed by the Project Document.

6.2. Interpretation of satellite images and map construction{ TC "6.2 Interpretation of satellite images and map construction" \f C \l "2" }

During the preparatory project phase accurate field-maps were produced of all tracts. The production of maps started after the sampling intensity had been decided upon, for this topic please refer to chapter 7 on methodology.

Once the design and intensity of the sampling grid had been decided, an unforeseen challenge related to the production of working maps was that the geographic coordinates provided by FORM for the chosen sampling intensity needed to be converted to Lambert Conformal Conic Levant (LCC) which is the national projection for Lebanon. The final Coordinates and text explaining the transformation is contained in appendix 12. The working maps were prepared using the national projection while GPS navigation was done using the geographic coordinates (WGS84) as this eliminated the conversion error.

The field maps for the field teams were produced by Mr. Selim Roukoz of DRDNR. These maps show the tract and immediate surroundings with tracts and plots overlaid the georeferenced topographic maps of Lebanon supported by sections of the satellite image and the LCLU map. The working maps also provide the relevant information concerning coordinates of tract centre and SW corner as well as plot-starting points. Examples of the working maps are contained in appendix 7.

The field maps are supplemented by maps of known mines and unexploded ordnance. The data was provided by the Demining Office of the Ministry of Defence and the maps printed by Mr Selim Roukoz. Examples of maps of mines and unexploded ordnance are contained in appendix 7.

6.3. Procurement of forest inventory and information system equipment{ TC "6.3 Procurement of forest inventory and information system equipment" \f C \l "2" }.

The list of equipment that was purchased for TCP/LEB/2903 is mentioned in section 4.4; please refer to this section for details. After clearance from FAO FORM during July 2003 it was established that the procurements could be undertaken directly by FAO-Lebanon. The final procurement lists were sent from FAO Lebanon to potential suppliers for collecting offers. For specialized forest equipment 3 external suppliers were contacted in early August 2003 for delivery in Beirut by October 2003, before the start of the training sessions for the field teams.

It was found necessary to modify the original list of procurements of the Project Document for a number of items. Specifically should be mentioned that the following items were added to the procurement list of the Project Document:

- 6 laser rangefinders with 1000 meters range were added to the equipment list, as it would seem a highly useful tool for certain conditions where visibility is good i.e. high altitudes, bare land and agricultural land. Under Lebanese conditions where the range of vision is often high these proved extremely useful.
- 6 metal locators were added to the equipment list allowing for relocating and re-measuring established plots.
- Extra 256 MB storage medias for the digital cameras – to allow for storing a larger number of images than the standard 16 MB media the cameras were delivered with.
- Large hammers for pounding the metal poles into the ground at plot starting points were purchased for each field team.

- Telescopic 4 meter rods were included for each field team. These will facilitate navigating in dense maquis vegetation and double for the radius measure of the circular subplot (radius = 3,99m, area = 50m^2).

And the following items were omitted from the procurement list of the Project Document:

- Increment borers were not purchased, as none of the parameters that were included in the survey, after all national recommendations had been added to the FAO base requirements, called for the use of increment borers
- An A0 plotter was available to the project through the Memorandum of Understanding with DSC and therefore it was not necessary to purchase one for TCP/LEB/2903.
- Access database software was already available through the MS Xp Office Pack Pro office package used by the Ministry of Agriculture (MOA). MOA also had Arc view 3.2 thus limiting the need for GIS software purchase to Map Source version 3.02.
- Uniforms and boots were not purchased, as the forest guards were already well equipped.

Where possible, Lebanese suppliers for technical equipment were preferred among others for ease of future servicing. This especially applied for the hardware and software purchases.

3 upgraded used PCs were donated to the project from the FAO representation of Lebanon in connection with routine upgrading of the hardware at FAO. The PCs were installed at the NRRDD and used for decentralised data entry by the team leaders.

6.4. Memorandum of Understanding between DRDNR and DSC{ TC "6.4 Memorandum of Understanding between DRDNR and DSC" \f C \l "2" }.

A formalised collabouration between the DRDNR and the *Directorate of Studies and Coordination* (DSC) within the Ministry of Agriculture concerning the use of and access to data and equipment was encouraged by the Project Document. Although a formal Memorandum of Understanding was not signed, there was full access for TCP/LEB/2903 to use the merged satellite images, the LCLU map and the A0 plotter of the DSC that were products of the Land Cover Land Use (LCLU) Mapping Project (TCP/LEB/2801).

The signing of a formal MoU would have been a visionary element in the project as would have institutionalized the inter-Directorate collabouration formalizing the synergetic use of the equipment and data collected in an earlier TCP Project, Land Use Land Cover Mapping Project (TCP/LEB/2801). During 2004, DRDNR physically moved to new office premises shared with, among others, the DSC which makes such collabouration even more feasible.

6.5. Field manuals and field forms.{ TC "6.5 Field manuals and field forms." \f C \l "2" }

During the initial months of the project, the standard FRA templates for the field manual and the field forms were used. Following the recommendations from the workshop on information needs and variables held 06.08.2004 and the additional suggestions for parameters to be measured, the field manual, the field forms as well as the database application were edited simultaneously during December 2003 so that the Lebanese version of the field manual was available to the field teams by the start of the field work phase by early 2004. Section F4 was revised slightly during April 2004. Final versions of Field Manual and field forms are attached in appendix 3.

7. Methodology{ TC "7. Methodology" \f C \l "1" }.

7.1. Sampling design, classification system and variables

{ TC "7.1 Sampling design, classification system and variables" \f C \l "2" **}**As mentioned in chapter 3, Project Output number 4 is to define a methodology for forest and tree assessment on the basis of the approach developed by FRA, taking into account the information needs for national use and international reporting, to carry out pilot assessment in selected and representative field sample sites in the country with focus on the multiple functions (environmental, social and economic) of the forest and tree resources, their management, uses and users, health and monitoring of the forest and tree resources and establish a register of permanent observation sites for future surveys.

The current section describes the various methodological aspects of TCP/LEB/2903 which took place during phase I of the project.

The strategy adopted by TCP/LEB/2903 for deciding on sampling, classification system and additional variables was to launch two workshops for participants from other government bodies, the environmental research community, NGOs, students and the Regional Development Services (RDS) as well as the staff of DRDNR that would be involved in the work. The workshops were launched during the first month of the project.

The first workshop would provide the participants with an overview of the standard FAO approach to NFA and raise the questions of which sampling grid, classification system and additional parameters should be adopted for Lebanon. The second workshop aimed at reaching a consensus on the issues among the workshop participants.

The workshops are briefly described below:

7.1.1 Workshop on national forest inventory methodology

{ TC "7.1.1 Workshop on national forest inventory methodology" \f C \l "3" **}**The workshop was held on the 22-23.07.2003. The workshop had about 30 participants from other government bodies, the environmental research community, NGOs, students and the Regional Development Services (RDS).

One day of presentations relating to the FAO support to NFA with special emphasis on Lebanese conditions was followed by one day of fieldwork to illustrate the FAO standard methods of data capture and to make it clear to the workshop participants what was registered by the FAO base parameters and variables. This combination would allow the workshop participants to provide qualified contributions to the workshop on information needs and variables where additional suggestions for parameters and how to measure them, as well as suggestions for a vegetation classification system, standardized and harmonized to fulfil national and international requirements.

The full report from the workshop of forest inventory methodology, including list of participants is included in the report from the workshop in Appendix 2 of DALSGAARD 2003A.

Between the workshops were 2 days of pre-assessment by DRDNR staff, the IC and FORM technical backstopping officer to North Lebanon and to Mt. Lebanon Mohafazas. These pre-assessment trips were instrumental in evaluating the challenges ahead for the field teams in order to determine a realistic sampling intensity. In total around 15 tracts were evaluated.

7.1.2 Workshop on information needs and variables{ TC "7.1.2 Workshop on information needs and variables" \f C \l "3" }

The workshop was held on the 06.08.2003 to gather suggestions for:

- a standardized and harmonized vegetation classification system according to national and international requirements.
- additional information needs for national use and how to measure the variables

The workshop had about 30 participants from other government bodies, the environmental research community, NGOs, students and the Regional Development Services (RDS). To allow for constructive feedback on the topics, the workshop participants had during the July workshop been introduced to the theory and the background of the work of FAO in Forest Resources Assessment (FRA) with emphasis on the FAO support to NFA and special focus on Lebanon, the classifications used by the Land Use Land Cover Project and the definitions employed by FAO/FRA.

The workshop was held as two initial presentations on

1.) the standardized and harmonized vegetation classification system and
2.) the additional information needs.

Both presentations were followed by plenary discussions.

A discussion on the basic sampling intensity and the question of whether or not to stratify the country allowing for more intensive sampling intensity in regions of high biodiversity took up a large part of the second working session. The discussion lead to the establishment of a working group that convened on the 08.08.2003, 2 days after the workshop to sum up the points brought forward under the various topics during the workshop, to arrive at a model for the standardized harmonized vegetation classification system and to reach a decision on the issue of stratification

7.1.3 Standardized and harmonized vegetation classification system{ TC "7.1.3 Standardized and harmonized vegetation classification system" \f C \l "3" }

A Land Classification Chart where the vegetation type is classified according to its structure in terms of crown cover percentage of the tree, shrub and grass layer was proposed by the FORM technical backstopping officer.

The initial proposal was adopted with the following amendments to suit the national purposes, i.e.:

- inclusion of riparian forest and other forest areas between 0,5 ha and 0,2 ha (minimal FRA area and minimal mapping area according to LCLU project respectively),
- a breakdown of the pine area into *Pinus pinea* and other pines,
- omission of pastures as a class under agricultural land

.

The initial proposal was subsequently refined further by FORM and the IC to arrive at the Land Classification Chart presented on the following page which was subsequently used in the field manual.

80. Land Use / Forest Type Classification Lebanon alphanumeric code describing the land use/forest type in the LUS				Trees			Shrubs		Grass	Code
				>10 %	5 - 10 %	<5 %	>10 %	<10 %	>10 %	
Forest	Coniferous	Pines	Pinus Pinea	**X**						**FCPP**
			Other Pines	**X**						**FCOP**
		Cedars		**X**						**FCCL**
		Juniper		**X**						**FCJ**
		Fir		**X**						**FCF**
		Cypressus		**X**						**FCCS**
		Mixed coniferous *		**X**						**FMC**
	Broadleaved	Evergreen		**X**						**FBE**
		Deciduous		**X**						**FBD**
		Mixed *		**X**						**FMB**
	Mixed *			**X**						**FMCB**
OWL	Coniferous Shrublands		With trees (crown cover 5-10%)		**X**		**X**			**SC1**
			without trees (crown cover < 5)			**X**	**X**			**SC2**
	Broadleaved Shrublands	Deciduous	With trees (crown cover 5-10)		**X**		**X**			**SBD1**
			Without trees (crown cover < 5%)			**X**	**X**			**SBD2**
		Evergreen	With trees (crown cover 5-10%)		**X**		**X**			**SBE1**
			Without trees (crown cover < 5%)			**X**	**X**			**SBE2**
		Mixed *	*With trees (crown cover 5-10%)*		**X**		**X**			**SMB1**
			Without trees (crown cover < 5%)			**X**	**X**			**SMB2**
	Mixed Shrublands		With trees (crown cover 5-10%)		**X**		**X**			**SMCB1**
			Without trees (crown cover < 5%)			**X**	**X**			**SMCB2**
	Grassland With trees				**X**			**X**	**X**	**GL1**
Other Land	Woodlots (0.2 -0.5 ha)	Riparian		**X**						**RIP**
		Others		**X**						**OTH**
	Grassland					**X**		**X**	**X**	**GL2**
	Cultivated Land	Annual crops								**CL1**
		Perennial crops**								**CL2**
	Artificial Area	Built-up								**BUP**
		Non-built up								**NBUP**
	Wetlands					**X**		**X**		**WETL**
	Barren Land					**X**		**X**		**BARL**
Inland Water										**WATE**

*** Mixed Forest:** Is a forest which contains at least 25 % of one component and 75% at most of the other component (Mixes can be between coniferous and Broadleaved, between Deciduous and Evergreen broadleaved, and between two species of coniferous)**.**

**** Perennial crops:** Areas of more than 0.5 ha and with a crown cover of more than 10 % containing olives, citrus trees or other fruit trees e.g. apples, almonds, pears and peaches are classified in the data analysis as the FRA 2005 subcategory Other Land With Trees.

7.1.4 Sampling design

{ TC "7.1.4 Sampling design" \f C \l "3" }

During the 08.08.2004 meeting of the working group it was agreed to establish a tract every 4 min x 4 min latitude and longitude i.e. a tract every 7.4 x 6.15 km throughout Lebanon, which is a sampling intensity of app. 0.04%. The working group arrived at the decision to adapt a sampling intensity of 4 x 4 minutes after analysing several different sampling intensities (2 x 2, 3 x 3, 4 x 4, 6 x 6 minutes and various stratified combinations of them). The analysis was done by producing a dot grid on a transparent A4 overhead sheet and placing the various dot grids over the map of vegetation levels of Lebanon (ABI SALEH, B., SAFI, S., 1999). Supported by the detailed knowledge of the vegetation of Lebanon possessed by the staff of MOA the various alternatives were evaluated with regards to how well they would capture the various types of Forest and TOF resources of Lebanon. The choice of 4 x 4 minutes seemed to be a good compromise between what was achievable within the time and resources available to the project and broad representation of the various vegetation types. It was also agreed to return to the question of whether to employ stratification in the future to allow for more intensive sampling in areas of high biodiversity after the results of the NFA had been processed and analysed.

For an overview of the sample grid please refer to the map of Climatic Indices for Lebanon overlaid with the sample grid contained in section 2.1.

7.1.5 Variables{ TC "7.1.5 Variables" \f C \l "3" }

Following the recommendations of the workshops the field manual, field forms and the database application were revised to versions applicable to Lebanese conditions allowing for:

- inclusion of the decided Land Classification system and the decided sampling intensity in the field manual.

- measuring all trees above 10 cm dbh in all land use sections throughout the plots (i.e. effectively eliminating the rectangular subplot). This simplified the fieldwork methodology and captured more trees.

- Measuring canopy coverage in all Land Use Sections (F5 section A - 92)

- filling out field form F5 section B for both forest and OWL to capture data on management and structure also in OWL.

- setting all commercial height to 0 meters by default as this parameter does not apply to the conditions in Lebanon. There is no forest industry. The observed silvicultural practices e.g. pruning of *Pinus pinea* or has been performed for increasing cone production not for reasons related to timber production. In the case of cutting for firewood the practice is one where major branches but not the entire tree is cut.

- Inclusion of occurrence and exploitation of some important NWFP in the measurements at circular subplot level (F4 Section B – 77c, 77d, 77e). These are *Ferula sp., Gundelia, Origanum, Rheum, Salvia sp., Thymus sp*.

- Inclusion of section for measuring coppice in (F4 section B – 78da, 78db, 78dc), allowing for registration of average stem height, stem diameter and number of stems per unit.

The measurements of biophysical variables and the interviews were conducted in accordance with the guidelines of the Field Manual.

The revised Field Manual and Field Forms for Lebanon are attached in Appendix 3.

7.2. Training{ TC "7.2 Training" \f C \l "2" }

As mentioned in chapter 3, Project Output number 2 states that the national team within the Forestry Department and the Regional Development Services should be adequately trained in forest inventory and assessments techniques and project management through on-the-job training, workshops and study tours.

The current section describes the various training aspects of TCP/LEB/2903.

7.2.1 Workshops{ TC "7.2.1 Workshops" \f C \l "3" }

The initial workshops held during the initial month of the project, in July and August 2003, provided the participants with an insight in how to establish a national forest assessment in accordance with FAO FRA guidelines, the design of the sample units and what data is collected through the base parameters of the FRA approach. The workshops also included a field trip with some measuring exercises.

7.2.2 Study Tour{ TC "7.2.2 Study Tour" \f C \l "3" }

As part of the training and capacity building of TCP/LEB/2903 three DRDNR officers visited NFA Guatemala during September 2003 to be trained in the fieldwork methodology and the data entry and processing[3].

The program for the training of the 3 DRDNR engineers in Guatemala 5-14.09.2003 was as follows:

05.09.2003	Arrival to Guatemala
08.09.2003	Introduction to Guatemalan Forestry Sector (Instituto Nacional de Bosques INAB) Presentation of NFI Guatemala (background and methods) - Visit to Forestry Information System of INAB - NFA Guatemala Organization
09-10.09.2003	Visit to Baja Verapaz to measure a tract (fieldwork)
11-12.09.2003	Workshop on database and data processing
13-14.09.2003	Return to Lebanon

[3] The three officers from DRDNR selected by the NPC for the study tour were Mr. Michel Bassil (NC-FI, DRDNR), Mr. Jean Estephan (Team Leader, Mt. Lebanon RDS) and Mr. Ghazi Kassar (Team Leader, North Lebanon RDS). The host in Guatemala was Ms. Carla Ramirez of NFA Guatemala.

7.2.3 Training of Engineers and Team Leaders{ TC "7.2.3 Training of Engineers and Team Leaders" \f C \l "3" }

The training of the engineers was done in the period 13th -16th October 2003 with Mr. Michel Bassil NC-FI as the main organizer assisted by Mr. Jean Estephan (Team Leader Mt. Lebanon) and Ghazi Kassar (Team Leader North Lebanon). These three key persons recently returned from the above mentioned study tour to NFA Guatemala and were thus able to share their experiences with the rest of the DRDNR engineers. Ms Zeina Tamim was essential in organizing the practical aspects. The training sessions were based at MOA Oceanographic Institute in Batroun.

The engineers and team leaders were trained in the various measurements, GPS navigation, correct use of measurement equipment and the filling out of the field forms in accordance with the revised Field Manual for Lebanon attached as appendix 3. The administrative distribution of the DRDNR engineers trained in FAO support to NFA & fieldwork methodology is indicated below:

Region	**Numbers of DRDNR engineers trained in**
Beqaa	2
North Lebanon	3
Mt. Lebanon	1
South Lebanon	1
Central FD	3
Total	**10**

The TCDC expert and the NC-FI also facilitated training sessions in data entry for the individual team leaders during May / June 2004 when the final version of the database application was ready and the PCs for decentralised data entry set up at the offices of the team leaders.

7.2.4 Training of Field Teams{ TC "7.2.4 Training of Field Teams" \f C \l "3" }

The training of the forest guards was done during the period 20th -24th October 2003 with Mr. Michel Bassil NC-FI as the main organizer assisted by the other participants of the Guatemala field trip Mr. Jean Estephan (Team Leader Mt. Lebanon) and Ghazi Kassar (Team Leader North Lebanon). The training sessions of the field teams were performed on continuation of the training sessions for the engineers at MOA Oceanographic Institute in Batroun and focussed on training the field crews in the various measurements, GPS navigation, and correct use of measurement equipment in accordance with the Field Manual attached as appendix 3. The administrative distribution of the DRDNR forest guards trained in fieldwork methodology

Region	**Number of forest guards trained in fieldwork methodology**
Beqaa	17
North	13
Mt. Lebanon	13
South	14
Total	**57**

According to the project document, the formal training of the engineers and forest guards should have been the responsibility of the TCDC expert. As mentioned in section 6.1, due to an unforeseen delay in fielding the TCDC expert, the training sessions were not held with the TCDC expert as the main organizer. When the TCDC expert was fielded in March 2004 he was instrumental, in cooperation with the NC-FI, to ensure constant training and supervision of the field teams in order to ensure homogenous and accurate field work and measurements by the field teams and in double checking the submitted field reports. The TCDC expert had a great practical experience in undertaking NFA according to the FAO guidelines from the Philippines which was transferred to the field teams through continual on the job training.

7.3. Production of a derived map of forest and TOF resources of Lebanon{ TC "7.3 Production of a derived map of forest and TOF resources of Lebanon" \f C \l "2" }

According to output 3 of the Project Document, a forest and tree cover map produced at appropriate scale on the basis of harmonised and standardised vegetation classification system according to national and international requirements must be produced as part of the training programme. The satellite Landsat TM data available with the UTF/LEB/016 within the Ministry of Agriculture will be used.

The current section describes the aspects of producing the above mentioned map within the framework of TCP/LEB/2903.

7.3.1 Methodology for mapping{ TC "7.3.1 Methodology for mapping" \f C \l "3" }

As mentioned in Chapter 2 the thresholds for crown cover and height of the woody vegetation differ between the classification system employed by the LCLU project and the classification system employed by FRA. An automatic transformation of the polygons from LCLU classes to the classification system employed by TCP/LEB/2903 was therefore not possible.

The mapping units of the LULC map are very accurate and employ a minimum size of 2000 m^2 and therefore the LCLU map is a highly useful base material for the delineation of the forest and TOF resources of Lebanon.

There are a large number of LCLU polygons where the translation from LCLU classification to the standardized vegetation classification system of TCP/LEB/2903 is evident and where they can be adopted directly from the LCLU map into one distinct TCP/LEB/2903 class. This is e.g. the case for the Non-Forest and Non-OWL areas such as agricultural areas, urban areas, inland water etc. For the translation of Non-Forest and Non-OWL please refer to appendix 8.

For the remainder of the LCLU polygons, that all lie in the global classes Forest and OWL, the existing satellite images were reinterpreted and classified according to the standardized vegetation classification system of TCP/LEB/2903 (Appendix 1). The reinterpretation of the satellite images was undertaken by the joint National Consultancy of Mr. Dany Lichaa who did the LCLU mapping to ensure consistency in the mapping supported by Mr. Salim Roukoz of DRDNR. The map production therefore implied a substantial capacity building component for the DRDNR.

The reinterpretation / redelineation was supported by auxiliary data in the form of:

- the scanned and georeferenced 1:50.000 forest map from 1965,
- climatic indices
- information on vegetation types and bioclimatic zones, data on altitude and precipitation.
- geological map of Lebanon
- recent road maps
- Landsat 7 image from 2003 – resolution 15 m
- georeferenced field information from the app. 220 tracts located systematically every 4 minutes longitude and latitude across Lebanon
- Extensive ground validation of polygons of the draft map

7.3.2 Output of Mapping{ TC "7.3.2 Output of Mapping" \f C \l "3" }

8. Fieldwork and coordination{ TC "8. Fieldwork and coordination" \f C \l "1" }

As mentioned in Chapter 6 TCP/LEB/2903 is characterized by 3 well defined phases:

Phase I July 2003-November 2003: Preparation, Training and Mapping;
Phase II November 2003-July 2004: Field Survey;
Phase III July 2004-December 2004: Data Processing and Reporting.

The current chapter describes the activities of phase II of the project. In accordance with the Project Document phase II includes the establishment of the permanent sample plots, measurements, observations, interviews and data entry in accordance with the revised Field Manual.

8.1. Distribution of tracts to Mohafazas.{ TC "8.1 Distribution of tracts to Mohafazas." \f C \l "2" }

The National Forest and Tree Assessment in Lebanon project (TCP/LEB/2903) was based on systematic field sampling grid with one tract located every 4 x 4 minutes longitude and latitude. This stratification resulted in 222 potential tracts fall inside the national land-territory of Lebanon after applying the coordinates to the accurately geo-referenced maps available to DRDNR. The original coordinates provided by FAO/FORM was based on very rough delineations and therefore included 226 tracts as the first estimate. Tract coordinates are indicated in Appendix 12.

After having received the maps of mines and unexploded ordnance from the Demining Office of the Ministry of Defence 8 tracts could be excluded as they were mined otherwise inaccessible. Furthermore in a number of tracts only some of the plots could be measured due to mines and unexploded ordnance.

The distribution of tracts to the individual Field Teams is indicated in the table below and in the map of Lebanon in figure 4 on the following page.

Region	Total Number of Tracts	Inaccessible tracts	Number of tracts for field survey
Mt Lebanon	43	0	43
South Lebanon	44	7	37
South Beqaa	46	0	46
North Beqaa	46	0	46
North Lebanon	43	1	42
Total	**222**	**8**	**214**

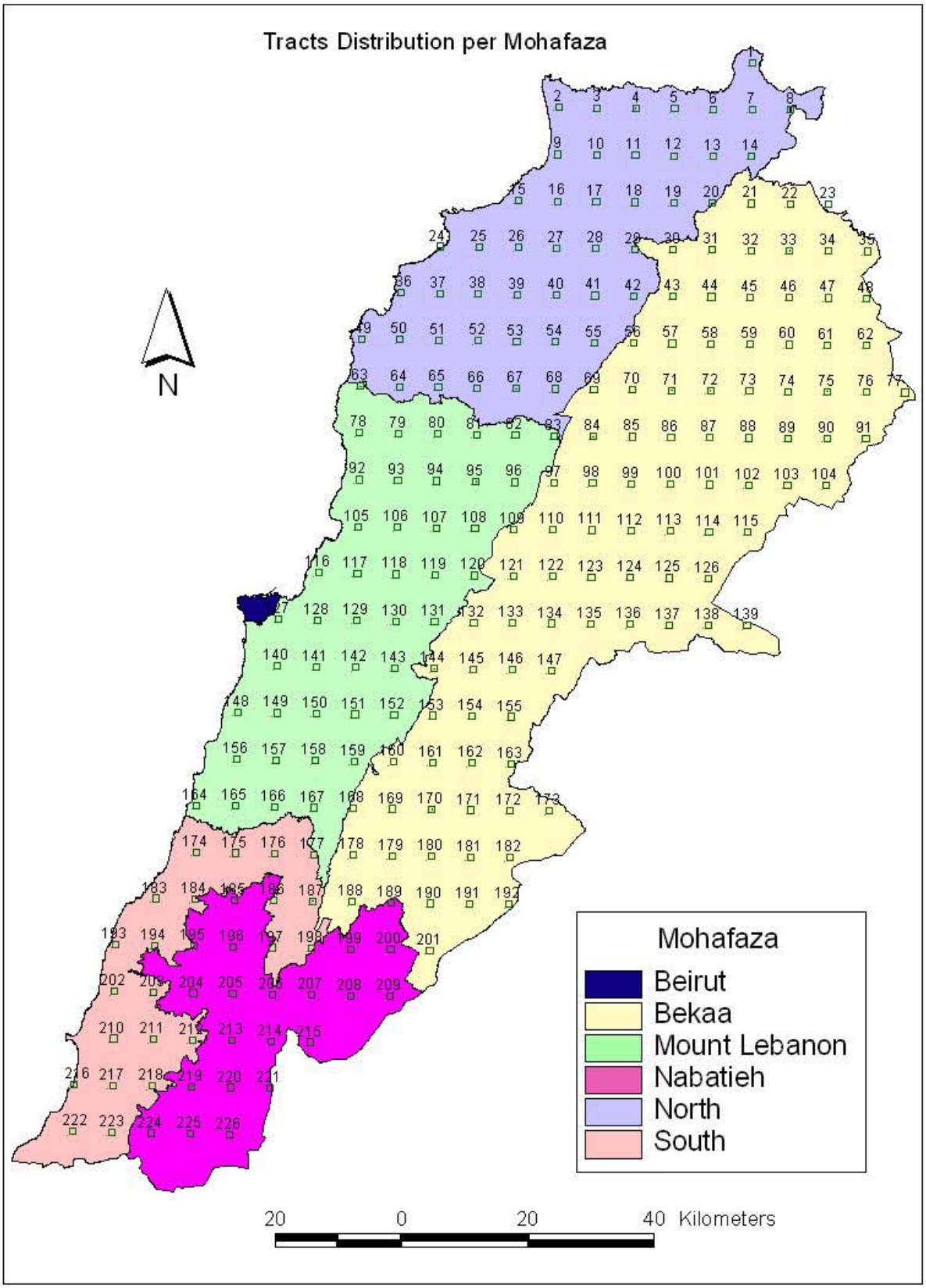


Figure 4: Distribution of Tracts to Mohafazas

8.2. Fieldwork timing and supervision{ TC "8.2 Fieldwork timing and supervision" \f C \l "2" }.

Fieldwork started late 2003 after the team leaders and crews had received training in the methodology. The field teams finished the work by mid September 2004. This was 2 months later than anticipated in the Project Document.

The reasons why the 2nd project phase took 9 months rather than 7, as prescribed by the Project Document, are the following:

- the TCDC expert was not fielded before March 2004, for various reasons (e.g. climate and unavailability of the first candidate);
- there was a delay in obtaining the final version of the database from FORM;
- the PCs for decentralized data-entry were installed at the RDS during the summer of 2004;
- the Team Leaders had other duties for MOA during the fieldwork phase and;
- the start of the fieldwork phase fell during the winter season.

Throughout the fieldwork phase, the NC-FI was active in supervising the work and providing guidance on the technical issues related to the measurements, navigation and registration of the data, to ensure homogeneity and high quality in the fieldwork. This function was supported by the TCDC-expert during his fielding March – July 2004. TCP/LEB/2903 did not operate with a control team – instead the continual supervision by the NC-FI and the TCDC expert functioned to ensure quality and homogeneity in the data capture.

The Team Leaders were responsible for all aspects related to the practical field measurements (logistics, quality, safety etc.) as well as for the correct registration of results and the subsequent data entry.

After completing the field forms in a tract, the team leaders were responsible for submitting the filled out field forms to the NC-FI/TCDC expert for review. The NC-ID and the TCDC expert both had to clear the field forms before they could be entered into the database by the team leader in the RDS. In case the field forms were not satisfactorily filled out and the NC-FI/TCDC expert did not clear the forms for data entry, the field forms would be returned to the team leader with instructions on which data did not fulfil the requirements and instructions on how to amend it.

When the field forms for a tract were cleared for entering into the database, they would be returned to the Team Leader for entry into the database. In this manner data entry was decentralized and physically undertaken in the RDS by the responsible Team Leader.

Due to the late establishment of functional facilities for decentralized data entry, the data entry did not start up before mid 2004. The entry of data was therefore the bottleneck for the 2nd project phase. It was therefore necessary to recruit additional assistance to assist in the final phases of data entry.

In accordance with the recommendations of the NC-FI and the TCDC-expert the team leaders were requested at regular intervals to submit progress reports containing a status for the field work and the data entry in the respective Mohafazas as well as a workplan for the remainder of the field work

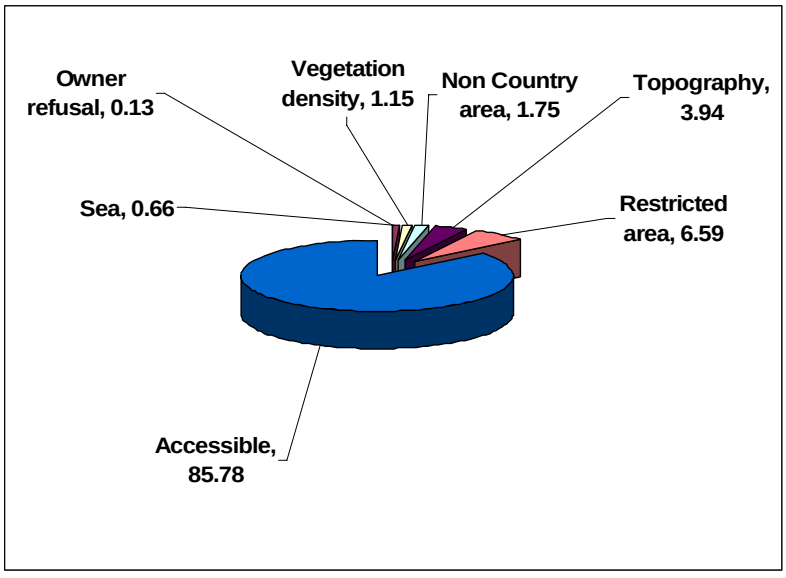
phase. This would facilitate keeping track of the fieldwork progress in order to allow for timely identification of areas in need of consolidation. Formal progress reports were only submitted for Mt. Lebanon Mohafaza (Appendix 4b). The rest were provided verbally and included in the overall progress reports for the compiled by the NC-FI and NC ID (Appendix 4a).

The establishment of forest and tree information system needs good quality of data, so supervision and control was a must followed by a long process of verification and rectification of data. During all the fieldwork period, the NC Forest Inventory and the TCDC were continually supervising the field teams through on-the-job training, by actively participating in the fieldwork, in order to ensure correct data capture and methodology. As soon as the data collection was completed, the team leader submitted the reports to the TCDC expert and NCFI for revision. This reviewing played an important role in ensuring that the field forms were filled out in a technical and correct manner. They were returned back to the team leaders with comments or requests for additional or correction data of encoding.

When the correction was done by the team leader and the report was submitted a second time to the TCDC expert and the NCFI for the clearance, it was ready for encoding by the team leader. Some tracts were visited again with the team leaders along with NFCI in order to clarify ambiguities.

In addition, the fieldwork did not take place on the entire surface of Lebanon due to several reasons.

Some tracts or plots were sometimes inaccessible due to the density and the type of vegetation. The presence of thorn and dense vegetation made 1.15% of the area inaccessible. This area is distributed between five complete plots (0.55%) and twelve incomplete plots (0.60 %).



The topographic conditions, especially the existence of steep slope, were also another constraint to collect data in some tracts. It was dangerous for the crew to collect data on 3.94% of the total area distributed on 28 tracts.

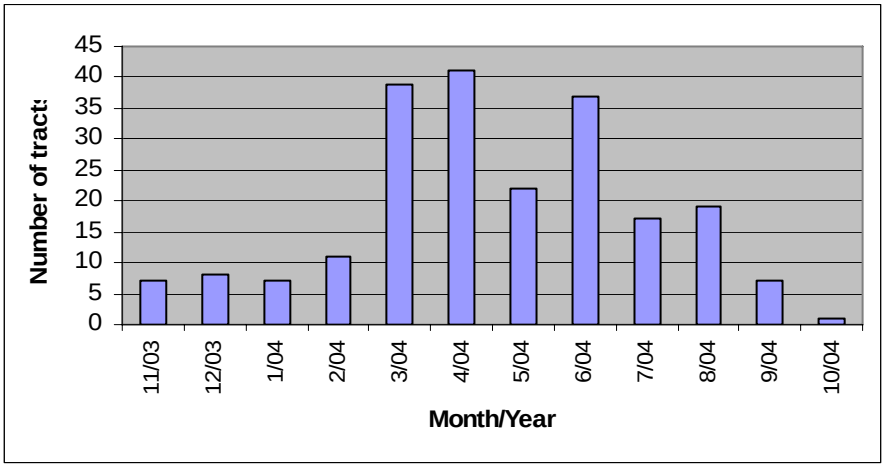
Another significant difficulty to collect data was the restricted area; it was due to either mines or military restriction. Most of this area was located in the South Lebanon region. It consisted of 6.58% of the total area distributed between 5.3% in 12 complete tracts and 1.28% in eight tracts.

The less important cause of inaccessibility to the tracts was the land ownership. The owner was either absent or rejectful. The refusal affected 0.13% (0.59 ha) of the total area of work distributed in three tracts (Table 2).

Finally, data on trees (diameter, height…) was collected in 387.71 ha out of 452 ha, this represents 85.78% of the total area.

8.2.1 Fieldwork Timing

The fieldwork was planned to finish during seven month. But, the climatic conditions and winter short days extended the duration. In addition, the administrative tasks of the team leaders took more time than it was expected. So the field work lasted one year distributed as follows:



This chart shows that data was collected in seventy per cent of the tracts during four months. One tract only was done in the first week of October 2004.

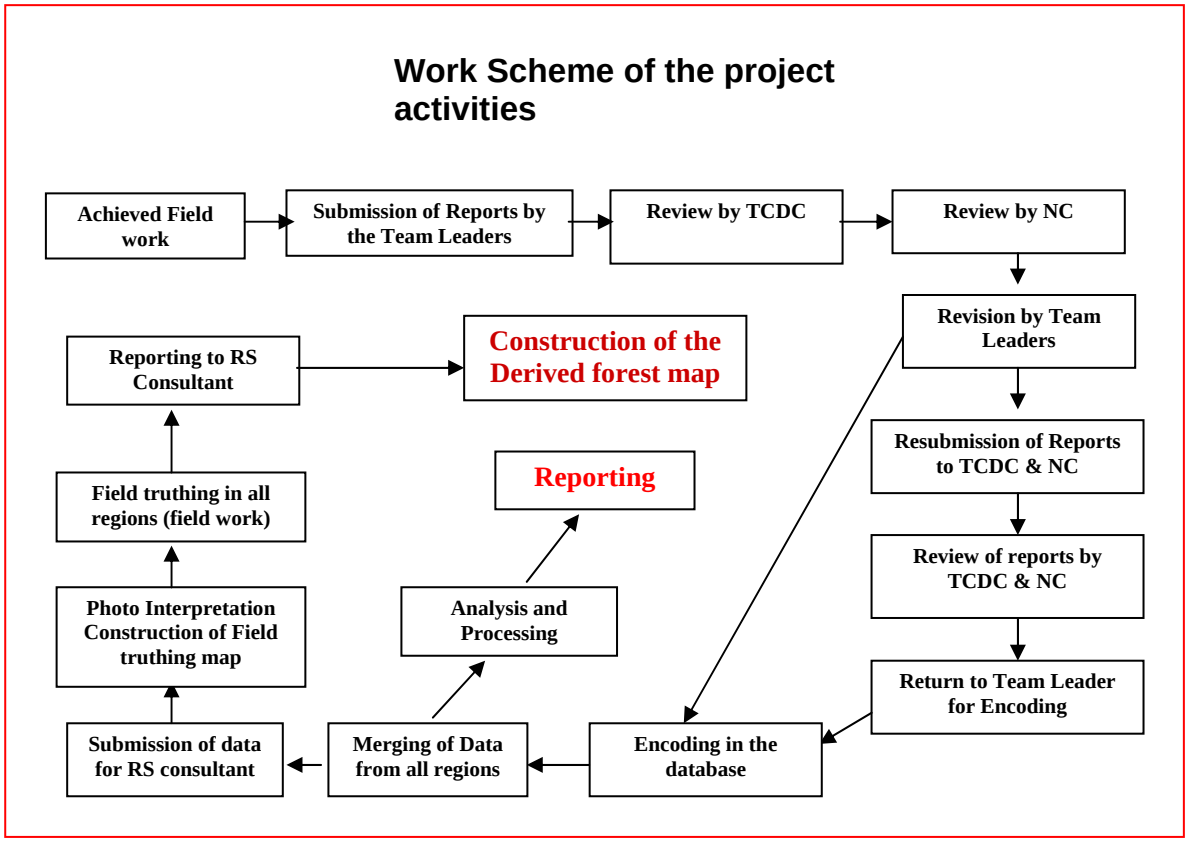
8.3. Field work experiences{ TC "8.3 Field work experiences" \f C \l "2" }

The TCP/LEB/2903 (T) National Forest and Tree Inventory and Assessment was the first technical project based on field measurement and permanent systematic sampling in Lebanon. It gave the opportunity for the Rural Development and Natural Resources Directorate staff to evaluate the Lebanese resources and to have accurate information on forest cover and resources.
On the other hand, the staff of the directorate got good view of the forest in Lebanon.
Five crews were responsible on the data collection. Each crew was composed of one team leader and three members.

Although they had almost all equipment needed, they faced some difficulties such as the identification of the deciduous trees during winter, determination of LUS and tree canopy coverage in mixed vegetation, in fragmented areas and when tree cover is low, or when trees are cut.

8.4. Coordination of activities{ TC "8.4 Coordination of activities" \f C \l "2" }

During the field work phase Progress Reports for the project activities were prepared be the NC-FI and NC-ID (contained in Appendix 4a). The Team Leaders were supposed to submit formal progress but with the exception of Mt. Lebanon they were delivered verbally. The progress report for Mt. Lebanon is contained in Appendix 4b.



The fieldings of the IC and the TCDC-expert were located at strategic periods during the projects lifespan. The actual timing of the consultancies differed slightly from the workplan of the initial Project Document as the workplan was adjusted a couple of times as the project progressed. For the debriefings of the various fieldings please refer to appendix 4c and 4d.

When the field work was executed and the reports submitted, the data entry started. The data entry was planned to be decentralized. That means the team leaders were responsible for the data entry for their respective Regions.

Before the data entry started, individual hands-on training sessions in data entry was held with each Team Leader to ensure high quality and full consistency in the work in all regions.

As planned, the team leader of the Beqaa North and Mount Lebanon had encoded the data they collected. The remaining team leaders could not encode collected data either due to the delay of the fieldwork or to their occupation by other official tasks. So, the NC forest inventory has called for two persons for two weeks to encode the rest of data. In this case, these two persons have followed hands on training on data entry. They encoded the remaining data in the main office of the ministry. Even though the NC was supervising the data entry, the encoders had committed some mistakes such as, incorrect reading of numbers, letters or scientific names…

Following the data entry, data processing took place, and then data went into two directions, the first for analysis and reporting and the second for mapping use and the production of derived forest map.

9. Database design, data-entry, processing and analysis{ TC "9. Database design, dataentry, processing and analysis" \f C \l "1" }.

According to Output 5 of the Project Document a data base based on the pilot assessment on the forestry resources must be established and the results disseminated to users.

The current Chapter Describes all aspects related to database design, data entry, data processing and data analysis.

As mentioned earlier TCP/LEB/2903 is characterized by 3 well defined phases. Designing the database took place during the first and the second project phase while data processing and data analysis occurred during the second project phase:

9.1. Database Design and Structure{ TC "9.1 Database Design and data structure" \f C \l "2" }

To store and manage the collected NFA data a database application was developed by FAO/FRA in collabouration with the country national team. The database application, based on the MS Access software (2000/2002), comprises two database files; one "data" database (NFI-data_<*COUNTRY*>.mdb) and one "application" database (NFI-<*COUNTRY*> v.*x.x*.mdb). All collected field data (dynamic data) are stored in inter-related tables in the "data" database, while the "application" database contains code tables (static data), forms and queries and macros. The users of the NFA database manage the data through the application database. To open the database application the users double-click on the *NFI-<COUNTRY> v.x.x.mdb* file. The data are managed through forms and the user navigates in the database by selecting different forms according to required operation.

The efforts in developing the NFA database application have initially been focused on wise data storage and on facilitating the input of primary data, why until now the only activated section in the database application is the section on "*Field Data*".

The design of the forms for adding/editing field data in the database application follows the same as the field forms employed for the data collection in the field inventory. The idea with this coherence is to facilitate the entering of field data into the database application since the instructions on how to register field data are given in the field manual (refer to Appendix 3).

9.1.1 Tables

All data in the NFA is stored in tables. All tables with collected inventory data (primary data) is kept in the "data" database (NFI-data_<*COUNTRY*>.mdb), while all static data like codes, expansion factors, etc. are kept in the "application" database (NFI-<*COUNTRY*> v.*x.x*.mdb) (refer to Figure 5).

2.1.1.1 Code tables

For each variable with attribute options there is a corresponding code table with defined options. The names of code tables all begin with "C-" and they contain internationally harmonized terminology and nationally adapted options to the variables, where every option has a unique code.

2.1.1.2 Data tables

For each level of data collection there is a corresponding data table with defined variables. The variables are internationally harmonized and nationally adapted terminology, and may have unbound values or may be bound to predefined attribute options according to code tables. The names of data tables begin with "F-", "P-", "Ph-" or "H-"(refer to Figure 6). The *F-tables* contain the values of all the variables that are collected at corresponding inventory level; Tract data is stored in the *F1-Tract* table, Plot data is stored in the *F1-Plot*, LUS data is stored in the *F5-LUS* table, etc. The *P-table* contains data on informants or other persons involved in the inventory, the *Ph-table* contains data on photos taken during the NFA, and the *H-tables* are help-tables that relate the data from two data tables to each other, for example the *H-Person-Function-Tract* relates the information of persons to tracts and indicates what function the person had in that tract.

2.1.1.3 Relation database

The NFA database application is developed in MS Access, which is a relation database. A relation database allows that data can be collected at different inventory levels (Tract, Plot, LUS, Tree, etc.) and still relate to each other. In practice this is accomplished by creating separate data tables for each inventory level. To relate (link) the data in on table to another the tables must have at least one common field. In this way the tract attributes can be related to the attributes in all plots in the tract through the "ID-TRACT" field, and the Plot attributes can be related to the attributes in all LUS in the plot through the "ID-PLOT" field, and the LUS attributes can be related to all product/service attributes in the LUS through the ID-LUS field and further to the attributes of all trees through the two common fields ID-PLOT and ID-LUS, etc (see Figure 4).

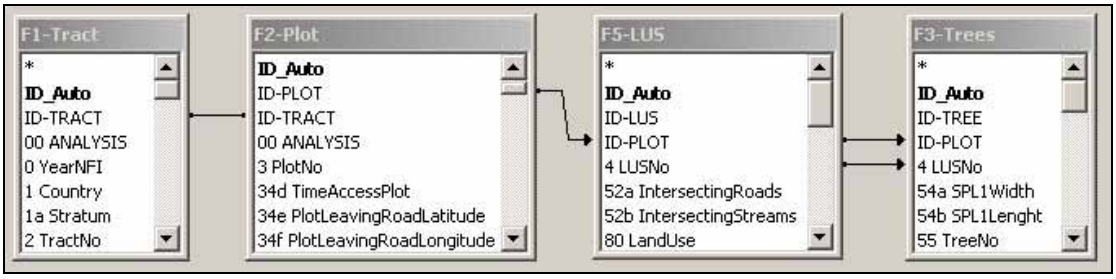


Figure 4: Illustration of the relationship between different data tables

Tables can be linked to each other even though they are not physically in the same database file. A fixed location of the database files is necessary as the database application has linked to the dynamic tables in the "data" database and therefore need to know where the "data" database is located. The NFA database application consists of the two database files "*NFI-data_<COUNTRY>.mdb*" and "*NFI-<COUNTRY> v.x.x.mdb*" and the location of the "data" database is set to the C:\NFA\ folder (see Figure 5).

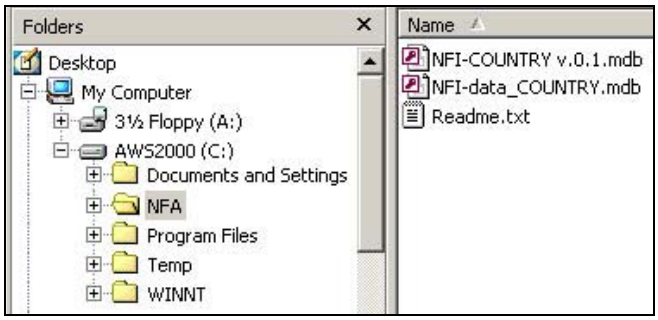


Figure 5: Location of database files

In Figure 6 the database window from the application database (*NFI-<COUNTRY> v.x.x.mdb*) is displaying some of the tables in the database application. The tables displayed with only a table symbol next to the table name are tables stored in the same application database, while the tables with an arrow symbol next to the table symbol are the tables with dynamic data (primary field data) and they are linked from the data database (*NFI-data_<COUNTRY>.mdb*).

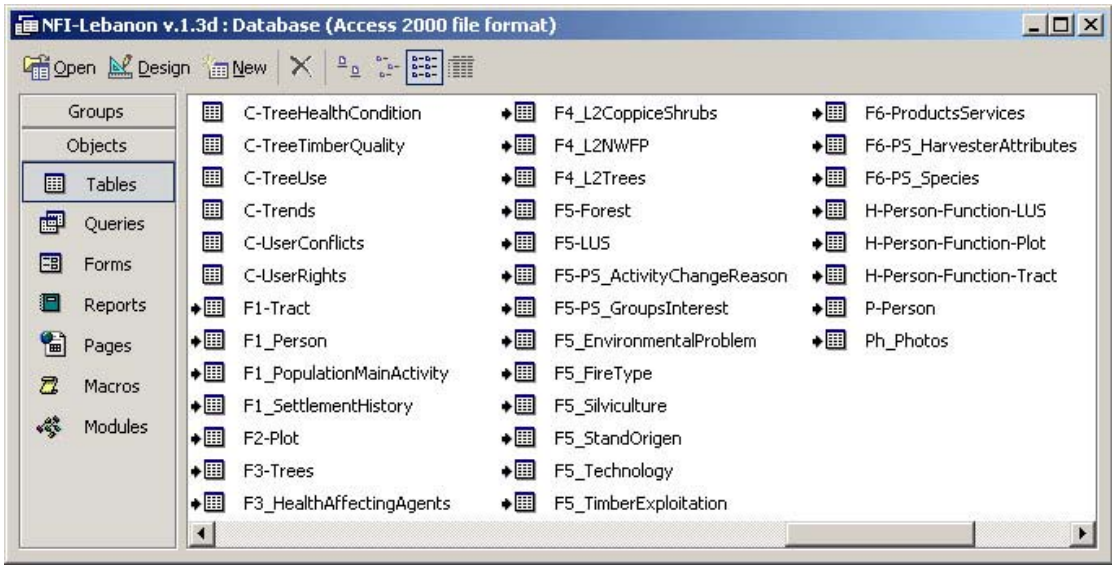


Figure 6: Database window in the NFA application database ("*NFI-<COUNTRY> v.x.x.mdb*") showing some of the code tables in the database (beginning with "C-") and some of the linked data tables (with an arrow symbol next to the table symbol).

The purpose of separating the dynamic field data from the rest of the database application is to allow users to work with the database application from different computers in a network and only have one main database with the inventory data. The NFA application database can be installed on computers in the network and they are all related to one database where the inventory data are stored. In this way only one version of the inventory data exist. Another benefit with separating the dynamic data from the rest of the database is to allow a smoother actualisation of the features in the database application without altering the primary data. A database specialist can in this way develop new versions of the NFA database application, with improved functionality, while other users continue to enter/edit data through an older version of the database application. When the new version of the application database ("*NFI-<COUNTRY> v.x.x.mdb*") is ready it will substitute the

older version, but the primary data remains unaltered in the data database (*NFI-data_<COUNTRY>.mdb*).

9.2. Forms

The users of the NFA database manage the data through forms. There is a form corresponding to every field form for field data collection, and further sub-forms within these forms (see Figure 7). The users add and edit the NFA field data through these forms. A validation of the field data built-in in the forms. Criteria for acceptable values and reasonable values are defined for most of the variables, so when the users enter the field data through the forms they automatically go through a general validation. For more information on the forms and on how to navigate in the NFA database application please refer to Appendix 13.

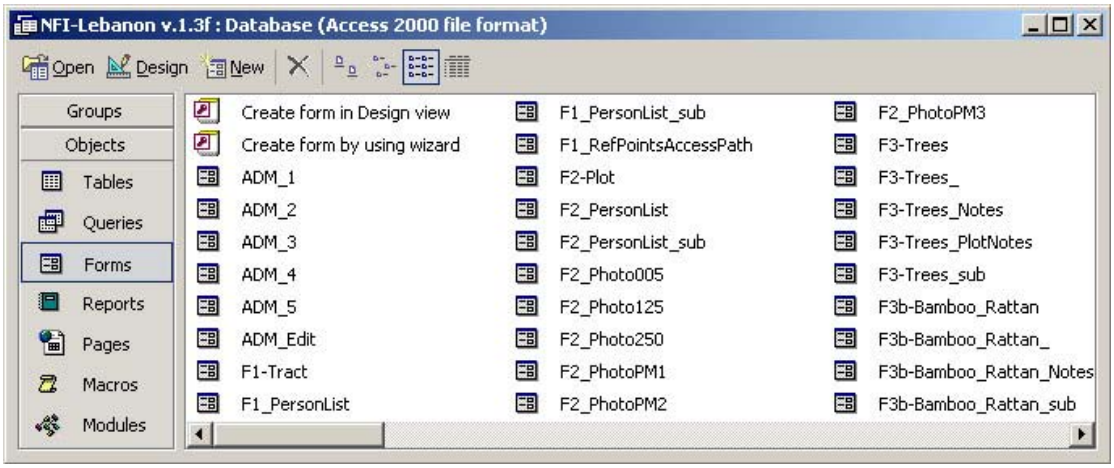


Figure 7: Database window in the NFA application database ("*NFI-<COUNTRY> v.x.x.mdb*") showing some of the forms that are employed in the database application.

9.3. Queries

Queries can be used for processing and analysing data that are stored in tables. However it is not recommended to process or analyse the NFA data in any of the two database application files, *NFI-data_<COUNTRY>.mdb* and *NFI-<COUNTRY> v.x.x.mdb*, as it would cause the application to become very "heavy". Instead the data processing and analysis should be carried out in a separate database that is linked to the two database application files.

In the NFA database application the Queries are only employed to filter the data in Tables or in other Queries. The information displayed through forms is filtered through Queries or through Tables with applied filters. For each form there can be one or more Queries employed depending on the structure and functionality of the form. For example the data source for every sub-form in a form could be based on a separate Query. Some of the Queries that are used as data sources for the forms in the NFA database application are displayed in Figure 8.

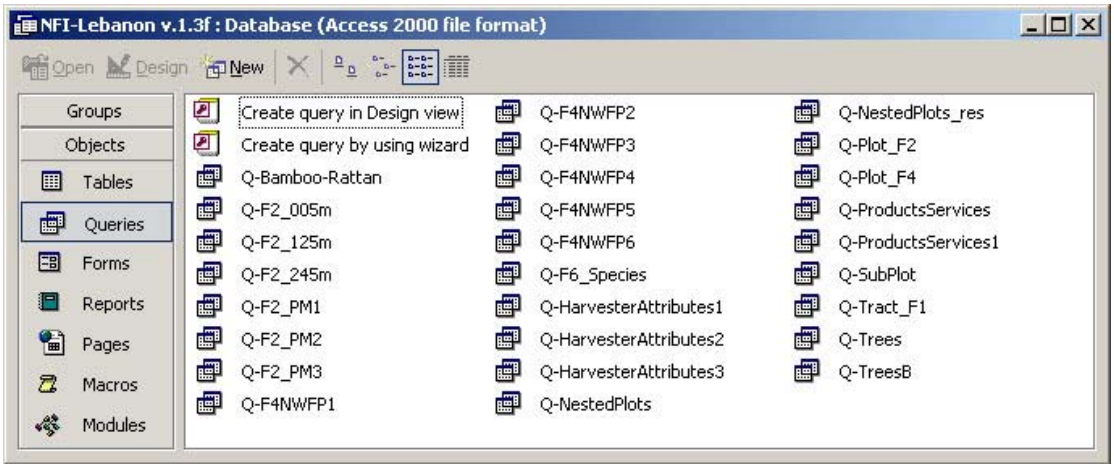


Figure 8: Database window in the NFA application database ("*NFI-<COUNTRY> v.x.x.mdb*") showing the queries in the database application.

9.2 Data entry{ TC "**9.2 Data entry**" \f C \l "2" **}**

As mentioned in section 8.2 the team leaders were responsible for submitting the filled out field forms to the NC-FI/TCDC expert for review. After both the NC-FI and the TCDC expert had cleared the submitted field forms for entry, the team leaders were responsible for the data entry on PCs that were installed at the RDS. The individual team leaders had received hands-on training in the respective RDS's by the NC-FI and the TCDC-expert to ensure that the data entry was performed correctly.

Due to the late establishment of functional facilities (PCs and database application) for decentralized data entry, the data entry did not start up before mid 2004. The entry of data was therefore the bottleneck for the 2nd project phase. It was therefore necessary to recruit additional assistance to assist in the final phases of data entry in order to have all field data entered by late September 2004.

After the team leaders had completed their data entry and submitted the files, the NC-FI double checked the database structures and data consistency before merging the secondary databases from the RDS's into the main database at MOA. The FAO backstopping officer had through his 2 week mission to Lebanon in September 2004 trained the NC-FI in performing these tasks

9.3 Data processing{ TC "**9.3 Data processing**" \f C \l "2" **}**

9.4. Data analysis{ TC "**9.4. Data analysis**" \f C \l "2" **}**

In addition to the TORs contained in the Project document and the data entry assistants mentioned in section 9.2, a specialist in data analysis and statistics was recruited during the third and final project phase to assist in data-processing and statistical analysis for a total of 3 months.

At the start of the third project phase, the recruitment of the specialist in data analysis and statistics was unanimously recommended by the NPC, the IC, the FAO technical backstopping officer and

FAO Lebanon to ensure high quality data processing and statistical analysis on the large quantity of detailed field data collected during the field work phase. The specialist has through the data-processing and analysis work ensured that the staff of the DRDNR was adequately trained in data processing and statistical analysis so that the staff of the Directorate can perform the tasks related to data processing and analysis in future repetitions of the inventory. Thus the recruitment of the specialist has implied a substantial capacity building component for the DRDNR.

10. Results

10.1. Introduction

The aim of this report is to present the results obtained in the statistical data analysis of the Inventory National Resources in Lebanon. The analysis procedure starts by generating the tables of the collected data using different queries in MS ACCESS. These tables are obtained by classification procedures, based on the definition of each variable. The tables are then converted to Excel format which can be used by the SPSS software. SPSS (Statistical Package for the Social Sciences) is a data management and analysis product for statistical data analysis, including descriptive statistics such as plots, frequencies, charts, and lists, as well as sophisticated inferential and multivariate statistical procedures.
Once the tables are obtained in the SPSS software, the descriptive statistics and the estimation based on the Ratio analysis method are applied on all measured variables which depend on the size of the area over which it's measured. All functions used for this study are illustrated in the Appendix 10.

Some of the results analysis for the National Forest Assessment has been excluded from this study as they were not applicable to Lebanon. These analyses are:

- Area section
  - Proportions of forest area by management system
- Volume section
  - Commercial volume (mean per hectare and total) of each forest type
  - Commercial volume per major species (mean per hectare and total)
  - Commercial volume (mean per hectare and total) of trees outside forests
  - Commercial volume per major species (mean per hectare and total)
  - Commercial volume per ecological zone, forest management system
- Biodiversity section
  - Forest by fragmentation level

10.2. Land Use/Land Cover Classification System

Based on the FRA classification and the National Inventory Resources, the classification of the Land Use Area was carried out into three levels as shown in the following figure:

Level 1	Level 2	Level 3
Forest	**Coniferous**	Cedars
		Pinus pinea
		Other Pines
		Juniper
		Fir
		Cypressus
		Mixed Coniferous[2]
	Broadleaved	Deciduous
		Evergreen
		Mixed Broadleaved[3]
	Mixed[1]	
Other Wooded Land (OWL)	**Coniferous Shrublands**	
	Broadleaved Shrublands	
	Mixed Shrublands	
	Grassland with trees	
Other Land (OL)	**Woodlots**	
	Grassland	
	Cultivated Land	
	Artificial Area	
	Wetlands	
	Barren Land	
InLand Water		

Table 1: Land Use/Land Cover classification system

[1]Mixed forest: is a forest which contains at least 25% each of coniferous and broadleaved tree species

[2]Mixed coniferous forest: is a forest which contains at least 25% each of two or more coniferous tree species

[3]Mixed broadleaved forest: is a forest which contains at least 25% each of deciduous and evergreen tree species

10.3. Area by land use classes (Level 1)

The total information of the land use area classes are expected and estimated based on the total area of the national area country, which is equivalent to 1,045,200 hectares.

Country area of Lebanon 1,045,200 ha

For the analysis, the total area of the country was represented by 226 sample units but 4 of the sample units located outside the country and 11 units were not inventoried why they have been excluded from the analyses.

As shown in the table 1, we find that the forest, defined as a land area of at least 0.5 hectares with trees higher than 5 meters and a tree canopy cover at least 10 percent, the Other Wood Land class which is a land area not classified as “forest” of at least 0.5 hectares; with trees higher than 5 meters and a canopy cover of 5-10 percent, the Other Land class is all land not classified as the two above classes, the Inland water class which includes rivers, lakes and water reservoirs.
The estimation of the land use areas (level 1) is presented in table 2 and figure 1.

Land Use Area	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Forest	211	13.3	0.034	0.067	50.37	139,376
Other Wooded Land	211	10.4	0.028	0.055	52.88	108,378
Other Land	211	76.3	0.046	0.09	11.79	797,152
Inland Water	211	----	0.00051	0.001	357.14	294
Total area		**100**				**1,045,200**

Table2: Estimation of the land use area per hectares (Ha) of the different classes area

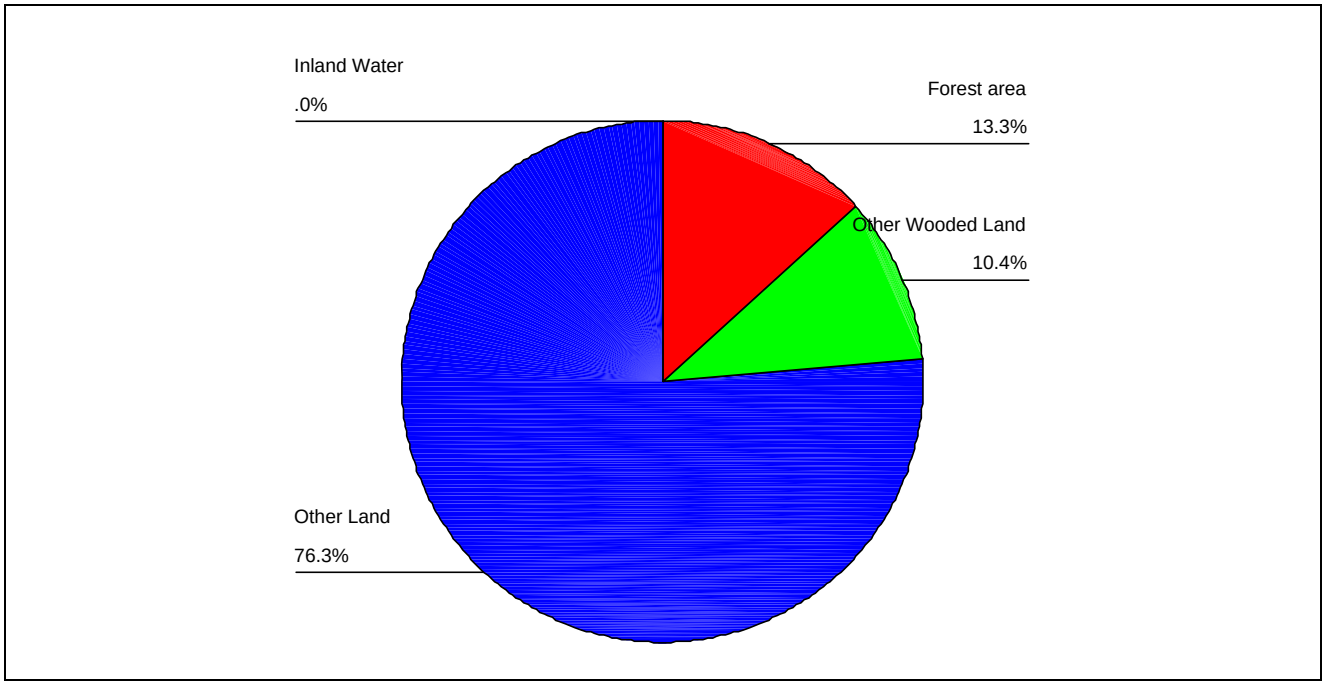


Figure 1: Distribution of county area by land use classes

The results show that the estimated area of the forest in Lebanon is about 13.3 % of the total area (or 139,376 hectares). The other wooded land covers about 10.4% (or 108,378 hectares) and a substantial part of the cover area 76.3% (or 797,152 hectares) belongs to the other land class. The Inland water is typically negligible comparing to the area of the other classes.

10.3.1 Forest area by forest type (Level 2)

The forest area in Lebanon, estimated to 13.3% of the total forest area (139,376 hectares), is divided into three sub-classes (level 2): Coniferous, Broadleaved and Mixed forest and is presented in table3 and figure 2.

Forest area of Lebanon 139,376 ha

Type	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Coniferous	68	32.2	0.1056	0.207	66.35	44,879
Broadleaved	68	56.6	0.1112	0.218	37.01	78,887
Mixed forest	68	11.2	0.112	0.057	113.13	15,610
Total area		**100**				**139,376**

Table 3: Forest area by forest type (level 2)

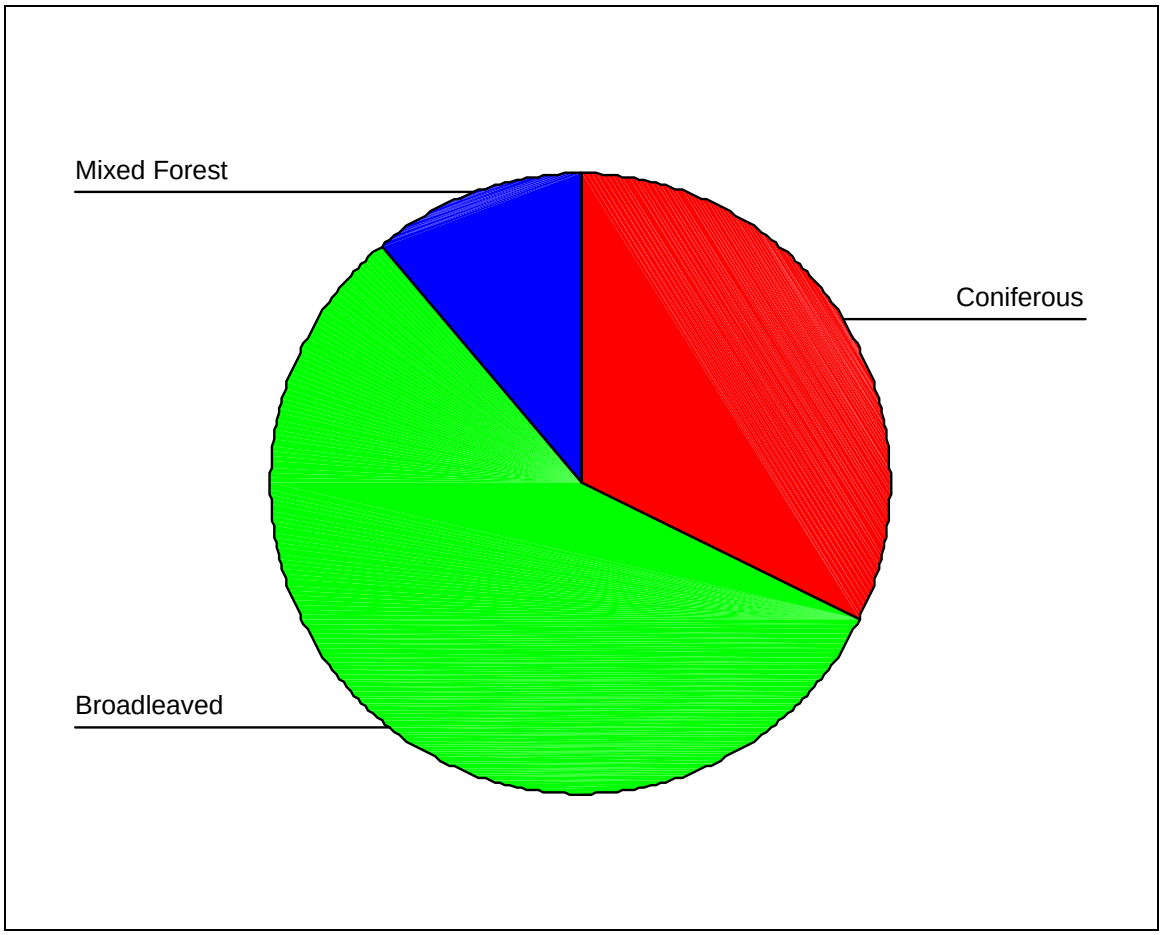


Figure 2: Forest area by forest type (level 2)

The results show that the forest area in Lebanon is dominated by the broadleaved forests representing 56.6% of the total forest area (78,887 hectares). The coniferous forests can be considered as the second important class for 32.2 % of the forest area (or 44,879 hectares). The Mixed Forest class, defined as a forest containing at least 25% each of coniferous trees and broadleaved trees, is about 11.2% (or 15,610 hectares) of the total forest area.

10.3.2 Forest area by Forest type (level 3)

2.1.1.4 Coniferous forest area

The coniferous forest subdivided into different forest type according to the tree species composition. Table 1 illustrates these types under level 3 sub-class. The total area of coniferous forests is estimated to 43,657 hectares.

Coniferous area of Lebanon	44,879 ha

The treatment of the collected data, gives the following estimation for each forest type (level 3) of the coniferous class:

OWL type	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Other pines	29	40.0	0.202	0.396	78.6	17,952
Juniper	29	23.4	0.17	0.335	150.9	10,502
Pinus pinea	29	17.7	0.11	0.216	229.7	7,943
Mixed Coniferous	29	11.6	0.09	0.183	215.3	5,206
Cedars	29	4.5	0.1336	0.262	194.1	2,019
Cypressus	29	2.8	0.078	0.154	342.2	1,257
Fir	29	0	0	0	0	0
Total		**100**				**44,879**

Table 4: Area estimations of the coniferous forest types

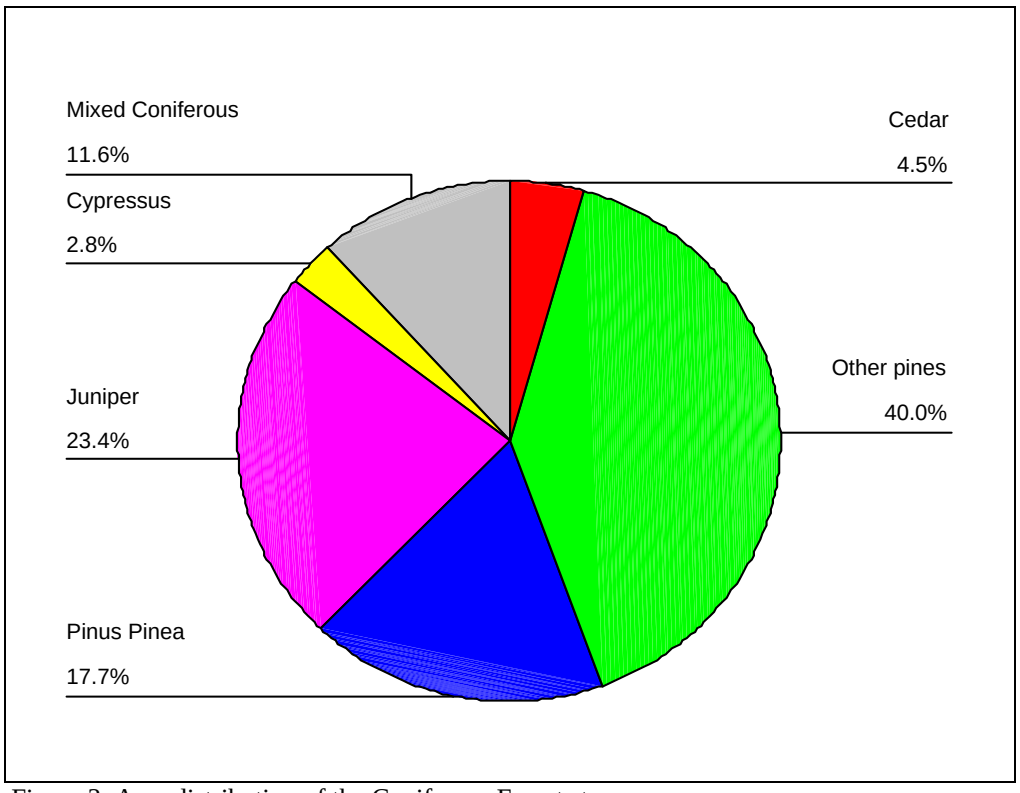


Figure 3: Area distribution of the Coniferous Forests types

As expected, the first observation is that the *other pine forest* defined by the National Inventory resources is by far the most important of the coniferous forests with 40% (or 17,952 hectares) of the total coniferous forest area. The rest of the coniferous forest is distributed into 23.4% (or 10,502 hectares) of *Juniper forest*, 17.7% (or 7,943 hectares) of *Pinus pinea forest*, 4.5% (or 2,019 hectares) of *Cedar forest*, and 2.8% (or 1,257 hectares) of *Cypressus forest* and 11.6% of *mixed coniferous forest* (or 5,206). The *fir forest* is not present in the inventory.

2.1.1.5 Broadleaved forest area

As defined in the table 1, the level 3 sub-classes of the Broadleaved forests area are composed by: Evergreen, Deciduous, and Mixed Broadleaved forest. The estimated area for the broadleaved forests is 78,840 hectares.

Broadleaved forests area of Lebanon	78,887 ha

The repartition of these classes is as follows:

Type	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Evergreen	48	41.8	0.142	0.279	68.2	32,975
Mixed Broadleaved	48	38.8	0.139	0.273	70.4	30,608
Deciduous	48	19.4	0.114	0.225	110.8	15,304
Total area		**100**				**78,887**

Table 5: Area estimations of the broadleaved forests types

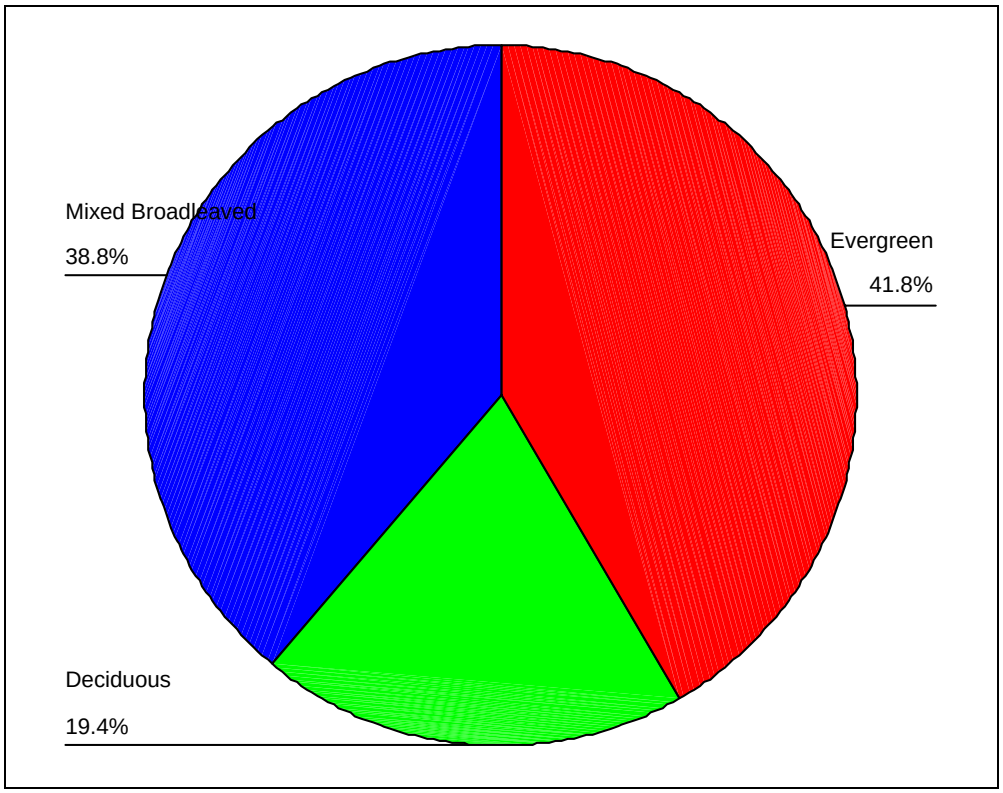


Figure 4: Area distribution of the Broadleaved forests types

The Pie chart of the Broadleaves classes shows that the repartitions are relatively homogeneous: it's 41.8% for the evergreen (or 32,975 hectares), 38.8% for the Mixed Broadleaves (or 30,608 hectares), and 19.4 % for the deciduous (or 15,304 hectares).

10.3.3 Other Wooded Land area by sub-class (Level 2)

The other wooded land (OWL) level 2 sub-classes are composed by: coniferous shrubs, broadleaved shrubs, mixed and grassland with trees (table 1). The estimated area of the OWL is about 108,378 hectares.

OWL area of Lebanon 108,378 ha

The estimation for each sub-class area is displayed in the following table and pie chart:

Type	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Broadleaved shrub	69	52.1	0.116	0.229		56,465
Grassland with trees	69	33.4	0.108	0.213	66.5	36,198
Mixed shrublands	69	13.3	0.087	0.172	97.7	14,414
Coniferous shrubs	69	1.2	0.04	0.082	282.7	1,301
Total		**100**				**108,378**

Table 6: Area estimations of other wooded land types (level 2)

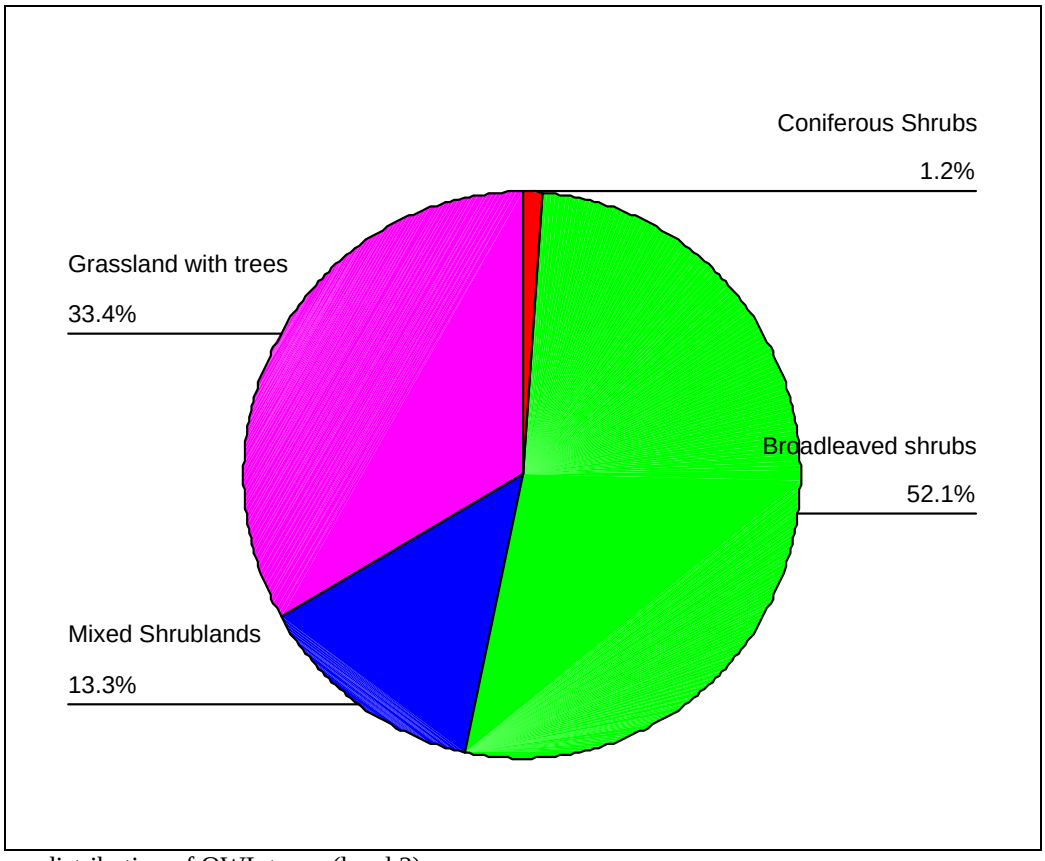


Figure 5: Area distribution of OWL types (level 2)

For the OWL area, a high proportion is related to the broadleaved shrubs sub-class with 52.1% (or 56,465 hectares), while the other proportions are: 33.4% (or 36,198 hectares) for the Grassland with trees sub-class, 13.3% (or 14,414 hectares) for the Mixed shrublands sub-class, and 1.2 % (or 1,301hectares) for the Coniferous shrubs.

10.3.4 Other Land use areas by sub-class (Level 2)

As indicated in table 1, the other land (OL) is composed by the level 2 sub-classes: Woodlots area, Grassland, Cultivated land area, Artificial area, Wetland and Barren land. The estimated area for the OL is 797,152 hectares.

OL area of Lebanon 797,152 ha

The following table and pie chart gives the estimation areas obtained for the OL sub-classes:

OL type	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Grassland	205	57.6	0.05	0.112	25.1	459,160
Cultivated land area	205	28.1	0.043	0.086	34.6	224,000
Artificial area	205	10.4	0.03	0.058	66.6	82,904
Barren land	205	3	0.024	0.048	129.7	23,914
Woodlots area	205	0.9	0.013	0.025	178.5	7,174
Wetland	205	0	0	0	0	0
Total		**100**				**797,152**

Table 7: Area estimations of Other Land types (level 2)

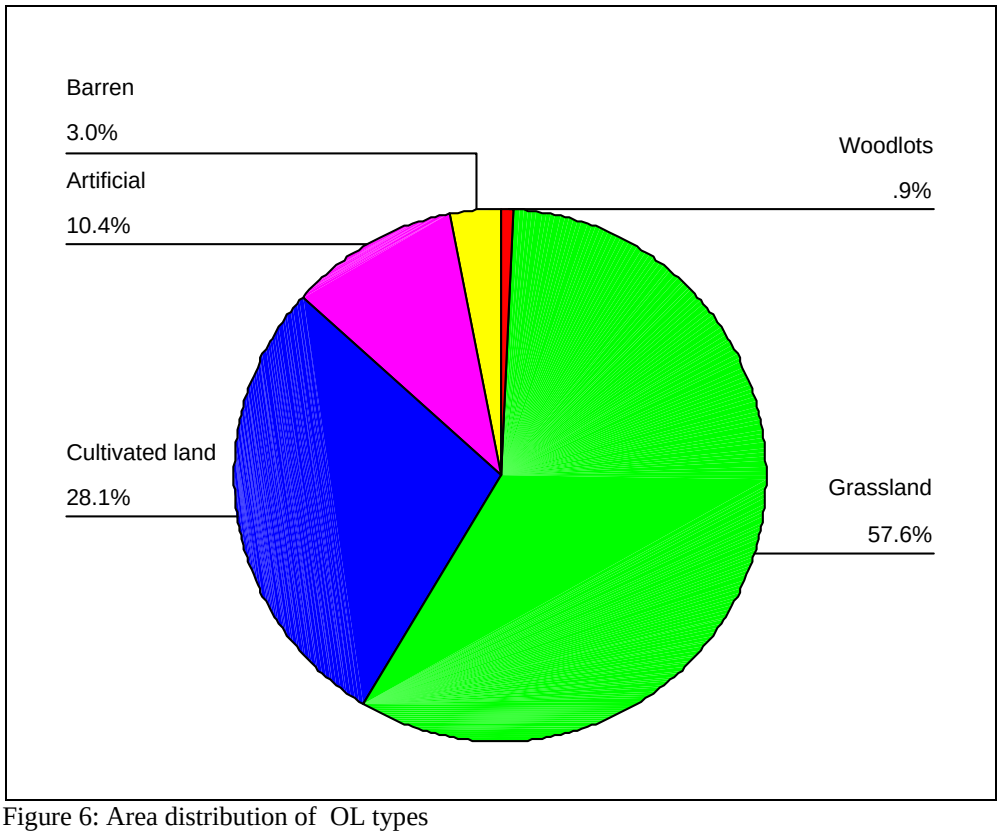


Figure 6: Area distribution of OL types

10.4. Areas by Ecological zone

Based on the FRA 2000 ecological zones map, the Global Ecological Zones (GEZ) in Lebanon were determined. The GEZ classes in Lebanon are composed by: ***Subtropical dry zones*** pronounced by a dry climate in the summer and includes zones with a Mediterranean climate, ***subtropical steppe zones*** with a long dry hot season of 6 to 8 months with a mean temperature of the coldest month always more than 7 degrees, and ***subtropical mountain system*** dominates the west chain mountain where the altitude reaches more than 1500 m.

10.4.1 Forest area by ecological zone

The three classes of the GEZ are considered to analyze the ecological zone of the forest area in Lebanon. The forest area is estimated to 13.3% of the total area (139,376 hectares).

Forest area of Lebanon 139,376 ha

The analysis of the collected data gives the following table:

Global Ecological Zone	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Subtropical mountain system	67	48.0	0.125	0.245	51.2	66,901
Subtropical dry	67	38.1	0.122	0.24	61.8	53,102
Subtropical steppe	67	13.9	0.085	0.167	124.6	19,373
Total		**100**				**139,376**

Table 8: Estimations of forest area by Ecological zone

10.4.2 Other Wooded Land (OWL) area by ecological zone

The same classes of the GEZ are considered for the analysis of the ecological zones in the OWL area. The OWL area is estimated to 10.4% of the total area (108,378 hectares).

OWL area of Lebanon 108,378 ha

The results obtained for the OWL area, are illustrated in table 9:

Type	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Subtropical mountain system	69	44.3	0.122	0.239	56.9	48,011
Subtropical dry	69	31.7	0.121	0.238	58.6	34,356
Subtropical steppe	69	24.0	0.093	0.184	105.7	26,011
Total		**100**				**108,378**

Table 9: Estimations of OWL area by Ecological zone

10.4.3 Other Land area by ecological zone

The same treatment of the GEZ classes is used in the analysis of the OL area by ecological zones. The OL area is estimated to 76.3% of the total area (797,152 hectares).

OL area of Lebanon 797,152 ha

The estimation of the OL area by ecological zones classes is as follow:

Type	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Subtropical dry	205	45.2	0.07	0.137	31.2	360,313
Subtropical steppe	205	28.2	0.06	0.12	47.2	224,797
Subtropical mountain system	205	26.6	0.064	0.127	41.36	212,042
Total		**100**				**797,152**

Table 10: Estimations of OL area by Ecological zone

In the following bar diagram, we illustrate the above three tables obtained for the three land use areas in Lebanon:

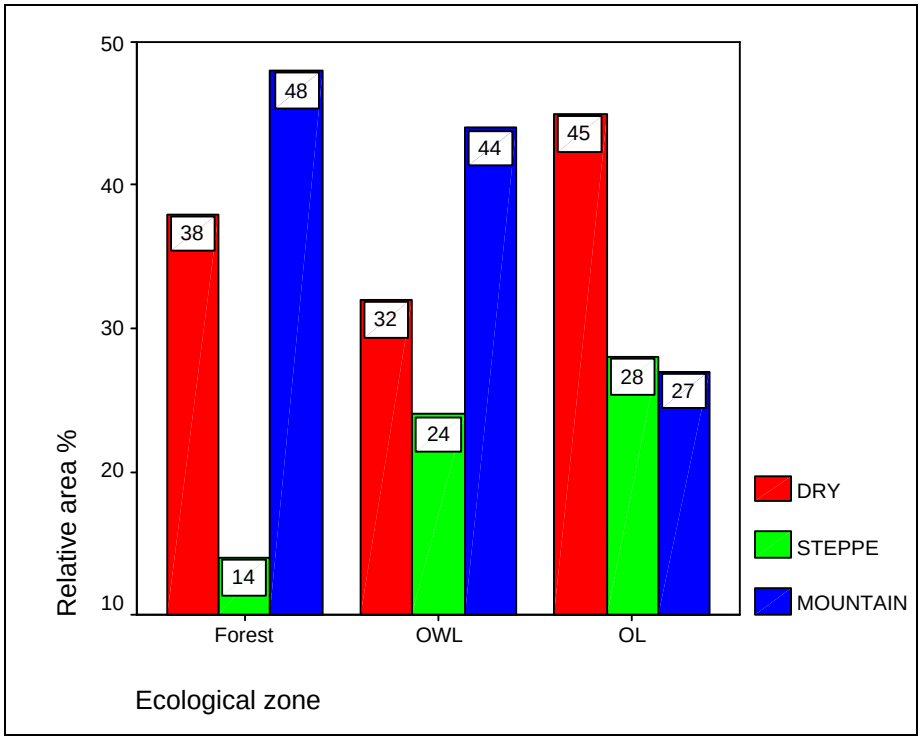


Figure 7: Area distribution of land use classes by ecological zones

The bar diagram of the three subtropical classes shows that the most significant forest area is found in the subtropical mountain system, which is normal due to the location of the forest in Lebanon. The repartitions in the OWL area are relatively average in subtropical dry, steppe and mountain ecological zones. The OL area is dominated by the subtropical dry zone.

10.5. Areas by Ownership

The area of the land use classes by ownership is founded by considering the accessible inventoried area.

10.5.1 Forest area by ownership

The ownership of forest area can be divided into private, state, municipality community, and not known. The proportion and the estimated area are shown in the following table:

Land tenure	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
private	59	60.4	0.124	0.243	40.0	84,183
State	59	27.4	0.112	0.22	87.3	38,189
municipality	59	10.0	0.076	0.149	140.5	13,938
community	59	1.2	0.034	0.068	400.0	1,672
Not Known	59	1.0				1,394
Total		**100**				**139,376**

Table 11: Estimations of forest area by ownership classes

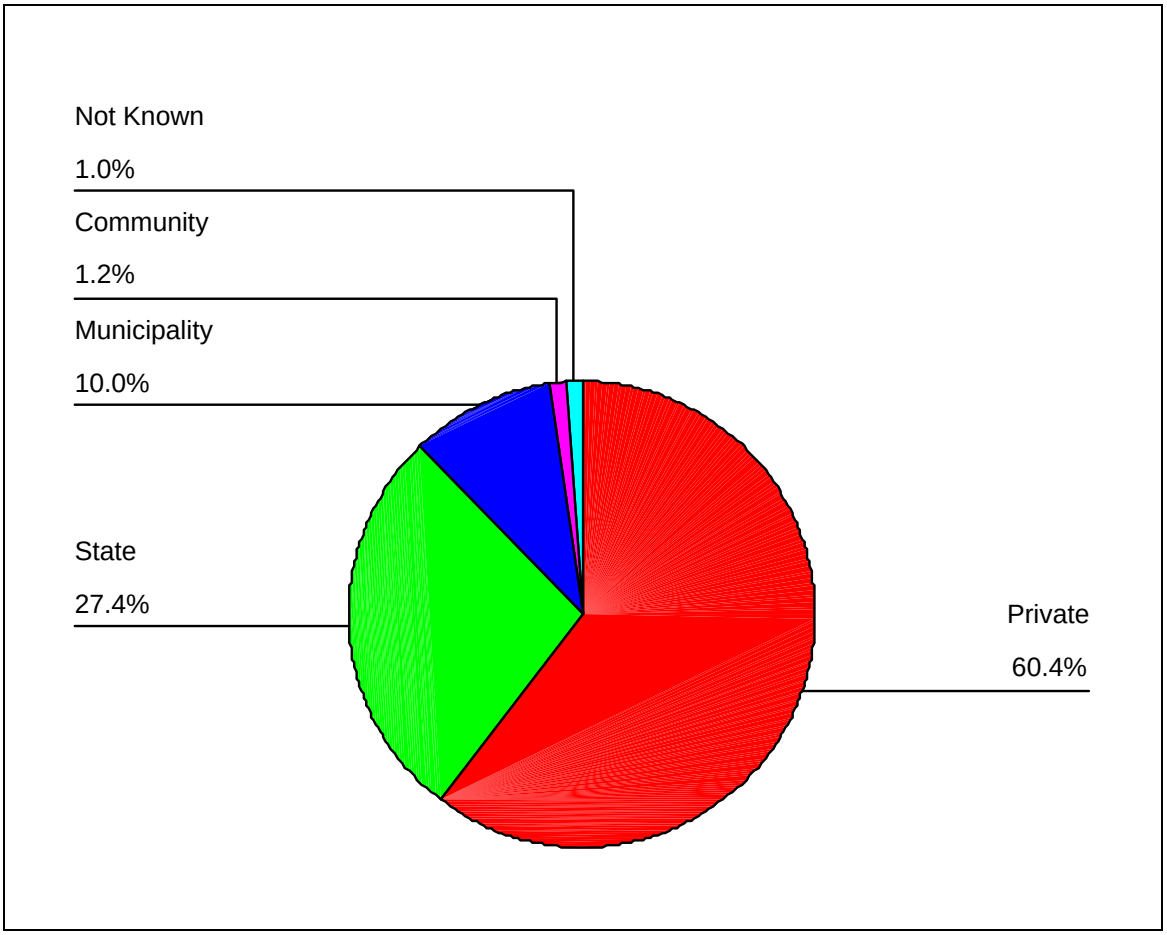


Figure 8: Area distribution of forest land by ownership

The above results show that more than half of the forest area in Lebanon is privately owned and less than half is state property and other forms of public ownership (municipalities and communes).

10.5.2 Other Wooded land area by ownership

For the other wooded land area, we consider the three classes: Private class, Public class in which we merge the State, municipality and community classes into the same class, and Not known class where all other forms of ownership are classified.

Land tenure	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Private	65	80.0	0.09	0.18	21.8	86,702
Public	65	13.8	0.087	0.172	114.0	14,956
Not Known	65	6.2	0.035	0.07	291.6	6,720
Total		**100**				**108,378**

Table 12 : Estimations of other wooded land area by ownership

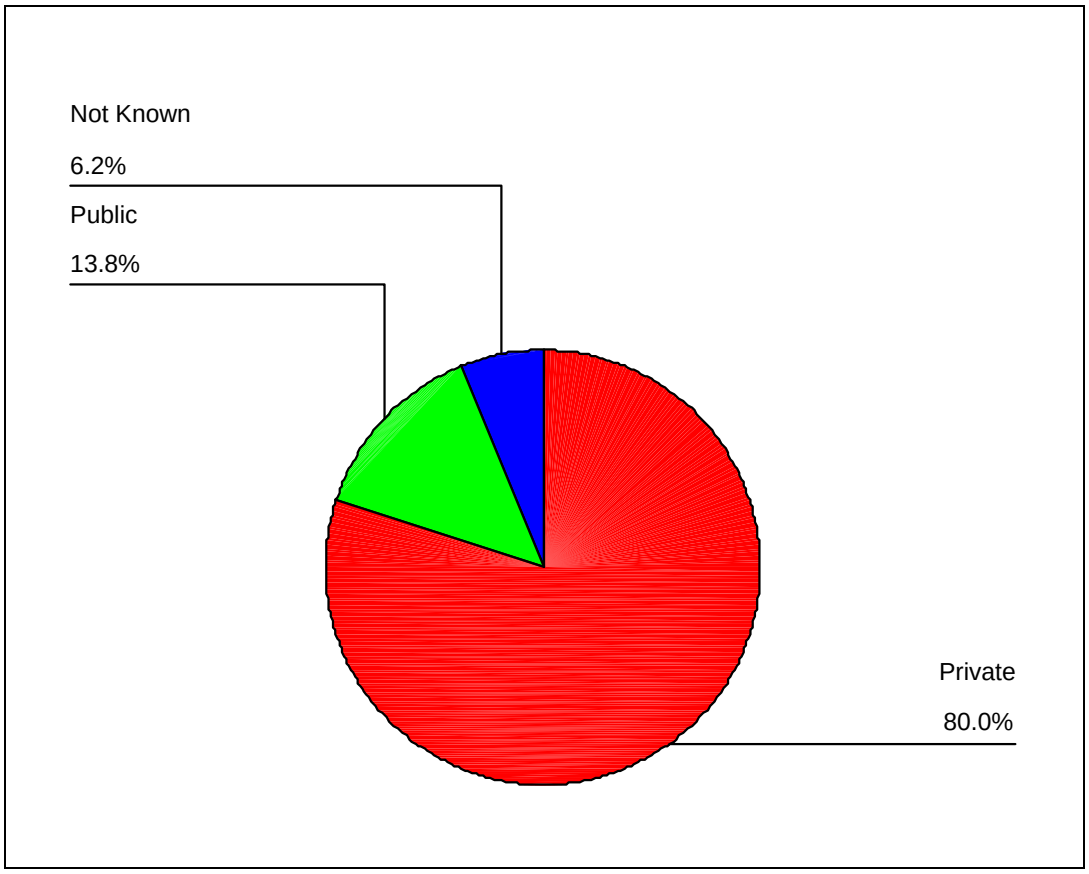


Figure 9: Area distribution of other wooded land by ownership

In Lebanon, ownership by private individuals is by far the most important ownership category, with more than 80% of OWL area. The State owns relatively small areas (13.8%) as other forms of public ownership, mainly by municipalities and communities.

10.5.3 Other land use area by ownership

The same classes are used for the classification for the other land use area by ownership

Land tenure	size	$\bar{x}$ %	S_x	S_E	S_E %	(ha)
private	203	88.2	0.41	0.081	9.2	703,088
public	203	11.0	0.04	0.078	69.6	87,687
Not Known	203	0.8	0.01	0.02	333.3	6,377
Total		**100**				**797,152**

Table 13 : Estimations of Other Land use area by ownership

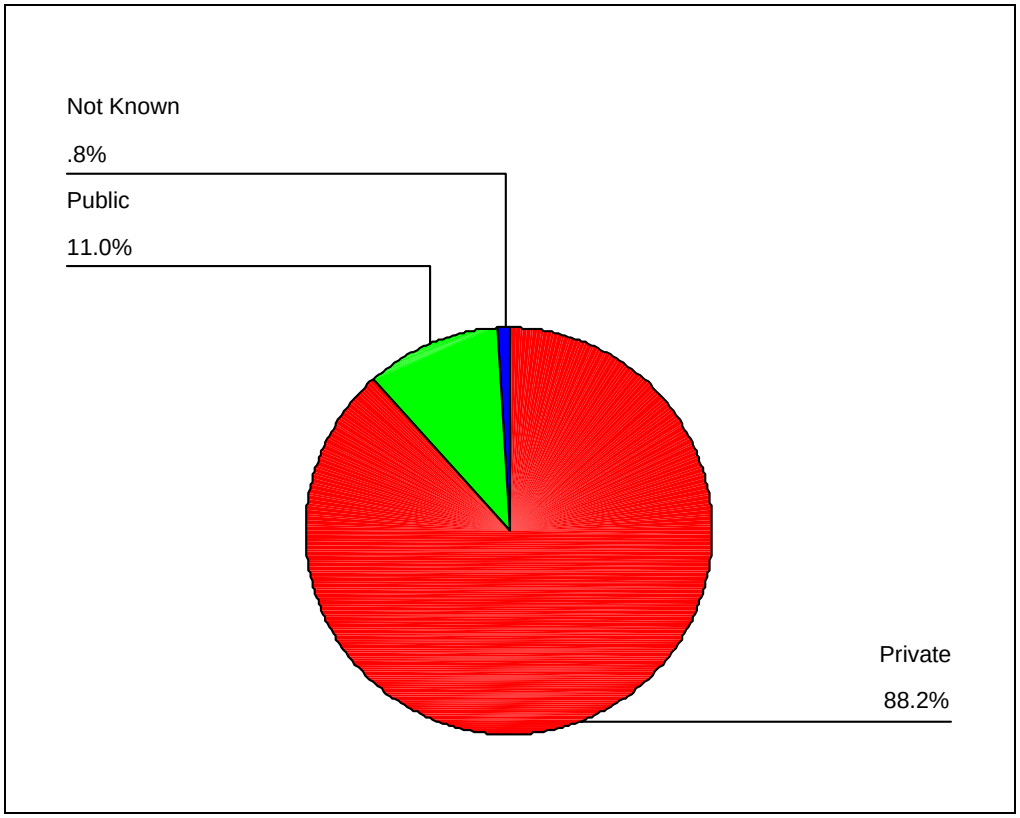


Figure 10: Area distribution of Other Land use area by ownership

The above estimation shows that in Lebanon, the other land area is dominated by the private property class with the proportion of more than three-quarters (88.2%). The State owns relatively small areas (11%) as public, municipality and community's ownership.

10.6. Area by Designation/Protection status

The classification of the designation/protection status in Lebanon is composed by the classes: Production, Protection and Natural reserve. The area of the land use classes by designation/ protection status is considered for the inventories area with only condition of the accessible part.

10.6.1 Forest area by designation/protection status

Based on the above classification, we obtain the following proportions for the forest area:

Designation/protection status	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Production	59	97.4	0.04	0.096	9.9	135,752
Natural reserve	59	2.6	0.04	0.096	246.1	3,624
Protection	59	0	0	0	0	0
Total		**100**				**139,376**

Table 14: Estimations of the forest area by designation/protection status

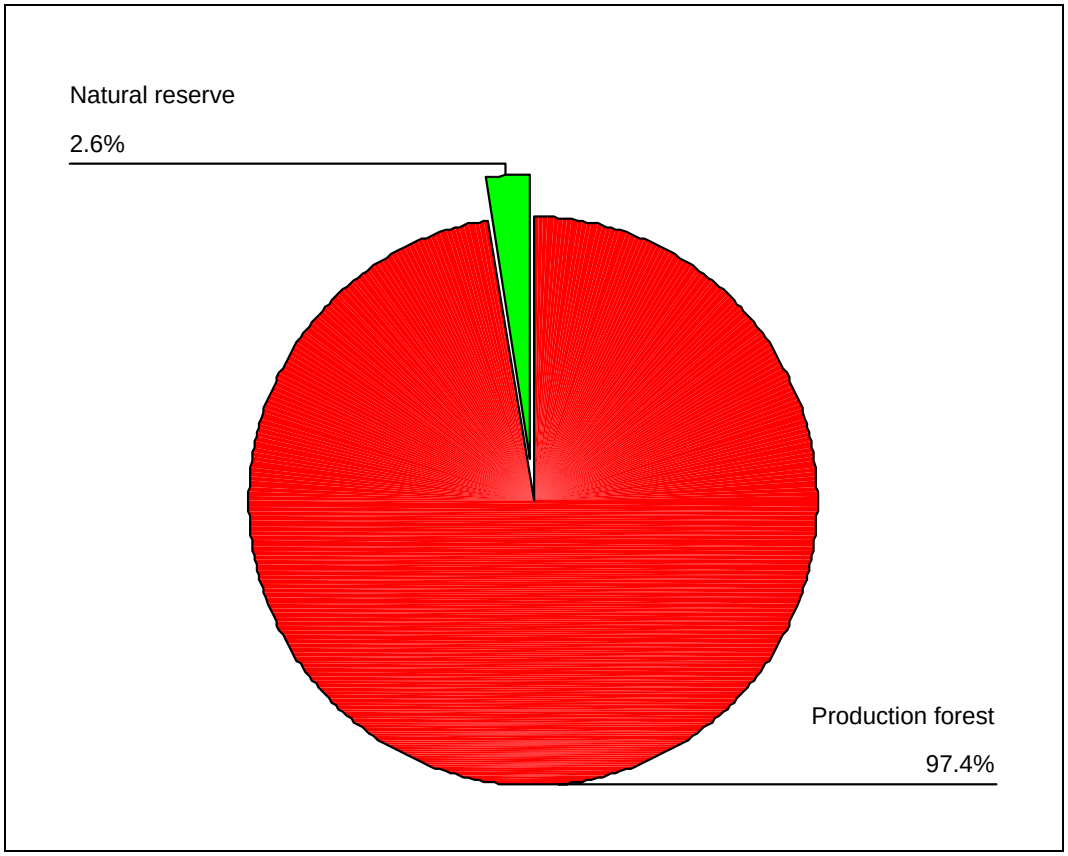


Figure 11: Area distribution of Forest land by Designation/protection status

Only a small proportion of 2.6% of the forest area is a natural reserve class, and the major area can be considered as a production forest class for 97.4%. The estimation shows that the two other classes are negligible in Lebanon comparing to the two others.

10.6.2 OWL area by designation/protection status

By using the same classes of the forest area by designation/protection status, the estimation for the Other Wooded Land (OWL) area is illustrated in the following table:

Designation/protection status	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Production	65	96.9	0.04	0.086	8.87	105,018
Natural reserve	65	3.1	0.04	0.086	277	3,360
Protection	65	0	0	0	0	0
Total		**100**				**108,378**

Table 15: Estimations of OWL area by designation/protection status

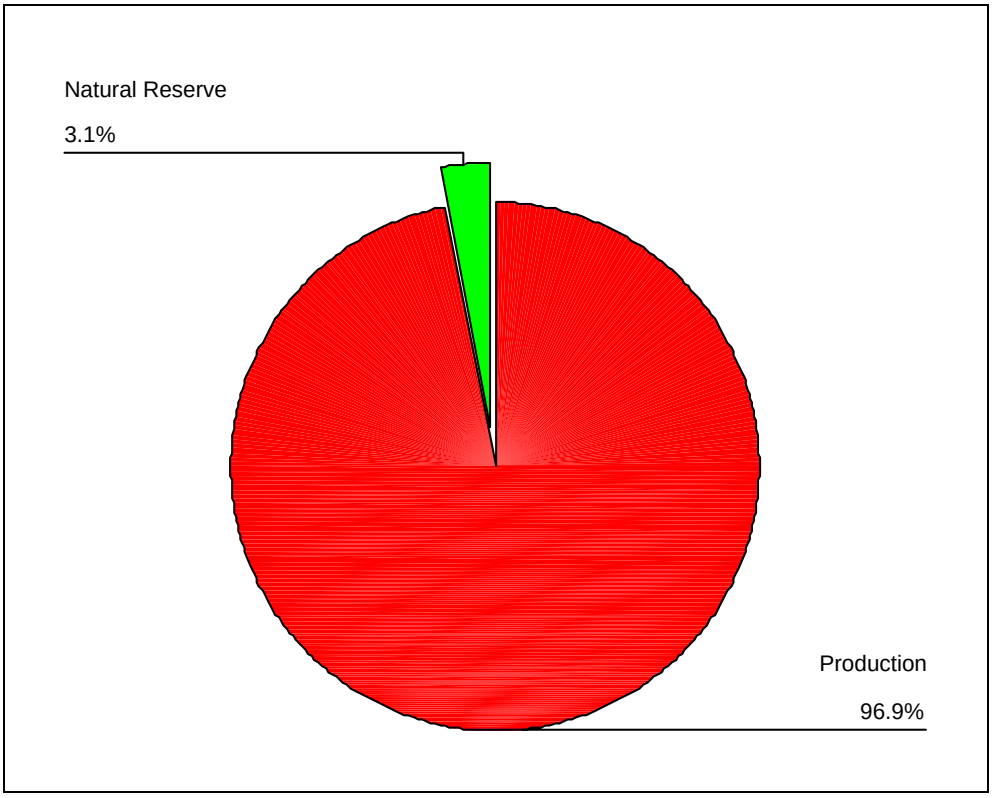


Figure 12: Area distribution of OWL by Designation/protection status

Figure 12 shows that the main status of the OWL area is classified as production class and relatively the same proportion obtained for the forest is obtained under the Natural reserve class.

10.6.3 OL area by designation/protection status

The same study is applied on the Other Land Area. The results are illustrated in the follow:

Designation/protection status	size	$\bar{x}$ %	S_x	S_E	S_E%	(ha)
Production	203	97.5	0.018	0.036	3.67	777,223
Natural reserve	203	0.4	0.01	0.02	400	3,189
Protection	203	0.2	0.002	0.005	500	1,594
Not Known	203	1.9	0.0153	0.03	200	15,146
Total		**100**				**797,152**

Table 16: Estimations of OL area by designation/protection status

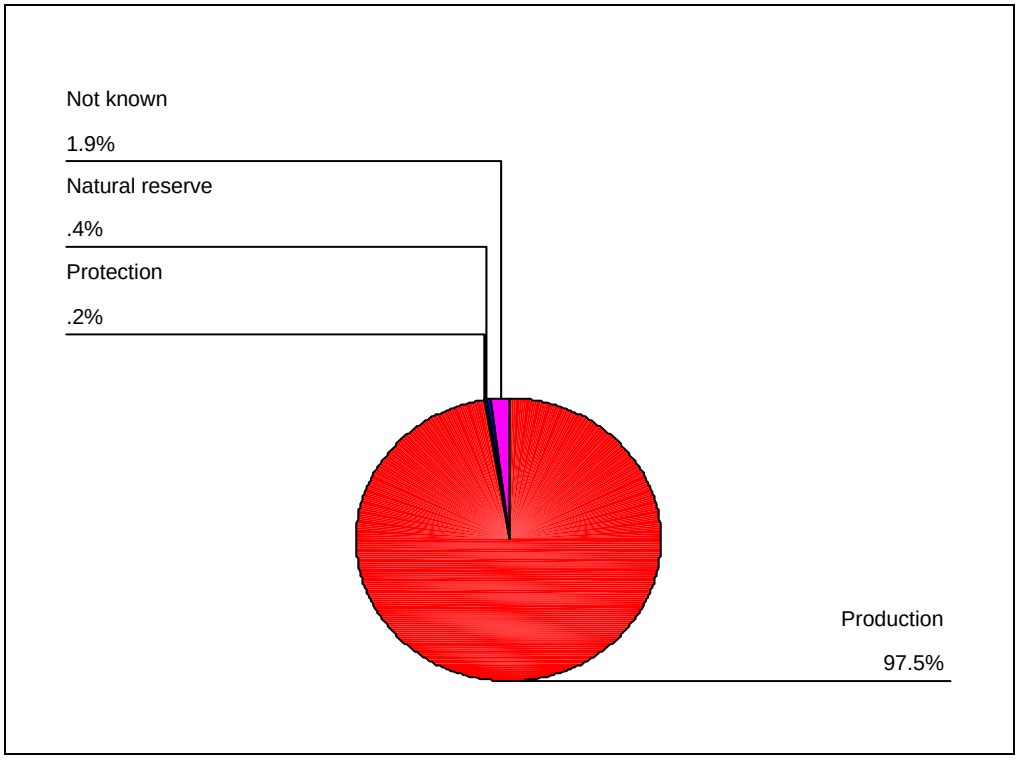


Figure 13: Area distribution of OL area by Designation/protection status

For the other land area, the four classes are present. The production class with very high proportion is observed and that for 97.5%, which is relatively the same proportion observed for the two other area classes. The natural reserve proportion is smallest than those observed before. The protection class is present with very low proportion.

10.7. DBH Distribution

Tree diameter is measured over bark in whole centimeters, at 1.3 meters breast height above the ground. The trees in forest and outside forest are divided into 9 diameter classes. The distribution (frequency) of the diameter classes is shown in table 17.

DBH Distribution

DBH Diam(cm)	Forest	TOF	Total
[10-15[	1993	6524	8517
[15-20[	759	2741	3490
[20-25[	554	1304	1858
[25-30[	405	660	1065
[30-35[	379	362	741
[35-40[	308	214	522
[40-45[	172	148	320
[45-50[	88	83	171
[50- +[	104	202	306
Total	**4762**	**12228**	**16990**

Table 17: Tree DBH Distribution in forest and outside forest (TOF)

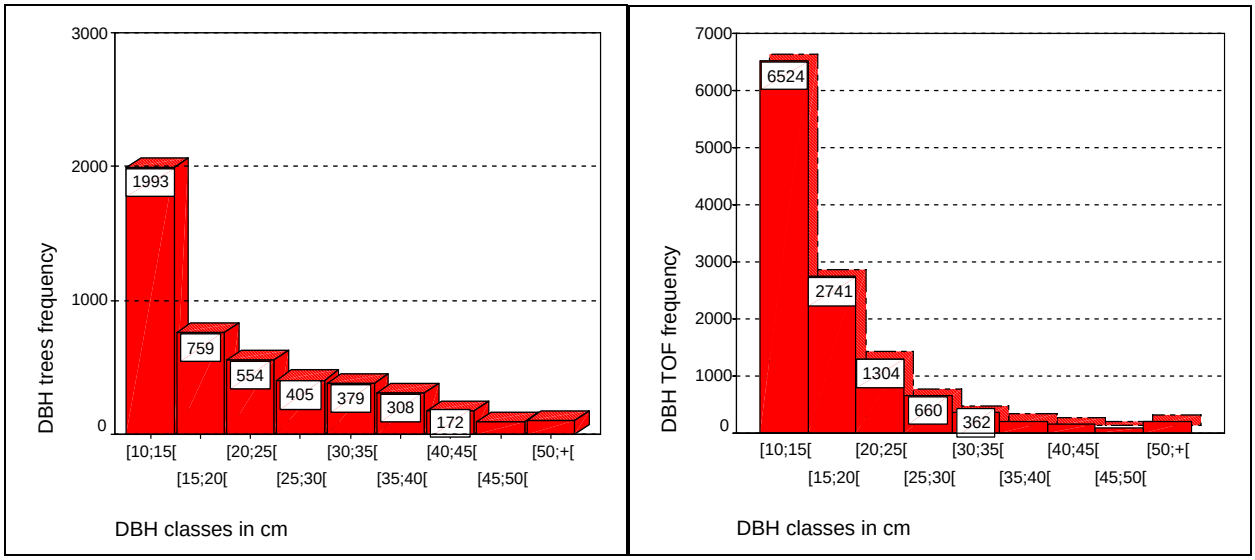


Figure 14: Tree DBH distribution in forest to the left and outside forest (TOF) to the right

The bar diagram of the tree DBH distribution shows that the most trees have a diameter at breast height between 10 and 15cm. For the other DBH classes, the frequencies are less than a half of this class.

10.8. Volume

Wood volume and woody Biomass are important indicators of the potential of forests and trees to provide wood and to sequester Carbon. Based on the terms and definitions of the FRA 2000, Volume is defined as the stem volume of all living trees more than 10cm diameter at breast height (or above buttresses if these are higher), over bark measured from stump to top of bole. Estimations of Volume were based on national inventory containing volume data for the various national forest types. The estimation of the tree stem volume is obtained by using the following formula:

$$\text{Tree stem volume } (m^3) = \left[\frac{(DBH)^2}{4} * \pi * total\,Height * VolumeFactor \right]$$

Due to not homogeneous cylinder of the tree stem, the Volume Factor is a correction of the tree stem's cylinder volume. This factor depends on the type of each tree and is around 0.5 – 0.7. The lower value is for broadleaved tree species and the higher value is for coniferous tree species. For fruit trees 0.55 has been applied as default.

The estimation of the global volume per hectare is the sum of the tree stem volumes over the corresponding area. The estimation of the global volume (in m^3) is obtained by multiplying the volume per hectare with the total area of that land use in the country.

Land use	size	Volume/ Area (m^3/ha)	S_x	SE	SE%	Total Volume (m^3)
Forest	61	35.6	8.5	6.7	46.9	4,967,361
Other Wooded land	65	5.1	1.6	3.2	63.7	550,777
Other land	149	3.7	1.0	2.0	52.4	2,984,537
Total		44.5				8,502,675

Table 18: Estimations of tree stem volume for trees with DBH>=10cm, by land use class

10.9. Biomass and Carbon

The information on biomass stock of forest and other wooded land is important for development of national and international policies. The methodology used for biomass calculation is based on the following formulas:

SB= GS x WD
AGB=SB x BEF
BGB=AGB x R

Where

SB Stem biomass (tonnes)
AGB Above-ground biomass (tonnes)
BGB Bellow-ground biomass (tonnes)
GS Growing stock (volume) over bark (m^3)
WD Wood density (Dry weight/green volume expressed in tonnes/m^3)
BEF Biomass expansion factor (above ground biomass/stem biomass)
R Root-shoot ratio (below-ground biomass/above-ground biomass)

For this calculation, we only consider 10 species group which have the most important growing stock (volume over bark).

Based on the appendix 2 (table 2.2), the value of the wood density factor (WD) for the Coniferous and Broad-leaved are taken respectively equal to 0.4 and 0.5. For the species present in Appendix 2, the corresponding factor is applied (0.58 for Oaks, etc.)

For the Biomass expansion factor (BEF), the value of 1.3 is used for the Coniferous, and the value of 1.4 is applied for the Broad-leaved. The Root-shoot ratio is equal to 0.27, as we consider Lebanon as the subtropical dry forest.

10.9.1 Biomass of forests species

Type	GS (million m^3)	AGB (million tonnes)	BGB (million tonnes)
Quercus cerris	0.96	0.78	0.21
Pinus Pinea	1.55	0.62	0.22
Pinus brutia	1.3	0.68	0.18
Cedrus	0.31	0.16	0.04
Juniper Excel	0.29	0.15	0.04
Juniper drupacea	0.09	0.05	0.01
Quercus Infectoria	0.186	0.15	0.04
Quercus calliprinos	0.177	0.14	0.04
Ostrya carp	0.016	0.01	0.003
Platanus	0.019	0.013	0.004
Others species	0.06	0.04	0.01
Total	**4.967**	**2.793**	**0.797**

Table 19: Calculation of living Biomass of forest species

10.9.2 Biomass of Other Land area

Type	GS (million m^3)	AGB (million tonnes)	BGB (million tonnes)
Olive	0.829	0.58	0.157
Eucalyptus spp.	0.434	0.304	0.082
Casuarina Equisetifolia	0.316	0.221	0.06
Pinus Pinea	0.2	0.104	0.028
Citrus	0.17	0.116	0.03
Cypressus	0.107	0.056	0.015
Juniper Excelsa	0.1	0.05	0.01
Quercus Calliprinos	0.1	0.08	0.02
Prunus	0.1	0.07	0.02
Quercus Infectoria	0.07	0.06	0.02
Platanus orientalis	0.06	0.044	0.012
Prunus Amygdalis	0.05	0.04	0.01
Apple	0.047	0.033	0.009
Others species	0.401	0.21	0.056
Total	**2.984**	**2.412**	**0.649**

Table 20: Calculation of living Biomass of other land species

10.9.3 Biomass of other wooded land

Type	GS (million m^3)	AGB (million tonnes)	BGB (million tonnes)
Juniper Excelsa	0.32	0.17	0.04
Quercus Calliprinos	0.1	0.08	0.02
Pinus Brutia	0.05	0.03	0.01
Pinus Pinea	0.02	0.01	0.003
Pyrus syriaca	0.01	0.01	0.002
Populus alba	0.01	0.005	0.001
Quercus infectoria	0.01	0.008	0.002
Prunus Amygdalis communis	0.006	0.004	0.001
Prunus Ursina	0.006	0.001	0.001
Others species	0.012	0.007	0.002
Total	**0.544**	**0.325**	**0.082**

Table 21: Calculation of living Biomass of other wooded land species

10.10. National table of the Biomass

Type	Above-ground Biomass (million tonnes)	Below-ground biomass (million tonnes)	Total living biomass (million tonnes)
Forest	2.793	0.797	3.59
OWL	0.325	0.082	0.407
OL	2.412	0.649	3.061

Table 22: calculation of the total living biomass

10.11. Carbon

The calculation of carbon stock is based on the biomass data. It is calculated by multiplying respectively the above-ground biomass and the below ground biomass with the default value for carbon content in living biomass (50% = 0.5 ton carbon per ton dry weight (Biomass)).

Type	Carbon of Above-ground Biomass (million tonnes)	Carbon of Below-ground biomass (million tonnes)	Total (million tonnes)
Forest	1.3965	0.3985	1.795
OWL	0.1625	0.041	0.2035
OL	1.206	0.3245	1.5305

Table 23: Calculation of the Carbon stock

10.12. Disturbances of the forest

The disturbance is defined as the impact level of the human activities in the forest. The analysis of collected data shows that the disturbed forest area is about 85.1 % of the forest area which is estimated by 118,609 hectares. This disturbed area is divided into three categories: Slightly disturbed, moderately and heavily disturbed. As shown in table 19, the moderately disturbed forest is the most important category with 52.3% or 62,033 hectares of the forest area, the Slightly disturbed forest area is in the second place with 43.9% (52,069 hectares) and the Heavily disturbed is about 3.9% (4,507 hectares).

Forest disturbances	$\bar{x}$ %	Ha
Not Disturbed forest	14.9	20,767
Disturbed forest	85.1	118,609

Forest disturbances	size	$\bar{x}$ %	S_E	S_E%	Disturbed forest area
Slightly disturbed	53	41.2	0.259	58.9	48,867
Moderately disturbed	53	55.6	0.26	49.7	65,947
Heavily disturbed	53	3.2	0.087	228.9	3,795
Total		**100**			**118,609**

Table 24: Estimations of forest area by disturbances levels

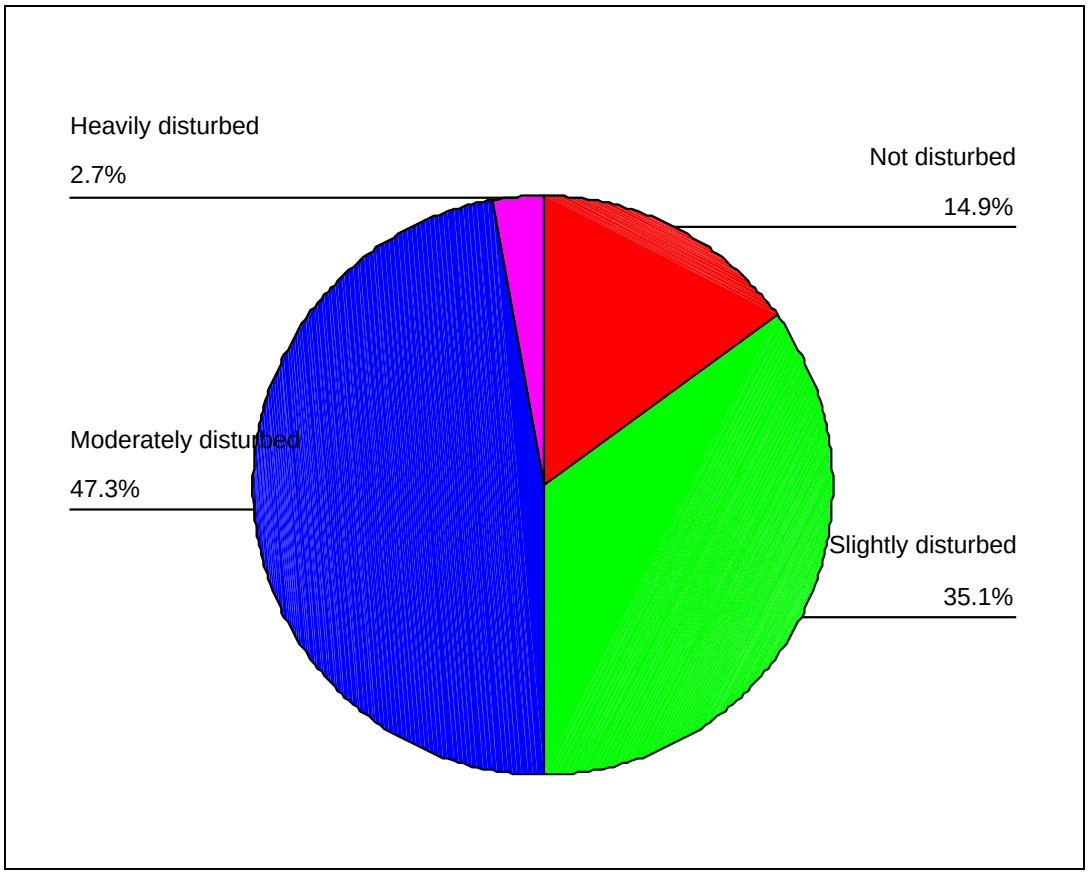


Figure 14: Distribution of forest area by disturbance level

To have more information about the disturbance on the forest area, we consider the level 2 sub-class of the forest classification (Coniferous, Broadleaves, and Mixed forest). The results of the estimation show that the disturbance affects all sub-classes with a similar proportion: for the coniferous is about 75.3% (or 33,794 hectares), for the broadleaves is 76.5% (or 60,349 hectares) and for the mixed forest sub-class is 96.16% (or 15,017 hectares). The level of disturbances varies between the three sub-classes as shown in table 25.

Forest disturbances	**Coniferous forest**		**Broadleaved forest**		**Mixed forest**	
	$\bar{x}$ **%**	(Ha)	$\bar{x}$ **%**	(Ha)	$\bar{x}$ **%**	(Ha)
No disturbances of forest	**24.7**	**11,085**	**23.5**	**18,538**	**3.8**	**593**
Slightly disturbed	37.1	16,650	41.2	32,501	34.5	5,385
Moderately disturbed	58.4	26,209	57.8	45,597	53.6	8,367
Heavily disturbed	4.5	2,020	1.0	789	11.9	1,858
Total	**100**	**44,879**	**100**	**78,887**	**100**	**15,610**

Table 25: Estimations of forest type area (level 2) by disturbance levels

One of the disturbances types of the forest in Lebanon is that caused by fire. We estimate the area of forest affected by fires and the presence of fires in the forest type. The results obtained are shown in table 26.

	Forest		Coniferous forest		Broadleaved forest		Mixed forest	
	%	Ha	%	Ha	%	Ha	%	Ha
No evidence of fire	85.9	119,724	25.9	36,098	52	72,476	8	11,150
Recent fire	0	0	0	0	0	0	0	0
Old fire	14.1	19,652	14.097	19,648	0	0	0.003	4

Table 26: Area estimations of fire occurrences by forest type (level 2)

The fire area of forest is about 14.1 % of the forest area (or 19,652 hectares). This fire area is divided into 14.097% of coniferous fire area estimated (or 19,648 hectares); the rest of this fire forest area is from 0.003% mixed forest (or 4 hectares). There is no fire area in the broadleaved forest area.

Another disturbance type of the forest in Lebanon is that caused by diseases attributable to pathogens, such as a bacteria, fungi, Phytoplasma or virus. For this case, the information on trees of the forest land use and its healthy state are very important. The total number of measured forests is 4775 trees distributed as 96% healthy and 4% affected by symptoms of disease or presence of parasites.

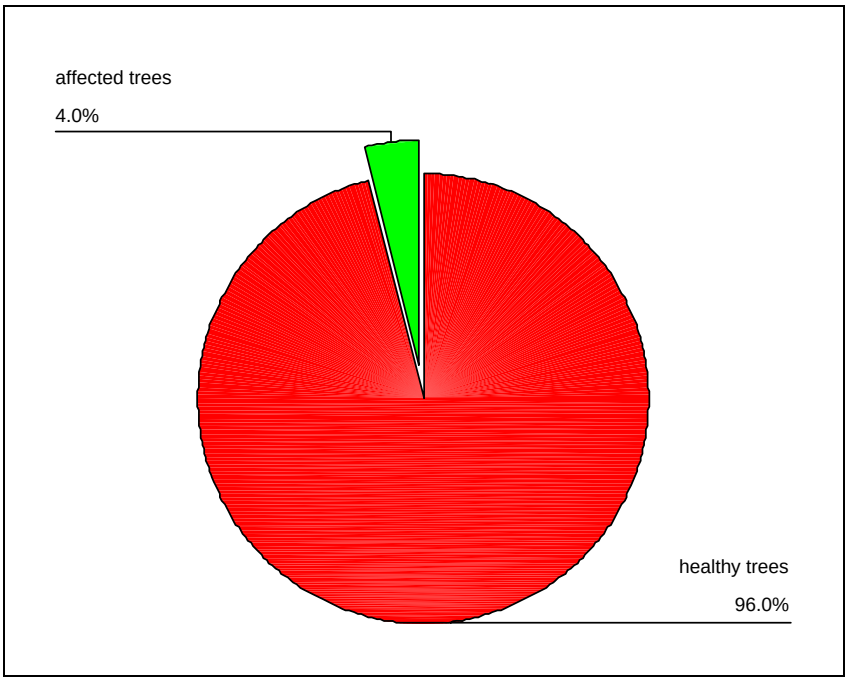


Figure 15: Distribution of trees by Health Status

To find the most causing disturbances in forest, we have to consider for all not healthy trees the causative agent like: disease, fire, insect, animals and others. The presence of causative agents on the 192 affected trees (4% of 4775 measured trees) is illustrated in figure 16:

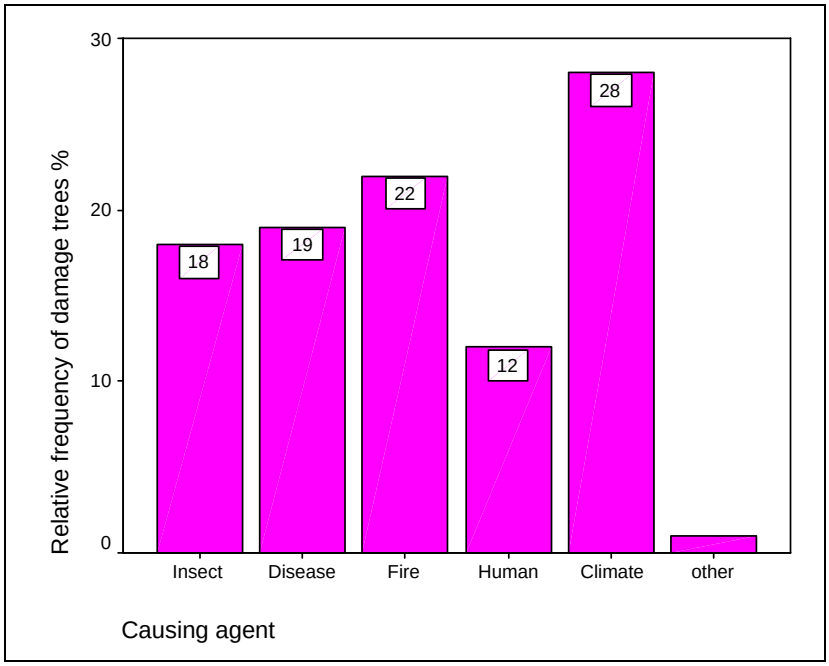


Figure 16: Relative frequency of damage trees by causative agent

Figure 16 shows that the most common causative agent in damaging the health of the trees in Lebanon are climatic factors with 28% of the affected trees. Fire, insects and deceases were each observed on around 20% of the damaged trees, while human induced damages only were observed on 12% of the damages trees.

10.13. Biodiversity

Lebanon has specific forest types determined by mountains and coastal nature. The country comprises large range of broadleaved species (Quercus, Acer, etc.). The best proportion of inventoried broadleaved trees was obtained for the Quercus species as shown in table 27.

Scientific name	Total species number	%
Quercus calliprinos	978	41.1
Quercus infectoria	746	31.4
Quercus cerris & var.pseudocerris	336	14
Ostrya carpinifolia	102	4.3
Prunus ursina	33	1.4
Quercus brantii	31	1.3
Platanus orientalis	29	1.2
Arbutus andrachne	28	1.2
Pyrus syriaca & var. boveri	25	1.1
Ceratonia siliqua	15	0.6
Cercis siliquastrum	11	0.5
Acer syriaca	10	0.4
Other broadleaved tree species	34	1.5
Total	2378	100

Table 27: Frequency of broadleaved tree species

Inventoried coniferous species were made by a range of several Pinus, Juniper, Cuperssus and cedar types. The main species being pines (Pinus brutia, and Pinus pinea).

Scientific name	Total species trees	%
Pinus brutia	1025	43.7
Pinus pinea	840	35.8
Juniperus excelsa	228	9.7
Cedrus libani	104	4.5
Juniperus drupacea	87	3.7
Cupressus sempervirens pyramidalis	38	1.6
Juniperus oxycedrus	16	0.7
Cupressus sempervirens	5	0.2
Pinus canariensis	2	0.1
Total	2345	100

Table 28: Frequency of coniferous tree species

Outside forest another tree species composition was found. These species were mainly dominated by the Quercus calliprinos as shown in table 29.

Scientific name	Trees Species	%
Quercus calliprinos	658	18.1
Juniperus excelsa	347	9.6
Prunus amygdalis agrestis	263	7.3
Ficus carica	239	6.6
Cupressus sempervirens	212	5.8
Quercus infectoria	203	5.6
Pinus pinea	202	5.6
Prunus amygdalis communis	165	4.6
Prunus ursina	159	4.4
Pyrus syriaca & var. boveri	153	4.2
Pinus brutia	145	4.0
Casuarina equisetifolia	98	2.7
Eucalyptus spp.	97	2.7
Platanus orientalis	84	2.3
Pistacia terebintus ssp. palaestina	76	2.1
Juglans regia	72	2.0
Malus trilobata	71	2.0
Pinus canariensis	45	1.2
Melia azedarach	39	1.1
Ceratonia siliqua	30	0.8
Juniperus oxycedrus	30	0.8
Crateagus monogyna	13	0.7
Prunus amygdalis korschinskii & orientalis	12	0.7
Other tree species	83	2.3
Total	3625	100

Table 29: Frequency of tree species outside forest

Another parameter of the biodiversity is the forest stand structure which was divided into two classes: the single layer structure defined as the stand with only one well-defined tree canopy layer, and the two layer structure defined as a stand with two distinct tree canopy layers, an upper tree canopy layer and a lower tree canopy layer. The distribution of forest area by stand structure and forest type is shown in figure 17.

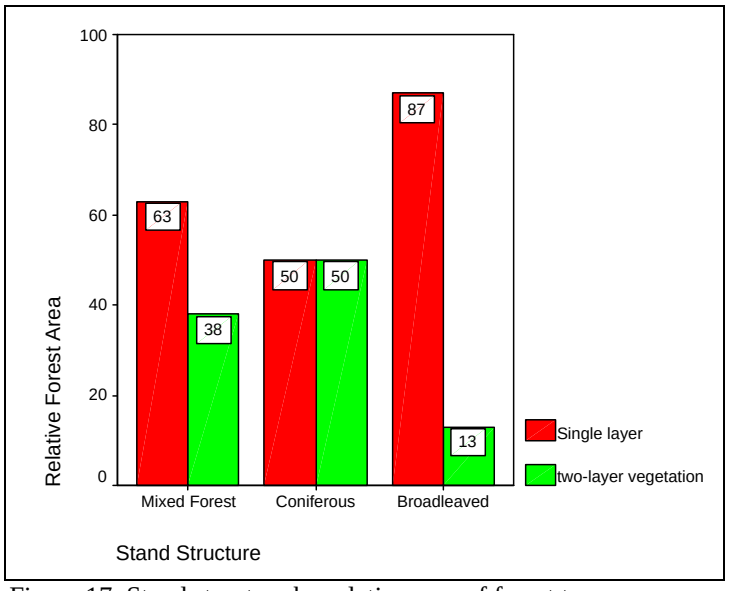


Figure 17: Stand structure by relative area of forest type

10.14. Use of resources: Products and Services

The present section is focused on the use of resources with highlight on the productive, protective, and social functions of forests and trees, including products and services provided by forests as well as by trees outside forests.

10.14.1 Exploitation of Products

Two categories are used to classify products: Wood and Non-Wood products. Information on areas accessible for wood supply is important for land use planning, for development of forest industries and for policy perspective. Non-wood forest products play an important role in the daily life as source of food and income.

2.1.1.6 Exploitation of Wood and Non-wood forest products

The percentage of the products is obtained according to their rank by interviewed people based on the three modalities: product of high importance, products of medium and products of low importance. The results are shown below separately for the two categories: forest and trees outside forest. The highest ranked product is fuel wood which was collected in 59.8% of the forest area. Plant food is the second highest ranked collected in 21% of the forest area.

%frequency of wood and non wood forest according to their rank (of 102 interviewed people)

Wood and non wood products	Rank			Total
	High	Low	Medium	
Bush meat			1.0%	1.0%
Charcoal	1.0%			1.0%
Fodder			1.0%	1.0%
Fuelwood	36.3%	2.9%	20.6%	59.8%
Honey, wax	2.0%	1.0%	3.9%	6.9%
Ornamentals	1.0%			1.0%
Plant food	12.7%	2.0%	6.9%	21.6%
Plant medicines		1.0%	3.9%	4.9%
Soap and cosmetics			1.0%	1.0%
Timber			2.0%	2.0%
Total	52.9%	6.9%	40.2%	100.0%

Table 30: Exploitation of Wood and Non-wood forest products (ranked) presented as relative forest areas in which the products are exploited

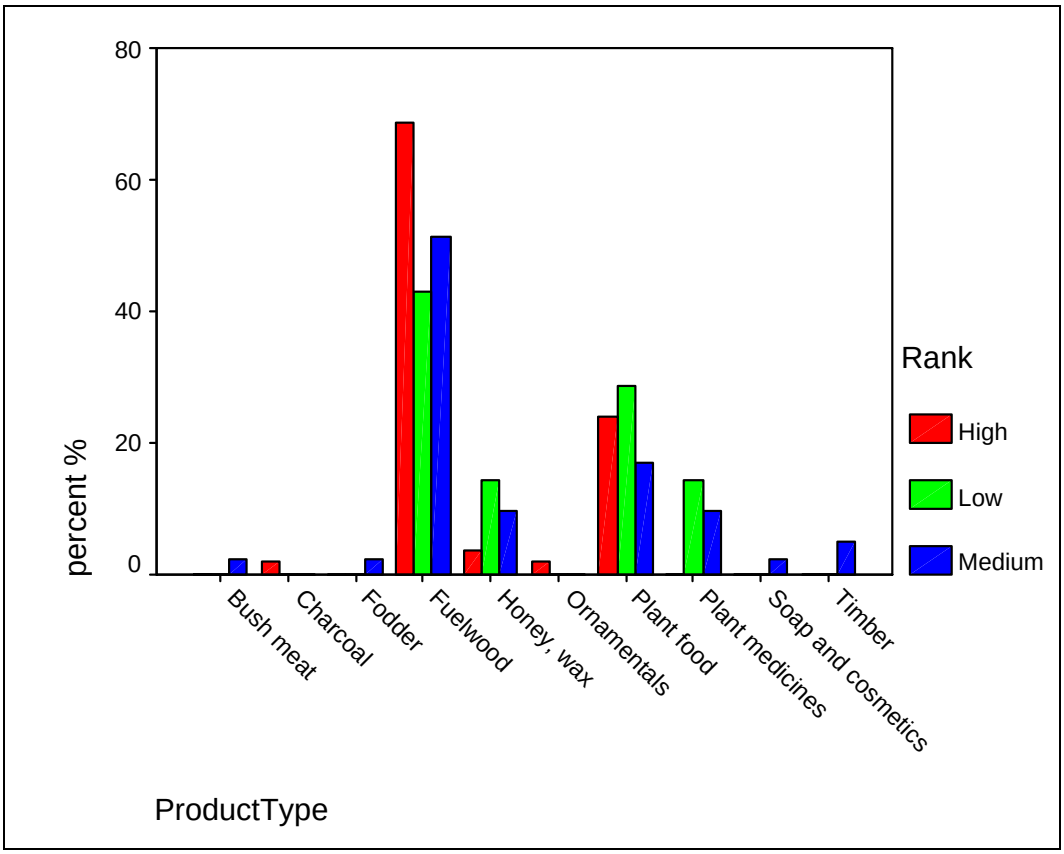


Figure 18: Exploitation of Wood and Non-wood forest products (ranked) presented as relative forest areas in which the products are exploited

2.1.1.7 Exploitation of wood and non-wood products from Trees Outside Forest (TOF)

% frequency of the wood and non wood products from trees outside forest according to their rank (of 633 interviewed poeple)

Wood and non wood products		Rank			Total
		High	Low	Medium	
	Bush meat			.2%	.2%
	Fodder	13.6%	2.2%	.2%	16.0%
	Fuelwood	5.4%	.5%	4.7%	10.6%
	Honey, wax	.8%	.5%	1.6%	2.8%
	Ornamentals	2.1%	.3%	.6%	3.0%
	Plant food	58.0%	.8%	4.9%	63.7%
	Plant medicines	.5%	.2%	.2%	.8%
	Soap and cosmetics	1.6%		.8%	2.4%
	Timber	.6%			.6%
Total		82.5%	4.4%	13.1%	100.0%

Table 31: Exploitation of Wood and Non-wood TOF products (ranked) presented as relative TOF areas in which the products are exploited

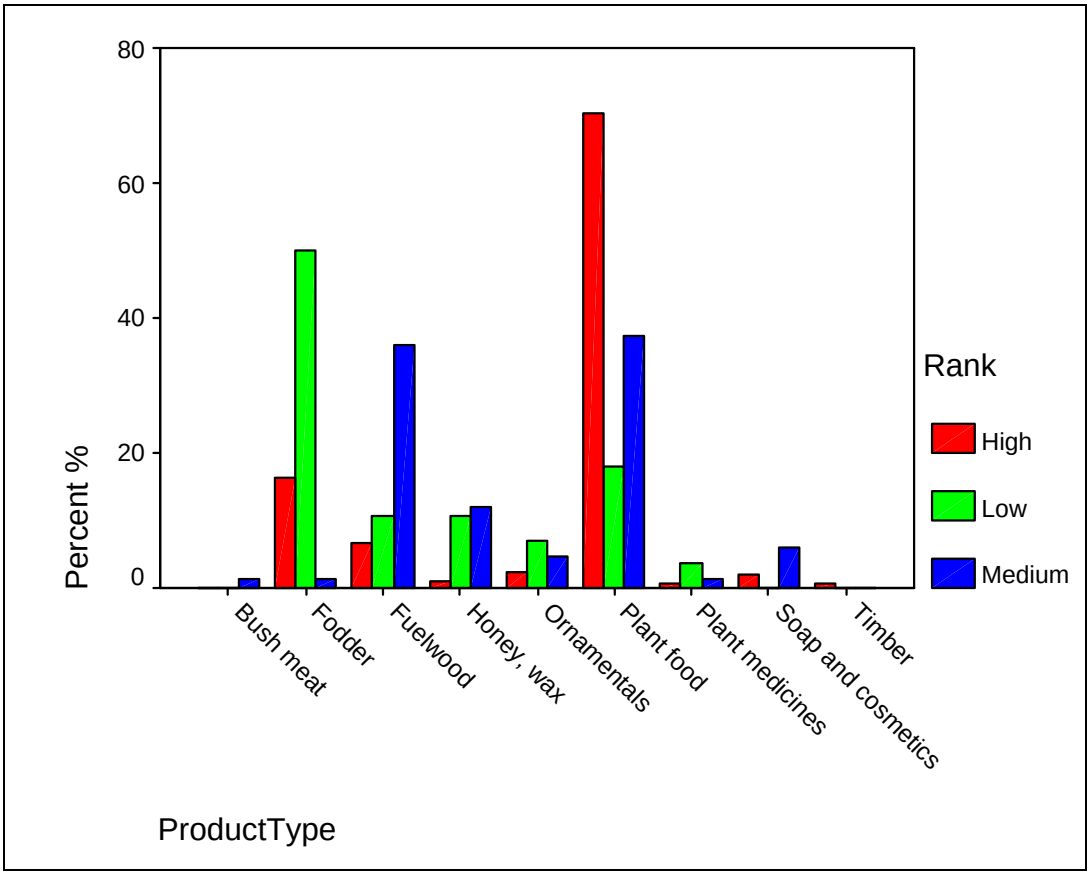


Figure 19: Exploitation of Wood and Non-wood TOF products (ranked) presented as relative TOF areas in which the products are exploited

The figure 19 shows that the overall highest ranked product from trees outside forest is plant food which is collected in 58% of the TOF area. The importance of the other products can almost be considered as negligible comparing to this product.

2.1.1.8 Demand and Supply trends for Wood and non-wood products from forest and TOF

In this part, we present the list of forest and trees outside forest products with the different modalities of the products demand during the last five years and according to the supply trends, stock by supply during the 5 years. The results in table 32 show the relative trends in the demand and supply of different forest products.

Relative frequency of Demand and Supply forest products (90 interviewed people)

% within ProductType_text_eng

SupplyTrend		DemandTrend			Total
		Decreasing	Stable	Increasing	
Decreasing	Fuelwood	28.6%	28.6%	42.9%	100.0%
	Honey, wax			100.0%	100.0%
	Plant food		42.9%	57.1%	100.0%
	Total	13.3%	33.3%	53.3%	100.0%
Stable	Fuelwood	7.3%	85.4%	7.3%	100.0%
	Honey, wax		25.0%	75.0%	100.0%
	Ornamentals		100.0%		100.0%
	Plant food	12.5%	75.0%	12.5%	100.0%
	Plant medicines		100.0%		100.0%
	Soap and cosmetics		100.0%		100.0%
	Timber	50.0%		50.0%	100.0%
	Total	8.6%	77.6%	13.8%	100.0%
Increasing	Charcoal			100.0%	100.0%
	Fodder			100.0%	100.0%
	Fuelwood	44.4%	44.4%	11.1%	100.0%
	Honey, wax			100.0%	100.0%
	Plant food		25.0%	75.0%	100.0%
	Plant medicines			100.0%	100.0%
	Total	23.5%	29.4%	47.1%	100.0%

Table 32: Supply and demand trends for forest products presented as relative forest areas in which the products are exploited

Relative frequency of TOF Denad and Supply (542 interviewed people)

% within ProductType_text_eng

SupplyTrend		DemandTrend			
		Decreasing	Stable	Increasing	Total
Decreasing	Fodder	50.0%	50.0%		100.0%
	Fuelwood	50.0%	13.6%	36.4%	100.0%
	Plant food	71.4%	18.4%	10.2%	100.0%
Total		64.4%	17.8%	17.8%	100.0%
Stable	Bush meat		100.0%		100.0%
	Fodder	1.4%	98.6%		100.0%
	Fuelwood	2.9%	97.1%		100.0%
	Honey, wax		30.8%	69.2%	100.0%
	Ornamentals		100.0%		100.0%
	Plant food	4.0%	94.5%	1.5%	100.0%
	Plant medicines		33.3%	66.7%	100.0%
	Timber		100.0%		100.0%
Total		3.2%	93.1%	3.7%	100.0%
Increasing	Fodder			100.0%	100.0%
	Fuelwood	25.0%	50.0%	25.0%	100.0%
	Honey, wax			100.0%	100.0%
	Plant food	29.4%	35.3%	35.3%	100.0%
	Plant medicines		100.0%		100.0%
	Soap and cosmetics	50.0%		50.0%	100.0%
	Timber	100.0%			100.0%
Total		29.7%	23.4%	46.9%	100.0%

Table 33: Supply and demand trends for TOF products presented as relative TOF area in which the products are exploited

2.1.1.9 User conflicts over wood and non-wood products from forest

The relative frequencies of conflicts are studied for the forest and TOF products. The conflict variable has two options: “No conflicts due to use/collection of product” and “Yes, conflicts due to use/collection of product”. The results show that in 91% of the forest area no conflicts due to the use/collection of products were reported.

% frequency according to the user conflicts of Products forest (102 interviewed people)

% within ProductType_text_eng

Products forest type		UserConflicts		Total
		Existing (Yes)	Not existing (No)	
	Bush meat		100.0%	100.0%
	Charcoal	50.0%	50.0%	100.0%
	Fodder	100.0%		100.0%
	Fuelwood	3.5%	96.5%	100.0%
	Honey, wax		100.0%	100.0%
	Ornamentals		100.0%	100.0%
	Plant food	11.1%	88.9%	100.0%
	Plant medicines	33.3%	66.7%	100.0%
	Soap and cosmetics		100.0%	100.0%
	Timber	50.0%	50.0%	100.0%
Total		8.7%	91.3%	100.0%

Table 34: User conflicts to forest products presented as relative forest areas in which the products are exploited

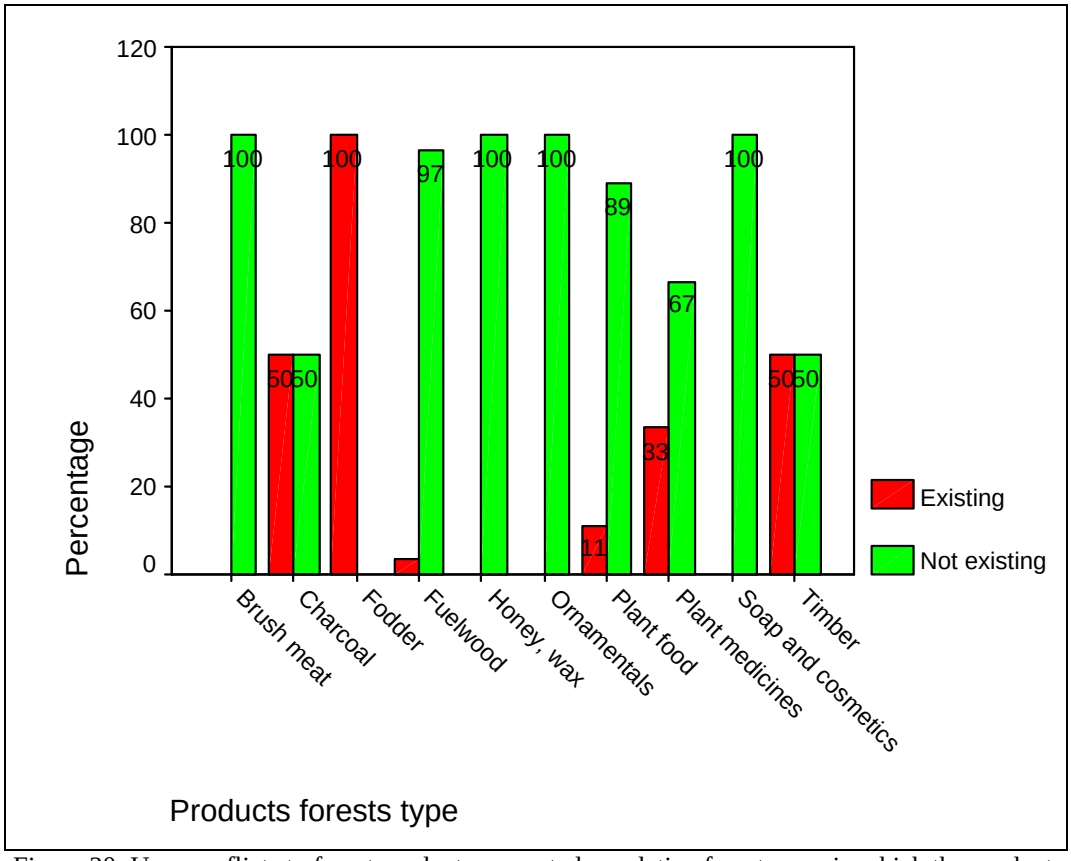


Figure 20: User conflicts to forest products presented as relative forest areas in which the products are exploited

2.1.1.10 User conflicts over wood and non-wood TOF products

The same procedure is done for the trees outside forest to see the conflicts user. The results are illustrated below. In more than 97% of the TOF area no user conflicts over the products were reported.

% frequency of TOF products according to user conflicts (599 interviewed people)

% within ProductType_text_eng

Products TOF	UserConflicts: Existing (Yes)	UserConflicts: Not existing (No)	Total
Bush meat		100.0%	100.0%
Fodder	3.8%	96.3%	100.0%
Fuelwood	1.6%	98.4%	100.0%
Honey, wax		100.0%	100.0%
Ornamentals		100.0%	100.0%
Plant food	1.5%	98.5%	100.0%
Plant medicines		100.0%	100.0%
Soap and cosmetics	50.0%	50.0%	100.0%
Timber		100.0%	100.0%
Total	2.8%	97.2%	100.0%

Table 35: User conflicts to TOF products presented as relative TOF areas in which the products are exploited

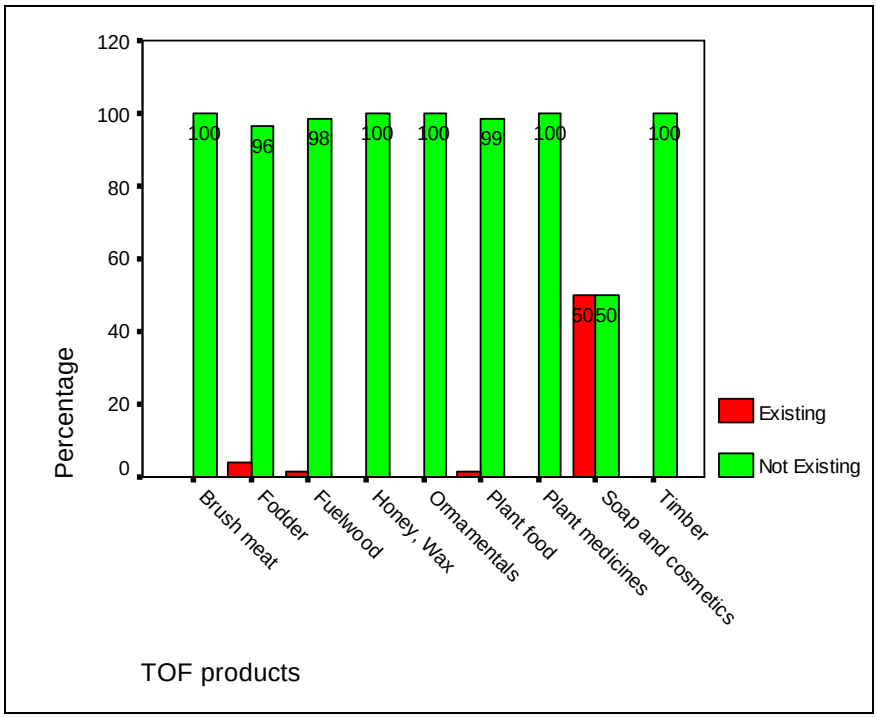


Figure 21: User conflicts to TOF products presented as relative TOF areas in which the products are exploited

2.1.1.11 User right to wood and non-wood forest products

To collect/use a wood or non-wood forest product, we find the following users right options: "*The use of product is reserved for the land owner*", "*the use of the product is a common right and the use of product is prohibited*" and "*no right to use product*".

The user rights to products are estimated from the areas from which the products are collected/ used and are shown in table 36.

% of interviewed people of user rights to exploit forest products (103 interviewed people)

% within D

	User Rights					
	Not applicable	Exclusive rights	No right	Not exclusive right	Not known	Total
Bush meat		100.0%				100.0%
Charcoal		50.0%	50.0%			100.0%
Fodder		100.0%				100.0%
Fuelwood	1.6%	90.2%	4.9%	3.3%		100.0%
Honey, wax		42.9%		42.9%	14.3%	100.0%
Ornamentals		100.0%				100.0%
Plant food		72.7%		22.7%	4.5%	100.0%
Plant medicines		20.0%		60.0%	20.0%	100.0%
Soap and cosmetics				100.0%		100.0%
Timber		50.0%	50.0%			100.0%
Total	1.0%	77.7%	4.9%	13.6%	2.9%	100.0%

Table 36: User rights to forest products presented as relative forest areas in which the products are exploited

As we can see in figure 22, for most of the forest area the use of forest products is reserved for land owner.

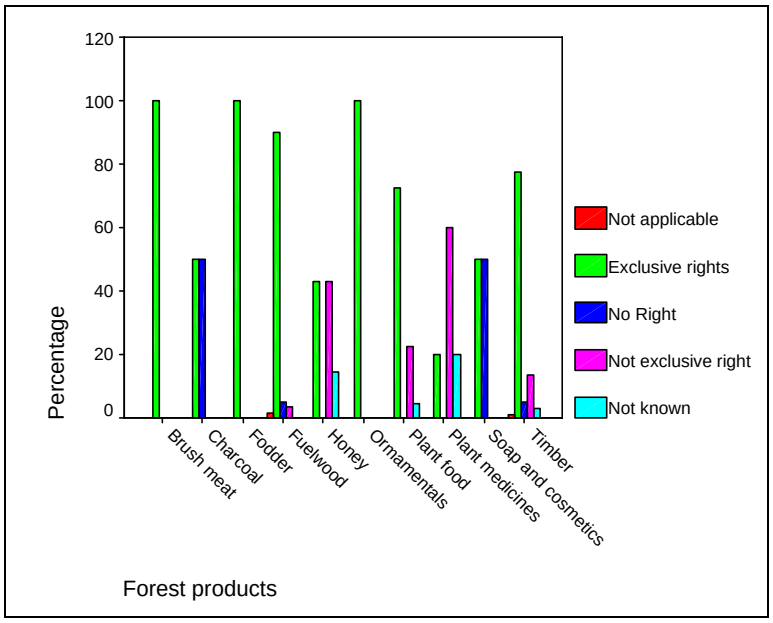


Figure 22: User rights to forest products presented as relative forest areas in which the products are exploited

2.1.1.12 User right to wood and non-wood TOF products

The same approach is done for users' right of the trees outside forest to exploit trees products by the percentage of interviewed people. The results show that 86% of products are with exclusive right and 12.2 % have no exclusive right.

% of Interviewed people of user rights to exploit TOF products (633 interviewed people)

% within D

ToF products	User Rights					Total
	Not applicable	Exclusive rights	No right	Not exclusive right	Not known	
Bush meat				100.0%		100.0%
Fodder		77.2%		21.8%	1.0%	100.0%
Fuelwood		85.1%	9.0%	6.0%		100.0%
Honey, wax		33.3%		66.7%		100.0%
Ornamentals		63.2%		36.8%		100.0%
Plant food	.2%	92.1%		7.7%		100.0%
Plant medicines	20.0%	80.0%				100.0%
Soap and cosmetics		100.0%				100.0%
Timber		100.0%				100.0%
Total	.3%	86.4%	.9%	12.2%	.2%	100.0%

Table 37: User rights to TOF products presented as relative TOF areas in which the products are exploited

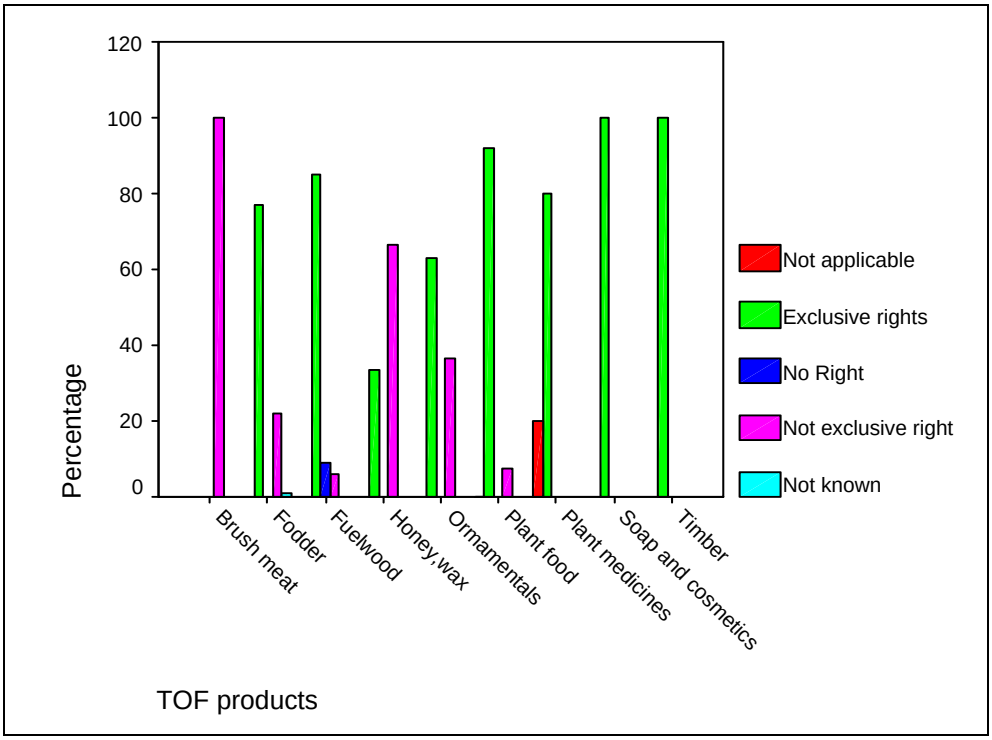


Figure 23: User rights to forest products presented as relative forest areas in which the products are exploited

2.1.1.13 Exploitation of wood and non-wood forest products by Gender, Child labour and Enterprise form

The exploitation of forest products by gender, child labour and enterprise form is presented as the relative forest area in which the products are collected.

Products	Gender balance (women labour)			Children labour		Enterprise form	
	30-70%	**<30 %**	**>70%**	**No**	**Yes**	**Spontaneous**	**Organised**
Bush meat		100%		100%			100%
Charcoal		100%		100%			100%
Fodder		100%		100%		50%	50%
Fuel wood	11%	88%	1%	92%	8%	30%	70%
Honey, wax	10%	90%		100%		20%	80%
Ornamentals		100%		100%			100%
Plant food	28%	72%		100%		19%	81%
Plant medicines	38%	62%		100%			100%
Soap and cosmetics		100%		100%			100%
Timber		100%		100%		33%	67%

Table 38: Exploitation of forest products by gender, child labour and enterprise form presented as the relative forest areas in which the products are exploited

2.1.1.14 Exploitation of wood and non-wood TOF products by Gender, Child labour and Enterprise form

Outside forest, children labours are used at 6.5% in harvest products especially in plant food. The enterprises are equivalent divided into spontaneous and organized.

Products	Gender balance (women labour)			Children labour		Enterprise form	
	30-70%	**<30 %**	**>70%**	**No**	**Yes**	**Spontaneous**	**Organised**
Fodder	28%	72%		77%	23%	67%	33%
Fuelwood	18%	82%		98 %	2%	46%	54%
Honey, wax	36%	64%		100%		13%	87%
Ornamentals	53%	47%		100%		.1%	1.7%
Plant food	30%	67%	2%	96%	4%	7%	93%
Plant medicines	50%	38%	12%	100%		56%	44%
Soap and cosmetics	26%	48%	26%	48%	52%	12%	88%
Timber	44%	56%		78%	22%	81%	19%

Table 39: Exploitation of TOF products by gender, child labour and enterprise form presented as the relative TOF areas in which the products are exploited

10.14.2 Use of Services

The same study of the products is done for the services types provided by forest and outside forest present in the plot. We begin by the rank order, than by the supply and demand types, and finally the user rights and conflicts and ending by the type of enterprises are done.

2.1.1.15 Use of Forest services

%frequency of forest services according to their rank (of 134 interviewed people)

Services of forest		Rank			Total
		High	Low	Medium	
	Conservation	.7%		.7%	1.5%
	Grazing	11.2%	3.0%	5.2%	19.4%
	Hunting (sport)	.7%	.7%	.7%	2.2%
	Recreation and tourism	1.5%	1.5%	3.0%	6.0%
	Soil and water	46.3%	10.4%	11.2%	67.9%
	Source for employment		.7%	1.5%	2.2%
	Vindbreaking curtins			.7%	.7%
Total		60.4%	16.4%	23.1%	100.0%

Table 40: Use of forest services (ranked) presented as the relative forest areas in which the services are used

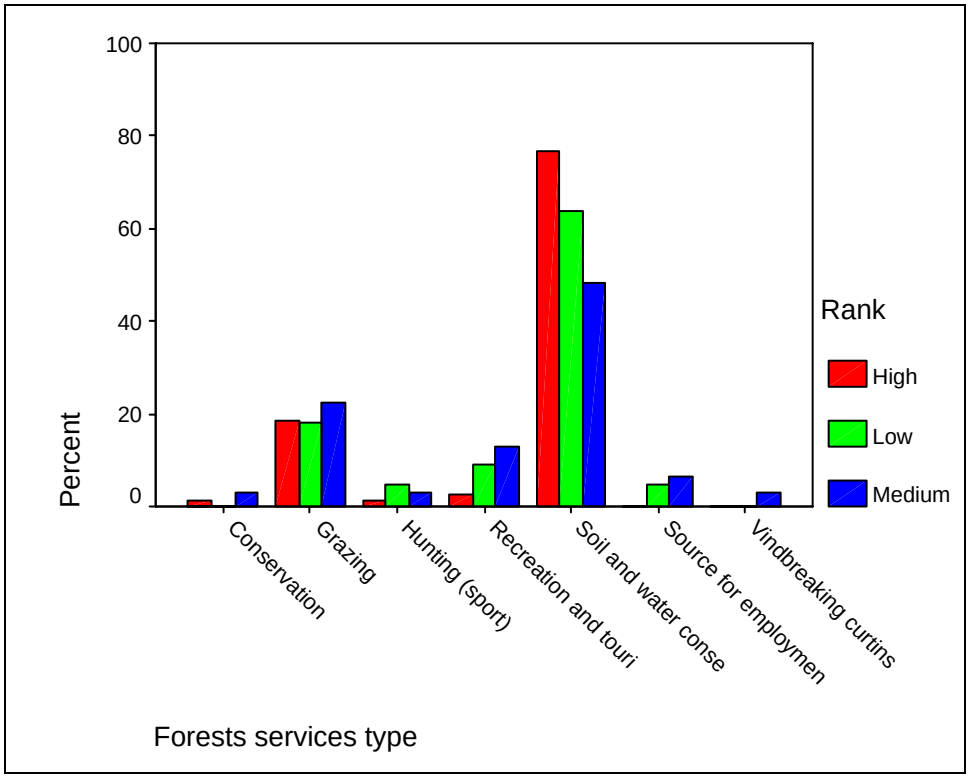


Figure 24: Use of forest services (ranked) presented as the relative forest areas in which the services are used

The soil and water are the most important services with 46.3%. The grazing has the second high importance of all the services type.

2.1.1.16 Use of TOF Services

Outside forest, grazing is the most important service, recorded as high ranked in 45.1% of the TOF area.

%frequency of TOF services according to their rank (of 384 interviewed people)

		Rank			
		High	Low	Medium	Total
	Grazing	45.1%	.3%	4.2%	49.5%
	Hunting (sport)	1.8%	1.6%	1.0%	4.4%
	Recreation and tourism	1.0%	.5%	.3%	1.8%
	Shade	3.9%	1.0%	6.8%	11.7%
	Soil and water	15.4%	3.9%	9.1%	28.4%
	Source for employment	.3%	.5%		.8%
	Vindbreaking curtins	1.6%	.3%	1.6%	3.4%
Total		69.0%	8.1%	22.9%	100.0%

Table 41: Use of TOF services (ranked) presented as the relative TOF areas in which the services are used

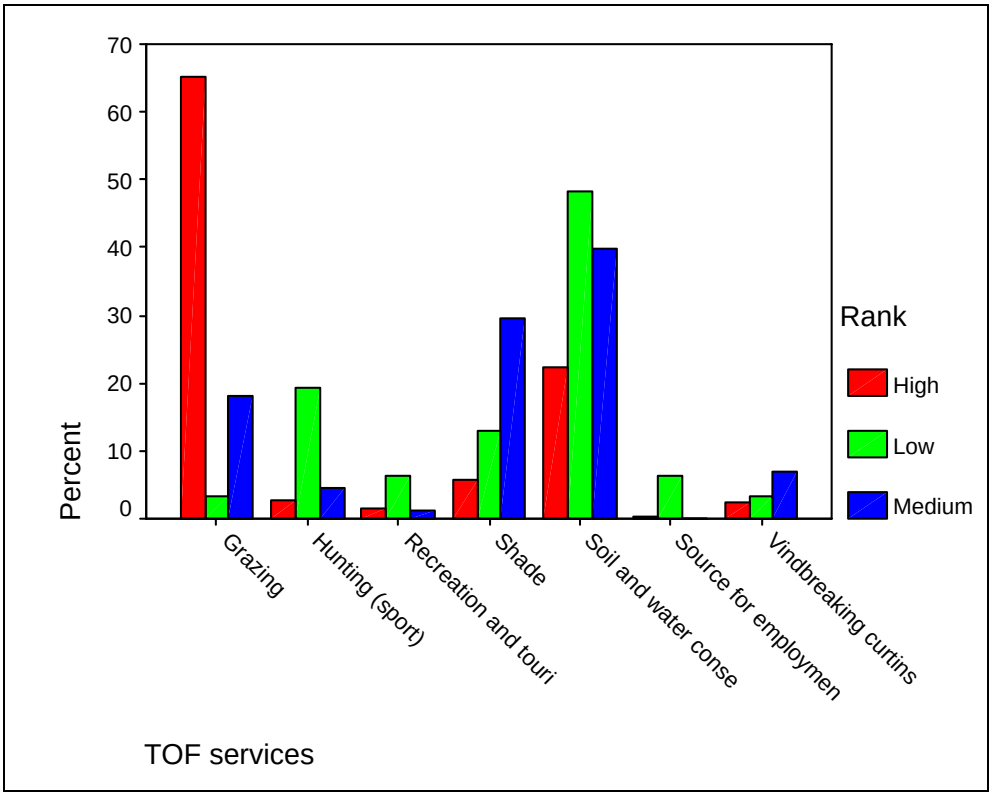


Figure 25: Use of TOF services (ranked) presented as the relative TOF areas in which the services are used

10.14.3 Demand and supply trends for forest services

For the services demand and stock/ supply of services during the five years, the frequency of each category of supply and demand for the different type of services, is listed below:

Relative frequency of forest services demand and supply (43 interviewed people)

% within ProductType_text_eng

SupplyTrend		DemandTrend			Total
		Decreasing	Stable	Increasing	
Decreasing	Grazing	11.1%	55.6%	33.3%	100.0%
	Hunting (sport)		100.0%		100.0%
	Total	10.0%	60.0%	30.0%	100.0%
Stable	Conservation		100.0%		100.0%
	Grazing		63.6%	36.4%	100.0%
	Recreation and tourism			100.0%	100.0%
	Soil and water conservation		100.0%		100.0%
	Vindbreaking curtins		100.0%		100.0%
	Total		81.5%	18.5%	100.0%
Increasing	Grazing			100.0%	100.0%
	Hunting (sport)		100.0%		100.0%
	Recreation and tourism			100.0%	100.0%
	Total		16.7%	83.3%	100.0%

Table 42: Supply and demand trends for forest services presented as relative forest area in which the products are used.

2.1.1.17 Demand and supply trends for TOF services

Relative frequency Demand and supply of TOF services (212 interviewed people)

% within ProductType_text_eng

SupplyTrend		DemandTrend			Total
		Decreasing	Stable	Increasing	
Decreasing	Grazing	1.7%	31.7%	66.7%	100.0%
	Hunting (sport)		61.5%	38.5%	100.0%
	Soil and water conservation		100.0%		100.0%
	Total	1.4%	37.8%	60.8%	100.0%
Stable	Grazing	2.9%	85.7%	11.4%	100.0%
	Hunting (sport)		100.0%		100.0%
	Recreation and tourism			100.0%	100.0%
	Shade		100.0%		100.0%
	Soil and water conservation		100.0%		100.0%
	Vindbreaking curtins		100.0%		100.0%
	Total	1.7%	88.7%	9.6%	100.0%
Increasing	Grazing	5.6%	16.7%	77.8%	100.0%
	Hunting (sport)	100.0%			100.0%
	Recreation and tourism	25.0%		75.0%	100.0%
	Total	13.0%	13.0%	73.9%	100.0%

Table 43: Supply and demand trends for TOF services presented as relative TOF area in which the products are used.

2.1.1.18 User conflicts to forest services

In table 44, we present the existence of user conflicts to forest services. There are relatively little user conflicts to forest services and grazing is the service with most user conflicts, recorded in 11.1% of the grazed forest area.

% frequency of conflicts over forest services (120 interviewed people)

% within ProductType_text_eng

Forest services	UserConflicts: Existing (Yes)	UserConflicts: Not existing (No)	Total
Conservation		100.0%	100.0%
Grazing	11.1%	88.9%	100.0%
Hunting (sport)		100.0%	100.0%
Recreation and tourism		100.0%	100.0%
Soil and water conservation	1.1%	98.9%	100.0%
Source for employment (paid)		100.0%	100.0%
Vindbreaking curtins		100.0%	100.0%
Total	2.5%	97.5%	100.0%

Table 44: User conflicts to forest services presented as relative forest areas in which the services are used

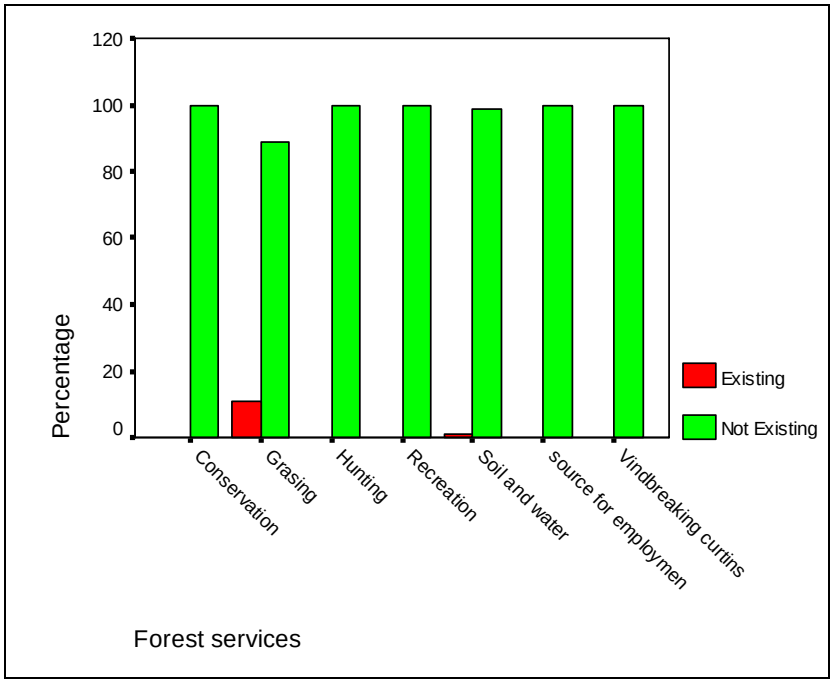


Figure 26: User conflicts to forest services presented as relative forest areas in which the services are used

2.1.1.19 User conflicts to TOF services

% frequency of user conflicts over TOF services (349 interviewed people)

% within ProductType_text_eng

TOF services	UserConflicts: Existing (Yes)	UserConflicts: Not existing (No)	Total
Grazing	5.1%	94.9%	100.0%
Hunting (sport)		100.0%	100.0%
Recreation and tourism		100.0%	100.0%
Shade		100.0%	100.0%
Soil and water conservation	3.7%	96.3%	100.0%
Source for employment (paid)		100.0%	100.0%
Vindbreaking curtins		100.0%	100.0%
Total	3.4%	96.6%	100.0%

Table 45: User conflicts to TOF services presented as relative TOF areas in which the services are used

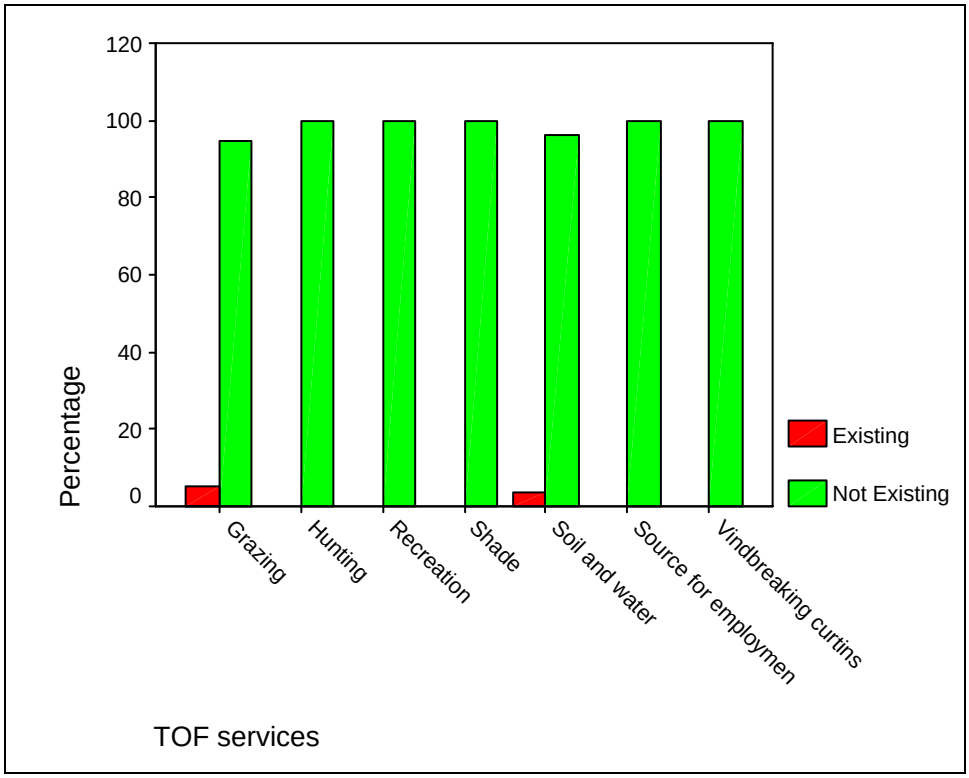


Figure 27: User conflicts to TOF services presented as relative TOF areas in which the services are used

2.1.1.20 User rights to Forest Services

User rights ditribution over forest services (136 interviewed people)

% within ProductType_text_eng

Forest services	UserRights					Total
	Not applicable	Exclusive rights	No right	Not exclusive right	Not known	
Conservation		50.0%		50.0%		100.0%
Grazing		100.0%				100.0%
Hunting (sport)		33.3%	33.3%	33.3%		100.0%
Recreation and tourism	25.0%	50.0%		12.5%	12.5%	100.0%
Soil and water conservation	3.2%	60.2%	1.1%	33.3%	2.2%	100.0%
Source for employment (paid)		100.0%				100.0%
Vindbreaking curtins		100.0%				100.0%
Total	3.7%	67.6%	1.5%	25.0%	2.2%	100.0%

Table 46: User rights to forest services presented as relative forest areas in which the services are used

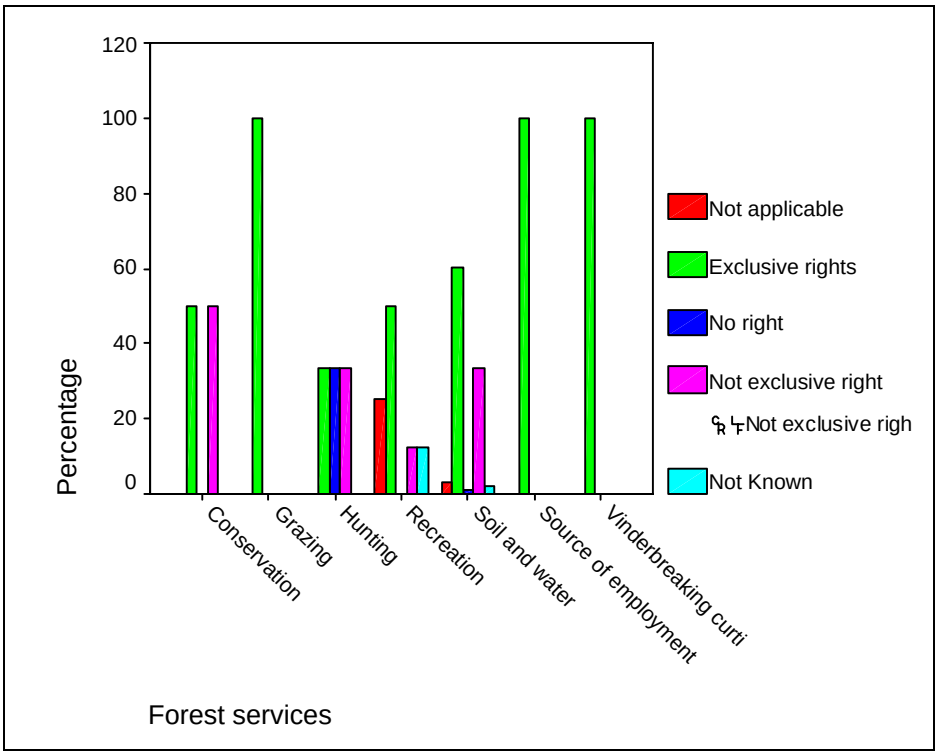


Figure 28: User rights to forest services presented as relative forest areas in which the services are used

2.1.1.21 User rights to TOF Services

Distribution of User right to exploit TOF services (389 interviewed people)

% within ProductType_text_eng

TOF services	UserRights: Not applicable	Exclusive rights	No right	Not exclusive right	Not known	Total
Grazing	1.1%	74.7%		22.1%	2.1%	100.0%
Hunting (sport)		17.6%	23.5%	58.8%		100.0%
Recreation and tourism	12.5%	62.5%		12.5%	12.5%	100.0%
Shade	2.2%	71.1%		26.7%		100.0%
Soil and water conservation	2.7%	27.7%	.9%	68.8%		100.0%
Source for employment (paid)		100.0%				100.0%
Vindbreaking curtins	7.1%	71.4%		21.4%		100.0%
Total	2.1%	58.1%	1.3%	37.3%	1.3%	100.0%

Table 47: User rights to TOF services presented as relative TOF areas in which the services are used

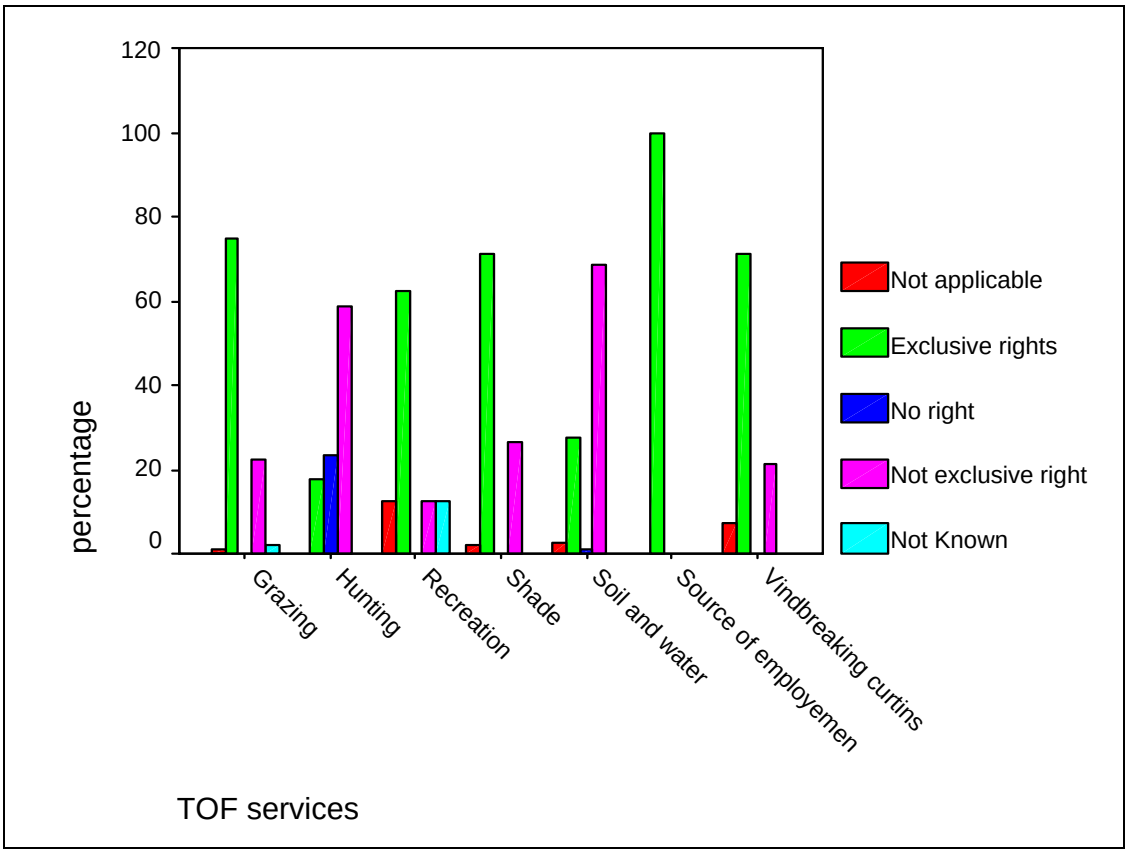


Figure 29: User rights to TOF services presented as relative TOF areas in which the services are used

2.1.1.22 Use of forest services by Gender, Child labour and Enterprise form

Services	Gender balance (women labour)			Child labour		Enterprise form	
	30-70%	**<30 %**	**>70%**	**No**	**Yes**	**Spontaneous**	**Organised**
Grazing	15%	83%	2%	88%	12%	25%	75%
Hunting (sport)		100%		100%			100%
Recreation and tourism	62%	38%		100%		38%	62%
Soil and water conservation	17%	82%	1%	97%	3%	27%	73%
Source for employment (paid)	86%	14%		100%		42.9%	57%
Vindbreaking curtins	100%			100%		100%	

Table 48: Use of forest services by gender, children and enterprise form presented as the relative forest areas in which the services are used

2.1.1.23 Use of TOF services by Gender, Child labour and Enterprise form

Services	Gender balance (women labour)			Child labour		Enterprise form	
	30-70%	**<30%**	**>70%**	**No**	**Yes**	**Spontaneous**	**Organised**
Grazing	21%	78%	1%	98%	2%	41%	59%
Hunting (sport)	31%	66%	29%	97%	3%	11%	89%
Recreation and tourism	47%	29%	24%	88%	12%	47%	53%
Shade	42%	53%	5%	92%	8%	39%	61%
Soil and water conservation	26%	72%	2%	100%		18%	82%
Source for employment (paid)	57%	43%		100%		29%	71%
Vindbreaking curtins	21%	79%		100%		79%	21%

Table 49: Use of TOF services by gender, children and enterprise form presented as the relative TOF areas in which the services are used

10.15. Local population

10.15.1 Tracts by settlement history

We study the local population by the major historical events affecting the local people and the date when the land was occupied. By excluding tracts that have not applicable settlement history, the frequency of the different settlement history is shown below. We can see that the agricultural expansion has been the most important settlement history (36.7%) in sampled tracts.

Settlement History	Percentage
Land Tenure Change	2
Wars/Armed conflicts	9
Socio-economical crisis	11
Agricultural contraction	20
Urban expansion	21
Agricultural expansions	37
Total	100

Table 50: Relative distribution of settlement history presented for the populated parts of the country

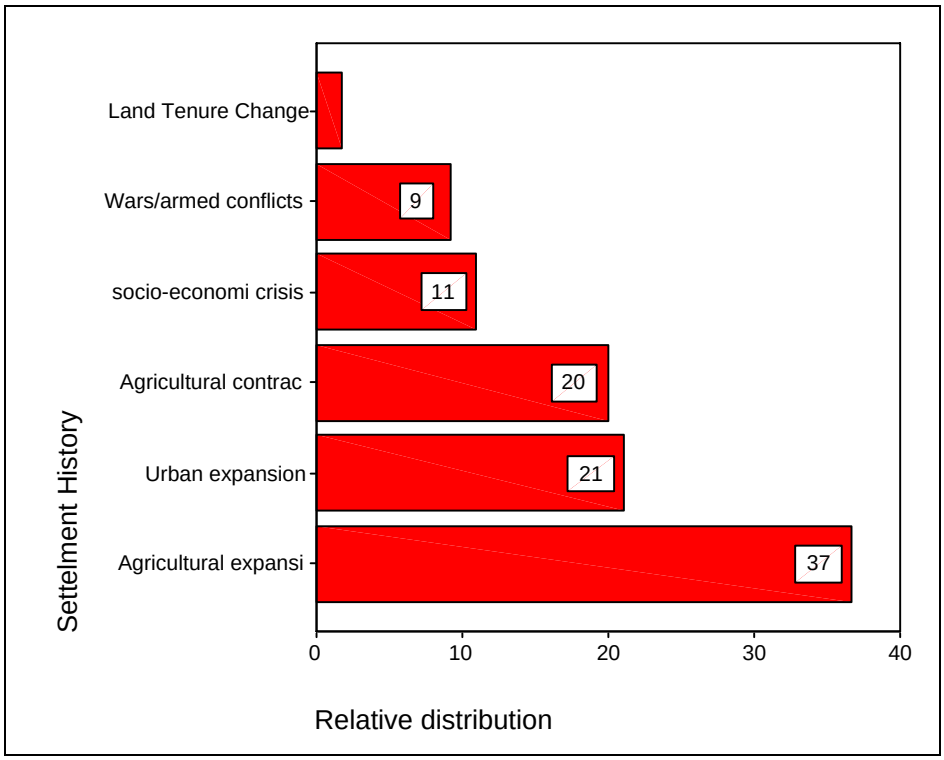


Figure 30: Relative distribution of settlement history presented for the populated parts of the country

10.15.2 Population main activities

The *Main Activity* is the main income generation and employment source of the permanent population living within tract, please refer to table 51 and table 52. The most common main activity is agriculture (58%) followed by urban and semi-urban activities (28%).

The *Overall Main Activity* is the main income generation and employment sources of most of the total population including both permanent and seasonal population living within tract, please refer to table 53.

Population Main activity	Percentage
Tourism	2
Forestry	3
Live stock	9
Urban or semi urban	27
Agriculture	58
Not Known	1
Total	100

Table 51: Relative distribution of the population's main activities

The trend of the size population lived in or close to the tract, in the past five years is shown in figure 31. We find that 59.6% of the populated country area had increasing population size during the last five years.

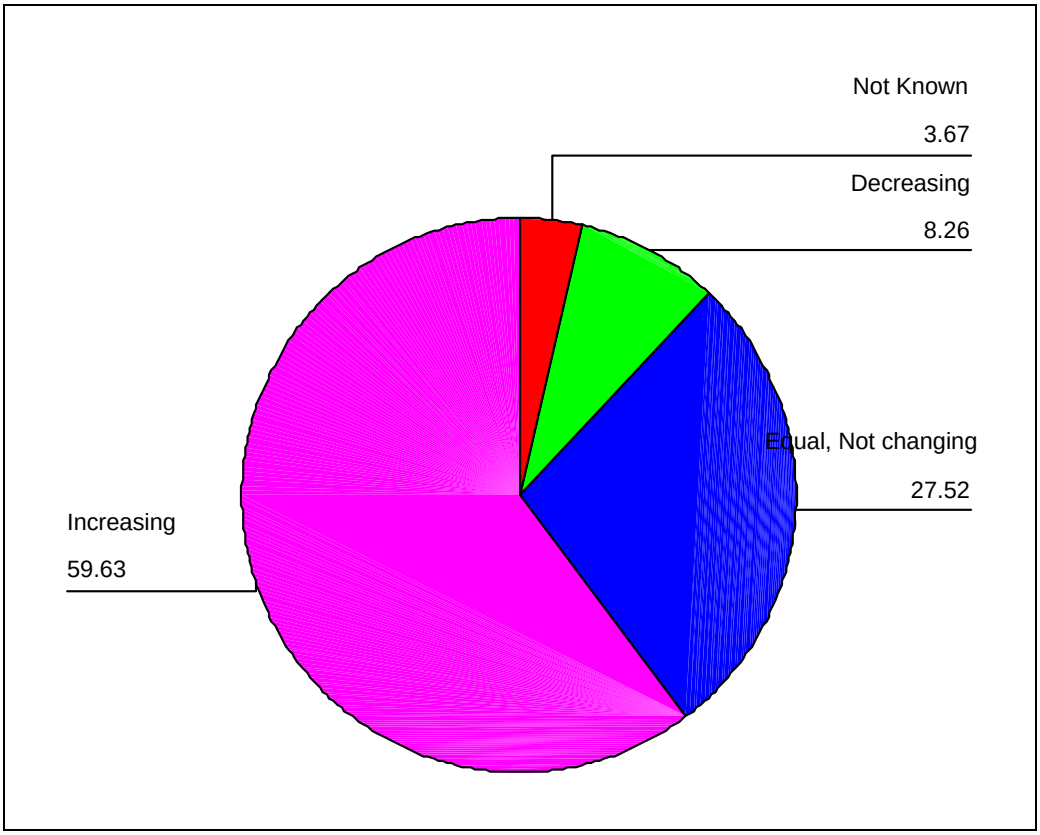


Figure 31: Relative distribution of the population dynamics within the last five years

10.15.3 Population dynamics by permanent population main activity

Pop Dynamics / Pop Main activities	Increasing	Equal, Not changing	Decreasing	Not known
Urban	72.4	13.8	13.8	
Agriculture	61.9	31.7	4.8	1.6
Live Stock	40	40	20	
Forestry	33.3	33.3		33.3
Tourism		50		50

Table 52: Relative distribution of the population dynamics by the permanent population's main activity (107 tracts)

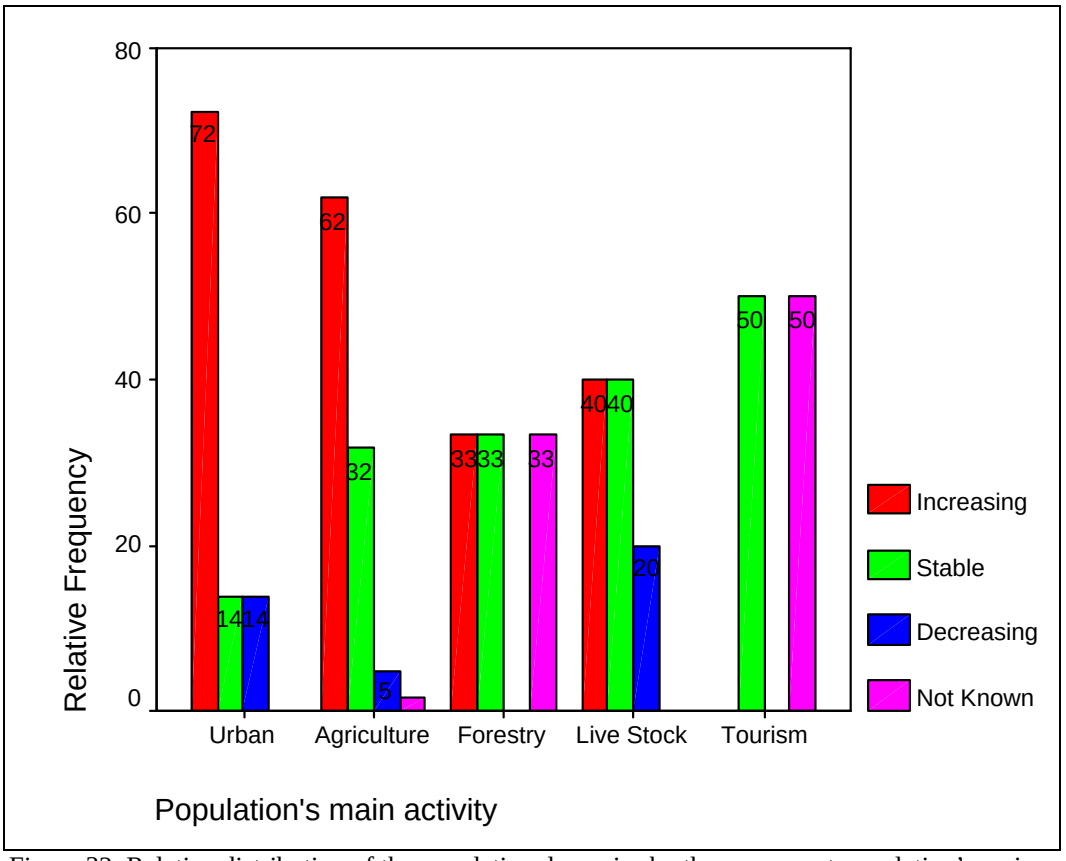


Figure 32: Relative distribution of the population dynamics by the permanent population's main activity (107 tracts)

10.15.4 Population dynamics by total population's main activity

Pop Dynamics / Total Pop Main activities	Increasing	Equal, Not changing	Decreasing	Not known
Urban	61.9	21.4	9.5	7.1
Agriculture	61.8	30.9	5.5	1.8
Forestry	50	50		
Live Stock	37.5	37.5	25	

Table 53: Relative distribution of the population dynamics by the total population's main activity (107 tracts)

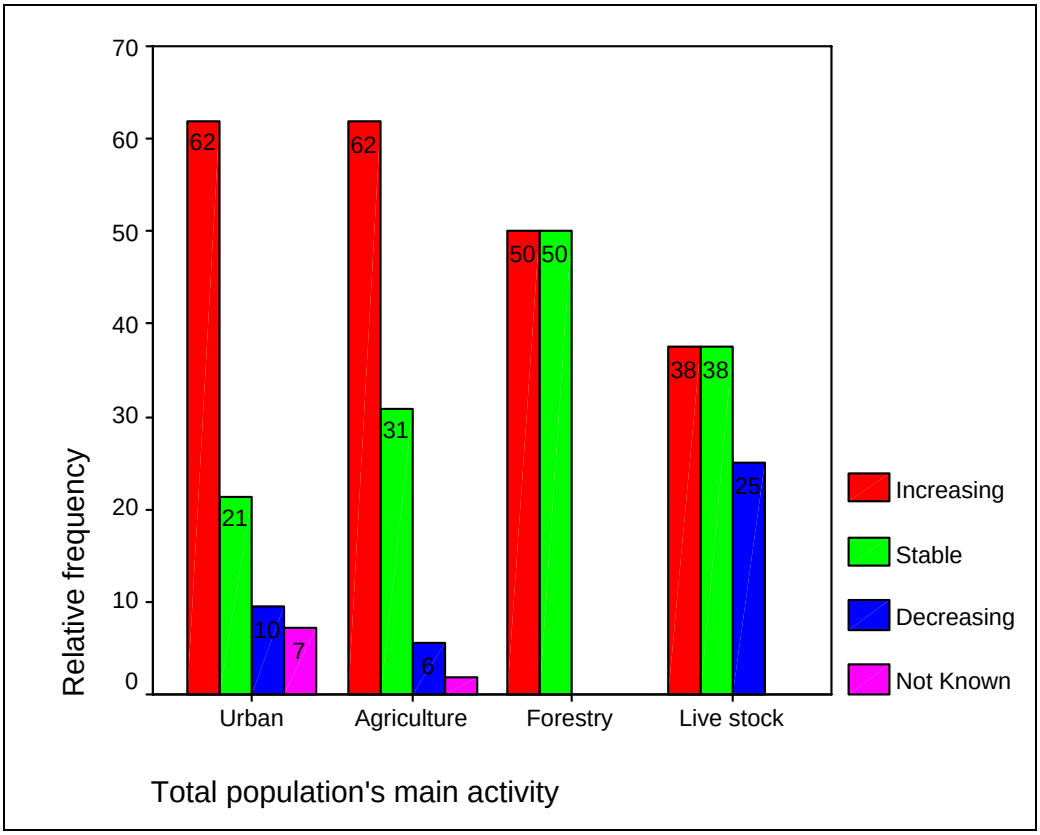


Figure 33: Relative distribution of the population dynamics by the permanent population's main activity (107 tracts)

10.16. Accessibility

It's important to see the accessibility to the tracts. We study the distance from tract centre to different services as; hospitals, schools, settlements, markets, roads, etc. The distances are classified in 2,5km classes and when we draw the histograms to see if it has a normal distribution we find the average and the standard deviation of each distance.

10.16.1 Accessibility to hospitals and schools

The accessibility to hospitals is shown as staples in figure 34 together with a curve for the normal distribution. Based on 210 accessible tracts, the average distance from the tract centre to the closest hospital is 7.7 km. The standard deviation is about 6.4 Km.

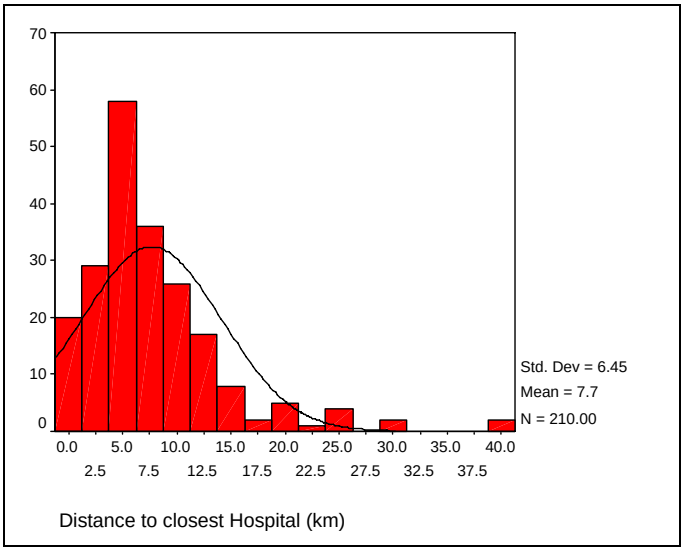


Figure 34: Distance from tract centre to closest hospital

The accessibility to schools is shown as staples in figure 35 together with a curve for the normal distribution. Based on 212 accessible tracts, the average distance from the tract centre to the closest school is 3.2 km. The standard deviation is about 4.5 Km.

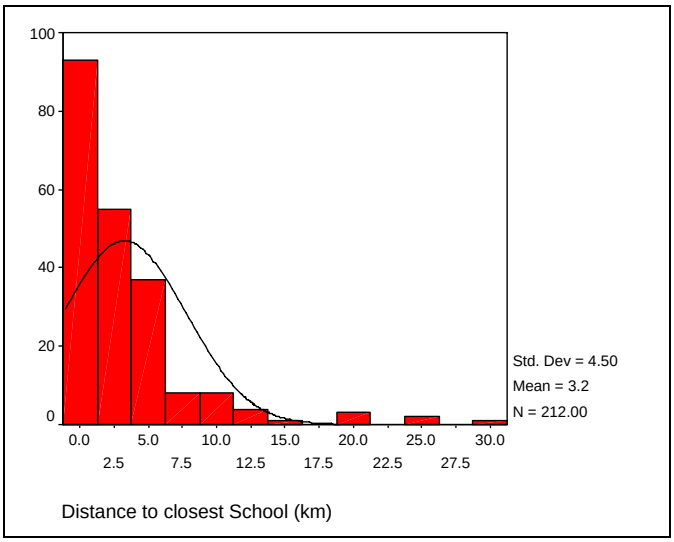


Figure 35: Distance from tract centre to closest school

10.16.2 Accessibility to the Settlements and Markets

The accessibility to markets is shown as staples in figure 36 together with a curve for the normal distribution. Based on 211 accessible tracts, the average distance from the tract centre to the closest market is 4.2 km. The standard deviation is about 5.1 Km.

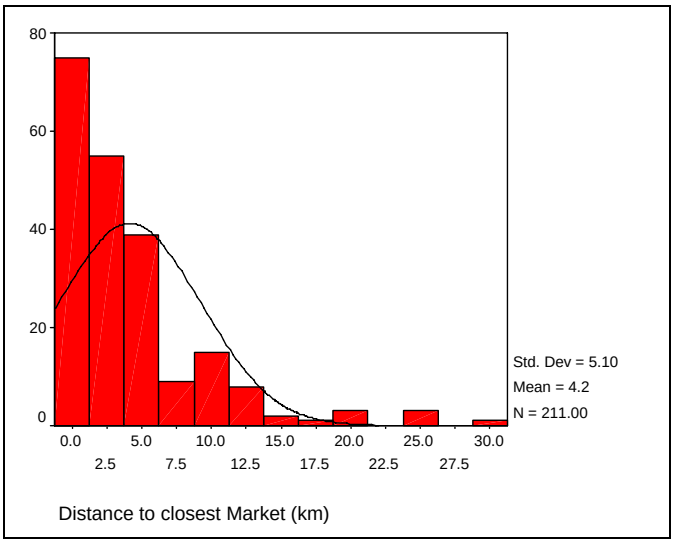


Figure 36: Distance from tract centre to closest market

The accessibility to settlements is shown as staples in figure 37 together with a curve for the normal distribution. Based on 211 accessible tracts, the average distance from the tract centre to the closest settlement is 1.7 km. The standard deviation is about 3.8 Km.

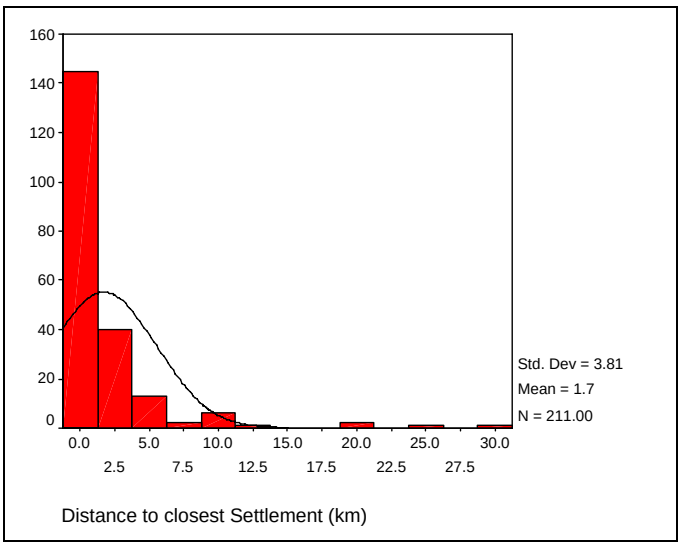


Figure 37: Distance from tract centre to closest settlement

Accessibility to the all weather road and Seasonal road

The accessibility to all-weather roads is shown as staples in figure 38 together with a curve for the normal distribution. Based on 213 accessible tracts, the average distance from the tract centre to the closest all-weather road is 0.9 km. The standard deviation is about 3.3 Km.

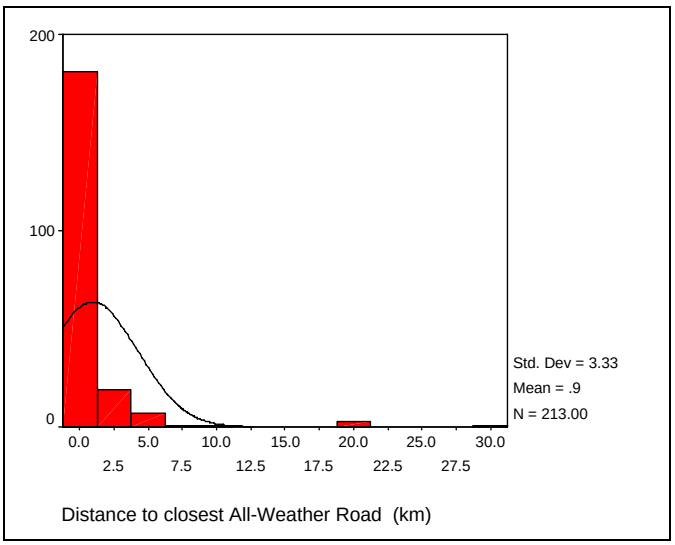


Figure 38: Distance from tract centre to closest all-weather road

The accessibility to seasonal roads is shown as staples in figure 39 together with a curve for the normal distribution. Based on 213 accessible tracts, the average distance from the tract centre to the closest seasonal road is 0.5 km. The standard deviation is about 2.86 Km.

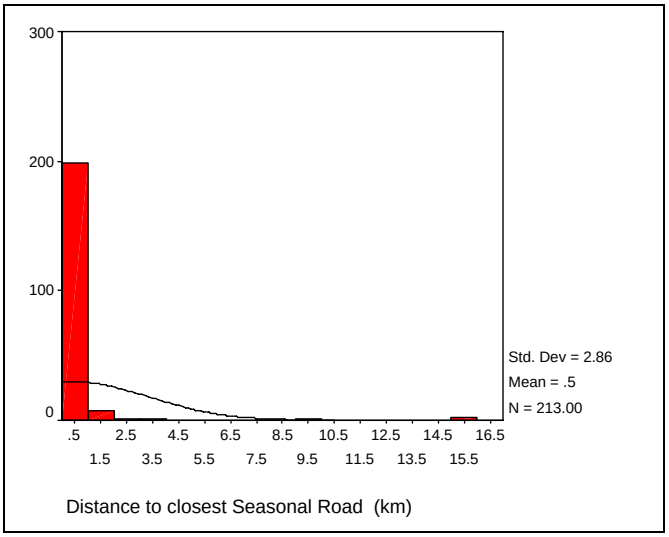


Figure 39: Distance from tract centre to closest seasonal road

14. Comparison of NFA results with existing information{ TC "14. Comparison of NFA results with existing information" \f C \l "1" }

- land use / land cover areas,
- timber volume,
- state of the forest and tree resources,
- local population,
- biodiversity

The project will generate 2 sets of area data, one from the field survey and one from the derived map of forest and TOF resources of Lebanon. Both sets should be compared with the earlier data sets: i.e. the LCLU map and the 1965 map of the forest of Lebanon.

The National classes reported for FRA 2000 was based on the 1965 forest type map and provided the following figures were reported:

National Class	**Area (000 ha)**
Oak forest	40.0
Pines on Limestone (*Pinus brutia* especially)	5.0
Pines on sandstone (*Pinus pinea*)	12.0
Cedar forests	2.0
Fir forests (*Abies cilicica)*	1.0
Juniper forest	9.0
Cypress forest	0.5
Total	**69.5**

Source: FAO 2004A)

Translated into FRA global classes the forest resources of Lebanon were interpreted as follows for the FRA2000:

FRA2000 Global class	**Area (000 ha)**
Forest	36
Other Wooded Land	35
Other Land	954
Inland Water	17
FAOSTAT Area	**1040**

Source: FAO 2001

15. Capacity building{ TC "15. Capacity building" \f C \l "1" }

According to the Project Document output 1, mentioned in Chapter 3, one of the major project outputs is that the capacity of the Forestry Department of the DRDNR to plan and implement forest inventories, monitor the resources, manage the related information, and contribute to advance sustainable forest and tree management by enabling an increased use of forestry knowledge in forest policy development and implementation must be enhanced and strengthened.

As TCP/LEB/2903 is the first time a systematic National Forest Assessment based on field measurements, interviews and observations was implemented in Lebanon, the starting point was therefore one where the basics of practical fieldwork had to be built up first.

The lack of tradition in the field of NFA was however outweighed by the very motivated, well educated staff of the Forest Department of DRDNR and the Regional Development Services of MOA who under the strong leadership of the National Project Coordinator quickly picked up on the various methodologies.

The current chapter describes the various capacity building aspects of TCP/LEB/2903.

15.1 Staff{ TC "15.1 Staff" \f C \l "2" }

The various training aspects of the project are described in section 7.2.

15.1 Capacity to undertake fieldwork – field teams

At the start of the project period the tradition for undertaking systematic NFA was non-existent. The field teams were initially trained in the various measurement techniques. The most valuable training however came with experience through the field work supported by the continual supervision of the NC-FI and the TCDC-expert.

Slope correction of the measured distances proved somewhat of a challenge for the teams initially as the method used relied on the slope correction table of the field manual. The TCDC-expert introduced break-chaining i.e. measuring slopes in horizontal steps, which for short distances and fragmented landscape is an advantage as there is no subsequent adjustment of distance.

The navigational skills of the field teams by using GPS, compass and the georeferenced field maps quickly became good, although the terrain could pose serious problems and sometimes render parts of plots inaccessible due to slope.

At the end of the fieldwork phase, the teams performed well and delivered high quality field data and through the built up experience the field work was also performed more rationally. One major asset throughout the fieldwork phase was that the fieldteams knew the areas and surroundings well as they were based in the RDS of the Mohafaza.

15.2 Capacity to register and enter data - team leaders

The first forms that were submitted by the field teams had room for improvement. Through intensive checking of submitted reports by TC-DC and NC-FI the team leaders received instructions on what items were in need of correction with instructions on how to complete them. The quality of the submitted reports improved with field experience and by the end of the fieldwork phase, the

errors contained in the submitted reports were minor. Field forms were only cleared for entry into the database once cleared by both the TCDC-expert and the NC-FI.

The team leaders had responsibility for entering the field data in the database application developed by FORM and installed at the RDS's. In this connection the team leaders got acquainted with the Access Database, with the importance of data discipline and the importance of entering data as soon as possible after completion of a tract while the work was still fresh in memory.

As mentioned in section 9.2 data-entry proved to be a bottleneck for the 2nd project phase. Part of the explanation was the late establishment of functional facilities (PCs and database application) for decentralized data entry. Part of the explanation was also that after long days of field work and with a multitude of other responsibilities, it was not always possible for the field team leaders to find the time to enter data after a plot had been completed.

It was therefore necessary to recruit additional assistance to assist in the final phases of data entry in order to have all field data entered by late September 2004.

Considering that the starting point for some of the field team leaders was zero direct database experience, the project did provide a lift in the capacity of the team leaders in this field. In light of the delay in data entry it might however be reconsidered whether the team leader himself should enter the data next time or whether there could be an alternative.

With the exception of Mt. Lebanon, the submission of formal progress reports and updated workplans by the team leaders was not functioning optimally during the fieldwork phase. The information of status and plans for the fieldwork was primarily delivered to the NC-FI verbally. For future repetitions the example set by Mt. Lebanon Mohafaza is recommended followed by all Team Leaders. Progress reports for Mt. Lebanon Mohafaza are contained in appendix 4b.

Capacity to validate and merge data – NC-FI

The NC-FI was trained by the Technical Backstopping Officer from FORM during September in the fundamentals of validating and merging data and provided with a crash course in the fundamental statistics behind the NFA. Validating and merging the data from the secondary databases of the team leaders into the primary database at MOA was a time consuming, tedious task which the NC-ID tackled well. Part of the reasons for the time consumption was that some of the RDS's had used an older version of the database application and therefore the database structure had to be checked before merging. Another cause of time consumption was that although the field forms had been double checked for errors, errors could still occurs when entering the data by the team leaders and these needed to be weeded out before processing and analyzing the data.

The NC-FI evolved his skills in the Access Database application, from user level before TCP/LEB/2903 to highly skilled after the survey. The NFA had therefore caused a building of the capacity of the NC-FI and thereby MOA. Preferably the skills should be transferred to more individuals within MOA to decrease the vulnerability.

Capacity to process and analyse data – NC-FI

At the end of the project, the capacity of the Forest Department and the Regional was at a level where it processed all the necessary skills to repeat the NFA. The main challenge ahead is maintaining this level of skills in order to allow for remeasurement of the permanent sample sites.

Capacity to produce Maps NC-RS

15.2 Institutional Strengthening{ TC "**15.2 Institutional Strengthening**" \f C \l "2" **}**
- Workshop on needs and requirements for strengthening the FD.
- Bilateral talks

16. Time and cost analysis{ TC "16. Time and cost analysis" \f C \l "1" }

17. Conclusions{ TC "17. Conclusions" \f C \l "1" }

18. Recommendations{ TC "18. Recommendations" \f C \l "1" }

According to Output 6 of the Project Document, mentioned in chapter 3, priority areas must be identified and recommendations given to the trained national team from the Forestry Department to build on the project findings in order to develop a forestry action plan, reformulate forestry policy/strategies if needed, identify specific projects for detailed forest inventories, forest and tree resources development and/or conservation, etc.

The strategy adopted by DRDNR for the formulation of recommendations and priority areas was to hold a workshop on project findings in late 2004/early 2005 and to consider the feedback provided from the workshop participants during this workshop in the formulation of recommendations and priority areas allowing for the completion of the current chapter so the current report can be completed and submitted to FORM in time for the February 2005 meeting of the FRA Advisory Group.

During the first quarter of 2005, the report will be fine polished, based on comments and recommendations and possibly suggestions for further data analysis provided by the workshop on project findings. The final report on the project findings and the final version of the derived map of forest and TOF resources of Lebanon will be presented to the public on a final workshop during the first quarter of 2005.

18.1 Future monitoring of the resources{ TC "**18.1 Future monitoring of the resources**" \f C \l "2" **}**

18.2 Additional information needs{ TC "**18.2 Additional information needs**" \f C \l "2" **}**

18.3 Actions for resources development{ TC "**18.3. Actions for resources development**" \f C \l "2" **}**

DRDNR could consider the following:
- increased collabouration with other institutions e.g. NCRS, DSC, NGOs, Universities etc
- proposal for future organizational diagram for NFA in Lebanon
- improved internet access in MOA will facilitate the exchange and dissemination of information
- a policy concerning data-security. The current project was luckily not affected by any virus infections of the computers, but would have been extremely vulnerable if infected.

18.4 International Reporting
{ TC "**18.4 International Reporting**" \f C \l "2" **}**

19. Bibliography{ TC "19. Bibliography" \f C \l "1" }

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