



# **NATIONAL FOREST ASSESSMENT PROGRAM**

## **LEBANON**

### **DATA ANALYSIS REPORT**

**BY**

**GENANE YOUNESS BEYDOUN**

**(FAO DATA ANALYSIS EXPERT)**

**JEAN ESTEPHAN**

**(MINISTRY OF AGRICULTURE)**

## **SOME GUIDELINES ON THIS REPORT**

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

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## I. Introduction

The aim of this report is to present the results obtained in the statistical data analysis of the National Forest Assessment of 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 I.

## II. Land Use/Land Cover Classification System

The Land Use / Land Cover classification system employed by the NFA is shown below. Level 1 corresponds to the FRA Global Classes – level 2 and 3 were decided upon at a workshop during the first project phase:

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

Table 1: Land Use/Land Cover classification system

<sup>1</sup>Mixed forest: is a forest which contains at least 25% each of coniferous and broadleaved tree species

<sup>2</sup>Mixed coniferous forest: is a forest which contains at least 25% each of two or more coniferous tree species

<sup>3</sup>Mixed broadleaved forest: is a forest which contains at least 25% each of deciduous and evergreen tree species

## II.1 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
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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 (due to inaccessibility) why they have been excluded from the analyses.

The classification system at level 1 can be summarized as follows<sup>1</sup>:

**Forest** is defined as a land area with a canopy cover of more than 10% and an area of at least 0.5 hectares. The trees should be able to reach a minimum height of 5 meters in situ.

**Other Wood Land** is defined as land either with a crown cover of 5-10% of trees that are able to reach a height of 5 m in situ or a crown cover of more than 10% of trees not able to reach a height of 5 m at maturity in situ or with shrub or bush cover of more than 10%.

**Other Land** is land that is not classified as the two above classes. It includes agricultural lands, built up areas, barren lands etc.

**Inland Water** 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)
<b>Forest</b>	211	13.3	0.034	0.067	50.37	139,376
<b>Other Wooded Land</b>	211	10.4	0.028	0.055	52.88	108,378
<b>Other Land</b>	211	76.3	0.046	0.09	11.79	797,152
<b>Inland Water</b>	211	----	0.00051	0.001	357.14	294
<b>Total area</b>		<b>100</b>				<b>1,045,200</b>

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

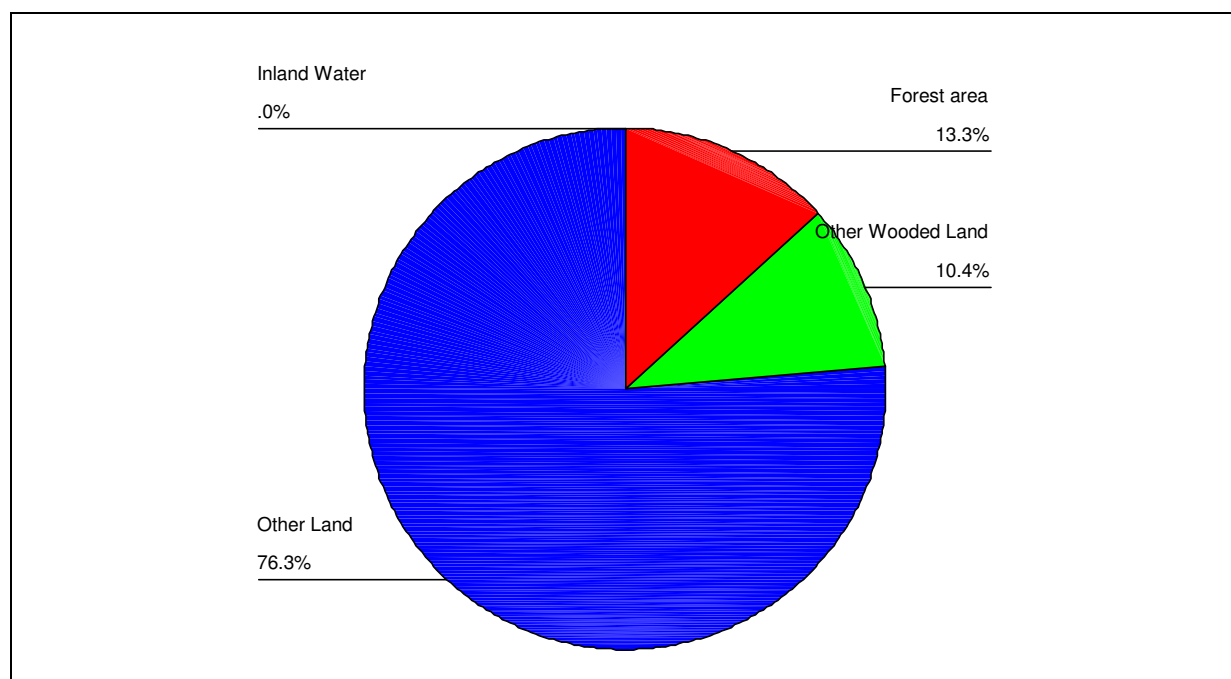


Figure 1: National area by land use classes

<sup>1</sup> For full definitions of the FRA Global Classes please refer to FAO Forestry Paper 140.

The results show that the estimated forest area of Lebanon is about 13.3 % of the total area (or 139,376 hectares). Other wooded land (OWL) covers about 10.4% (or 108,378 hectares) and a substantial part of the area 76.3% (or 797,152 hectares) is other land. Inland Water is negligible compared to the area of the other classes.

The estimated forest area of Lebanon is above 10% of the total area of the country, while former reports and estimations showed figures between 5 and 7%. The difference between former estimations and the result of the NFA can be attributed to the following:

- Unclear definitions for “forest” and “other wooded lands” for Lebanon in earlier estimates.
- Rapid urbanization with a considerable rural migration caused abandoning of agricultural lands and pastoral activities followed by invasion of many areas by forest during the second part of the 20<sup>th</sup> century.
- Reforestation activities and relative protection of many coniferous stands from cutting and felling during the past decades.

## II.2. 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 table 3 and figure 2.

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

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

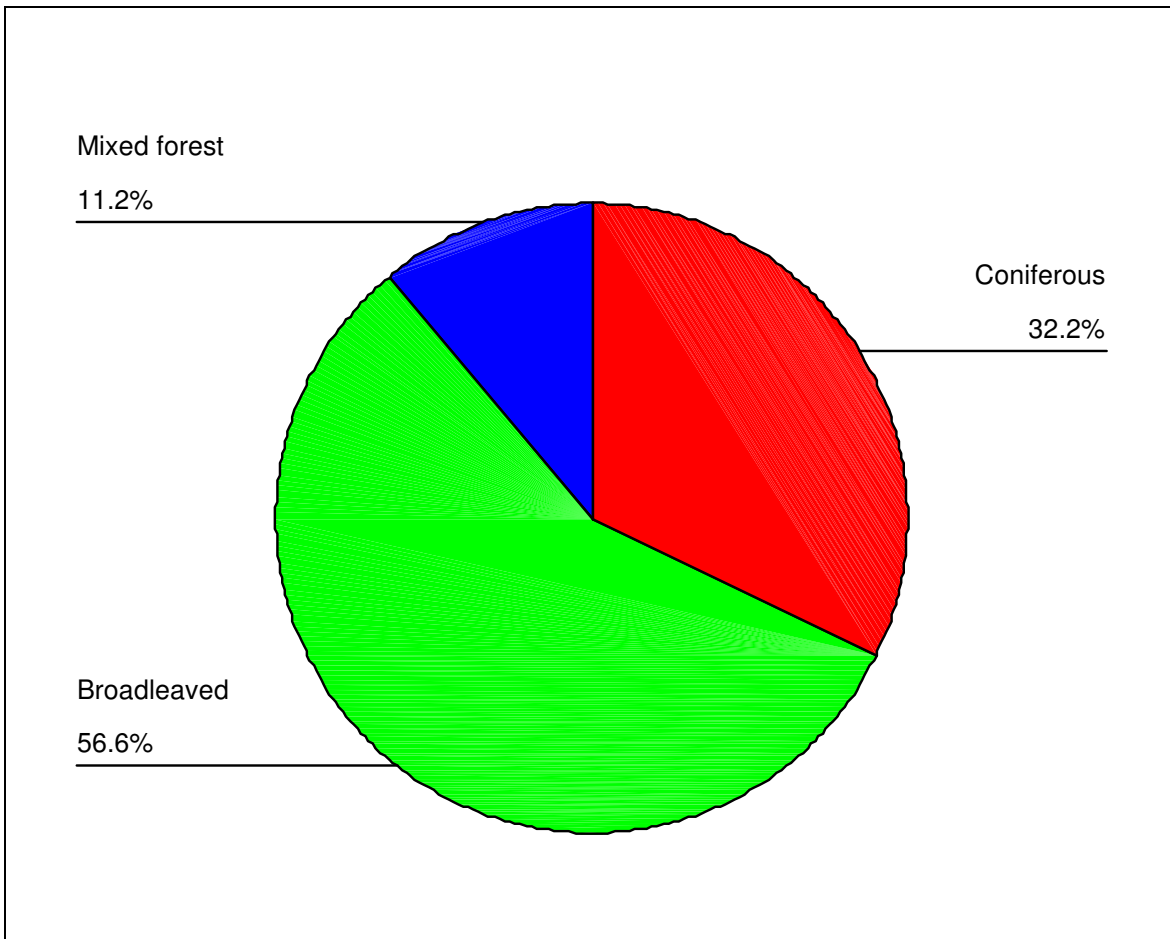


Figure 2: Forest area by forest type (level 2)

The results show that the forest area in Lebanon is dominated by broadleaved forests representing 56.6% of the total forest area (78,887 hectares). Coniferous forests are the second largest class accounting for 32.2 % of the forest area (44,879 hectares). Mixed Forest, defined as forest containing at least 25% each of coniferous trees and broadleaved trees accounts for 11.2% (15,610 hectares) of the total forest area.

Broadleaved species occupy the largest area because they constitute the major original vegetation formation in the Mediterranean area. In the subtropical dry forest and steppe, they form evergreen and mixed broadleaved coppices. In subtropical mountain they form mixed and deciduous forests. Broadleaved species have been always exploited, but as they regenerate easily (naturally and by coppicing) after cutting, they still occupy large areas although often in a somewhat degraded state.

Conifer forests are found mainly in the subtropical mountain zone in Mediterranean area. Through the times they have been exploited for wood consumption, and their area is assumed to have decreased dramatically. According to the NFA, 45,000 ha. of coniferous forest exist in Lebanon, primarily pine plantations for production of nuts, protected coniferous stands and reforested areas.

## II.3 Forest area by Forest type (level 3)

### II.3.1 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 be 43,657 hectares.

Coniferous area of Lebanon	44,879 ha
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The treatment of the collected data, gives the following estimation for each forest type (level 3) of the coniferous class:

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

Table 4: Area estimations of the coniferous forest type

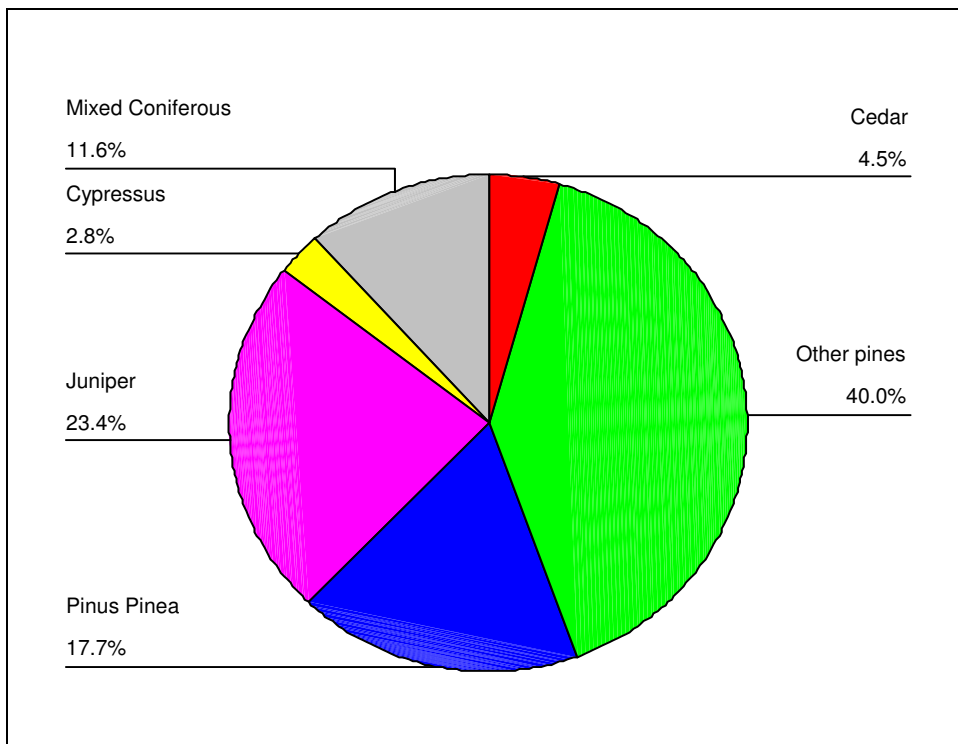


Figure 3: Area distribution of the Coniferous Forests types

As expected, the first observation is that the *other pine forest* defined by the National Forest Inventory (*Pinus brutia* and *Pinus halepensis*) are by far the most important of the coniferous forest types accounting for 40% (or 17,952 hectares) of the total coniferous forest area. The remainder of the coniferous forest is composed of 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). *Fir forest* is not captured by the inventory.

“Other pines” contains mainly *Pinus brutia*, and to some extent also *Pinus halepensis* occupies the largest area. These species thrives in all type of soils up to altitudes of 1500 m. They are pioneer species. They grow and grow fast and spread easily after fires, which explains why they occupy the biggest area, especially in subtropical dry forest ecological zone. Juniper (mostly *Juniperus excelsa*) comes in the second place because it occupies large

areas of the subtropical mountain, above 1800 m where other species do not compete. *Pinus pinea* is widely planted up to 1500 m mainly on sandy siliceous soils. Mixed forests contain fragmented and scattered stands of mixed pines, mixed pine and cypress and mixed conifers plantations. Cedar groves (*Cedrus libani*) are few and scattered on the western slopes of the western chain between 1300 and 1950m. They include spontaneous stands, and plantations. This species has been heavily exploited for its wood since antiquity, and is now reduced to scattered stands covering only 2000 ha. Cypress (*Cypressus sempervirens*) is rarely found in pure stands. It is a pioneer species in marginal lands with steep slopes. It is quickly supplemented by *Pinus brutia* and is therefore mostly found in mixed stands. Fir (*Abies cilicica*) which is mainly found in pure stands or mixed with cedar and juniper in certain areas of North Lebanon was not measured within the tracts.

### II.3.2 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
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The area estimates for these classes are shown below:

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

Table 5: Area estimations of the broadleaved forest types

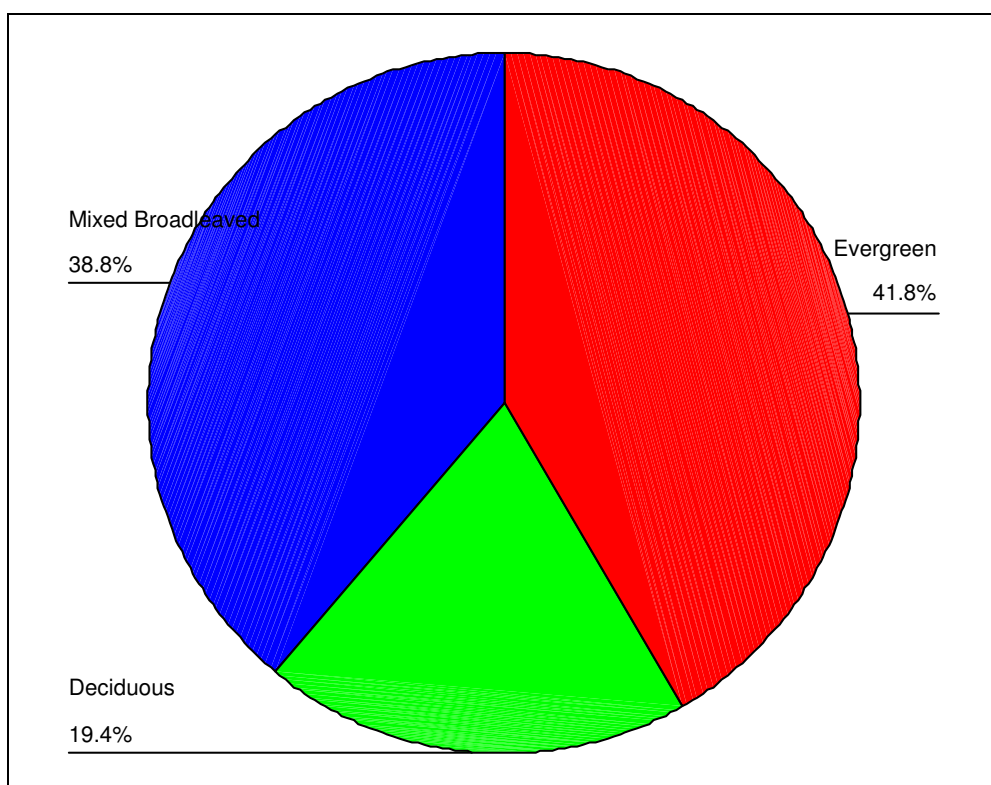


Figure 4: Area distribution of the Broadleaved forest types

The Pie chart of the Broadleaved classes shows a relatively even distribution of the broadleaved area at level 3: it's 41.8% for the evergreen (or 32,975 hectares), 38.8% for the Mixed Broadleaved (or 30,608 hectares), and 19.4 % for the deciduous (or 15,304 hectares).

The proportion of each forest type is correlated to the different ecological zones. *Quercus calliprinos* which is the dominant species in evergreen forests grows between sea level and 1500m. *Quercus infectoria* is found as an accompanying species to *Q. calliprinos* from 200m, and contribute the most in mixed forests formation. In the subtropical mountain ecological zone, cool and humid weather associated with a flattened relief and deeper soil make the optimal condition for deciduous forest formations of *Quercus infectoria*, *Quercus cerris*, *Quercus brantii* and *Ostrya carpinifolia*.

#### II.4. Other Wooded Land area by sub-class (Level 2)

The estimated area of the OWL is about 108,378 hectares. At level 2, OWL has 4 sub-classes: Coniferous shrubs, Broadleaved shrubs, Mixed shrublands and Grassland with trees (table 1).

OWL area of Lebanon	108,378 ha
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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)
<b>Broadleaved shrub</b>	69	52.1	0.116	0.229		56,465
<b>Grassland with trees</b>	69	33.4	0.108	0.213	66.5	36,198
<b>Mixed shrublands</b>	69	13.3	0.087	0.172	97.7	14,414
<b>Coniferous shrubs</b>	69	1.2	0.04	0.082	282.7	1,301
<b>Total</b>		<b>100</b>				<b>108,378</b>

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

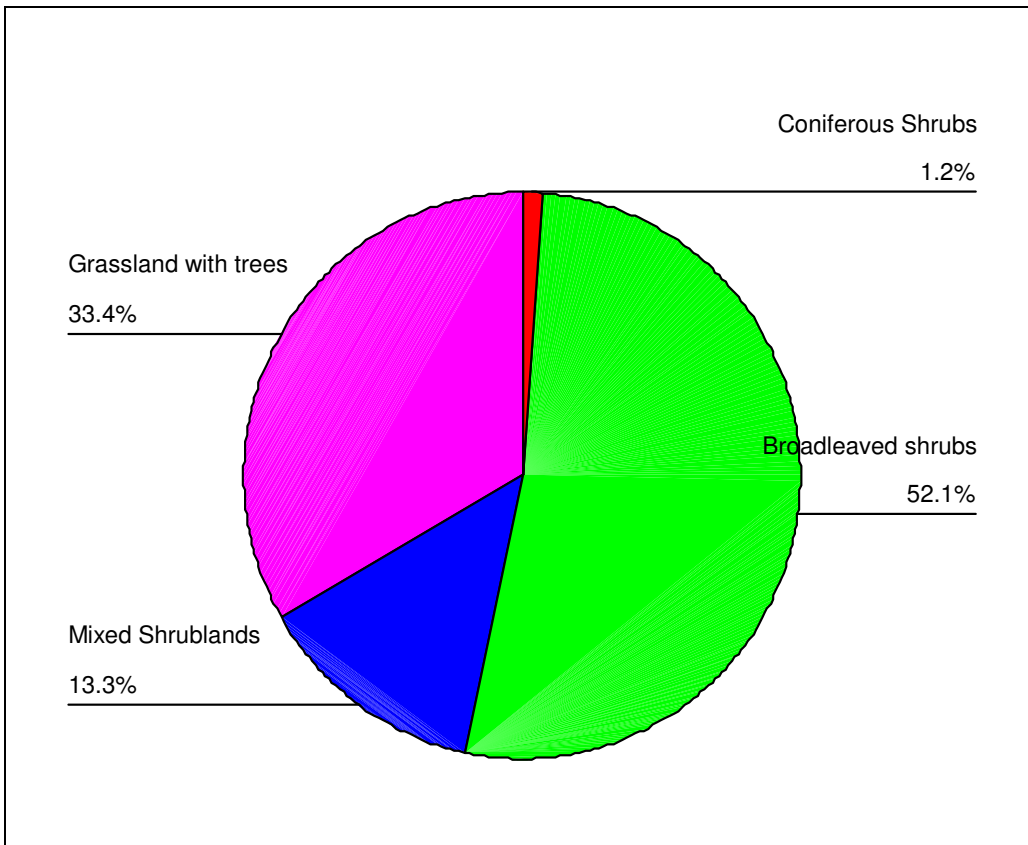


Figure 5: Area distribution of OWL types (level 2)

For the OWL area, the broadleaved shrubs sub-class makes up 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 1,301 hectares) for the Coniferous shrubs.

In Mediterranean area, broadleaved shrubs which regenerate easily by coppicing are found in the subtropical dry forest and a part of the subtropical mountain, this category is therefore the most common. It is followed by the grassland with trees, mainly juniper formations in high altitudes. Mixed shrublands occur mainly between the subtropical mountain and subtropical steppe ecological zones. Coniferous shrubs are rare and consist mainly of degraded juniper formations and dwarf cedar plantations that grow beyond their natural geographical zone, and cannot reach *in situ* a tree height above 5 m.

## II.5 Other Land use areas by sub-class (Level 2)

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

OL area of Lebanon	797,152 ha
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The following table and pie chart gives the estimated areas obtained for the OL sub-classes:

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

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

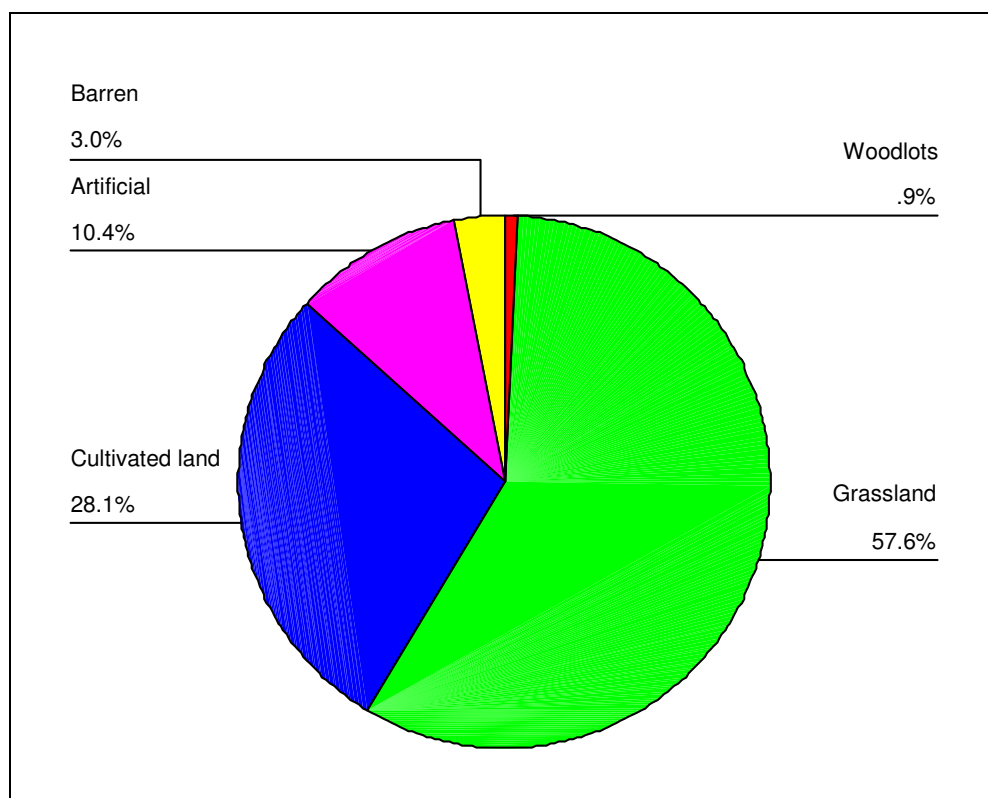


Figure 6: Area distribution of OL types

The dominant type of other land in Lebanon is grassland. The arid steppes in Northern Bekaa and Anti-Lebanon chain and the plateau that is above the tree line (2000m) in the western chain and Mount Hermon constitute the major part of this land use.

Cultivated land follows with more than the quarter of the other land use class. It covers the fertile parts of central and western Bekaa, the narrow coastal plains, and the domesticated slopes of the western slopes of Mount Lebanon and Mount Hermon. Human settlement in the mountains has contributed in increasing agricultural lands in forest areas.

Artificial areas, which includes all urban zones has relatively an important share of land use, due to the high demographic pressure and population density (4 millions inhabitants with 400 inhabitants/km<sup>2</sup>).

Barren lands are constituted by karstic rock formations, cliffs and degraded grasslands.

Woodlots are small and fragmented (natural and planted). They are negligible in land use distribution, but very important when they make green groves in urban areas or riparian formations along rivers.

### III. Areas by Ecological zone

Based on the FRA 2000 ecological zones map, the Global Ecological Zones (GEZ) in Lebanon were determined. The GEZ classes of Lebanon are: *Subtropical dry zones* characterized 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 and Mount Hermon where altitude is above 1000-1100 m (which is the natural limit for olive tree).

#### III.1 Forest area by ecological zone

The forest area is estimated to be 13.3% of the total area (139,376 hectares).

Forest area of Lebanon	139,376 ha
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The below table shows the forest area broken down by Global Ecological Zone:

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

Table 8: Estimates of forest area by Global Ecological Zone

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

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

Table 9: Estimates of OWL area by Global Ecological Zone

### III.3 Other Land area by ecological zone

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

OL area of Lebanon	797,152 ha
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The estimation of the OL area by ecological zones classes is as follow:

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

Table 10: Estimations of OL area by Global Ecological Zone

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

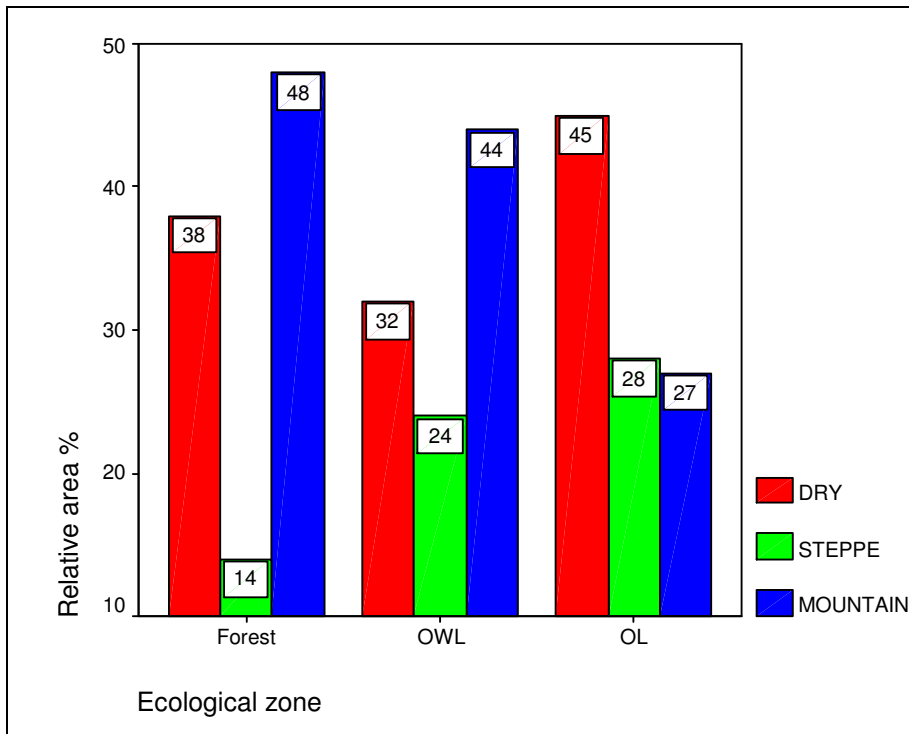


Figure 7: Area distribution of land use classes by ecological zones

The bar diagram shows that the forest area is found mainly in the subtropical mountain ecological zone. The OWL area is rather evenly distributed between the 3 GEZs. The OL area is dominated by the subtropical dry zone.

Half of the forests are located in subtropical mountains, because it is the most suitable ecological zone for forest formation in the Mediterranean area (cedar, fir and deciduous broadleaved forests). This zone is also less exposed to demographic pressure. It also includes a large proportion of the OWL, which is mainly composed of broadleaved coppice and juniper formations.

The Subtropical dry forest GEZ on the coastal areas up to 1000 m is characterized by evergreen broadleaved coppice (Mediterranean maquis) which shares 32% of the OWL, and *Pinus brutia* and *Pinus pinea* stands that constitute about 40% of the forest cover. Subtropical steppe has a limited share of forest and OWL. It integrates mainly broadleaved tree species.

## IV. Areas by Ownership

### IV.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)
<b>Private</b>	59	60.4	0.124	0.243	40.0	84,183
<b>State</b>	59	27.4	0.112	0.22	87.3	38,189
<b>Municipality</b>	59	10.0	0.076	0.149	140.5	13,938
<b>Community</b>	59	1.2	0.034	0.068	400.0	1,672
<b>Not Known</b>	59	1.0				1,394
<b>Total</b>		<b>100</b>				<b>139,376</b>

Table 11: Estimates of forest area by ownership classes

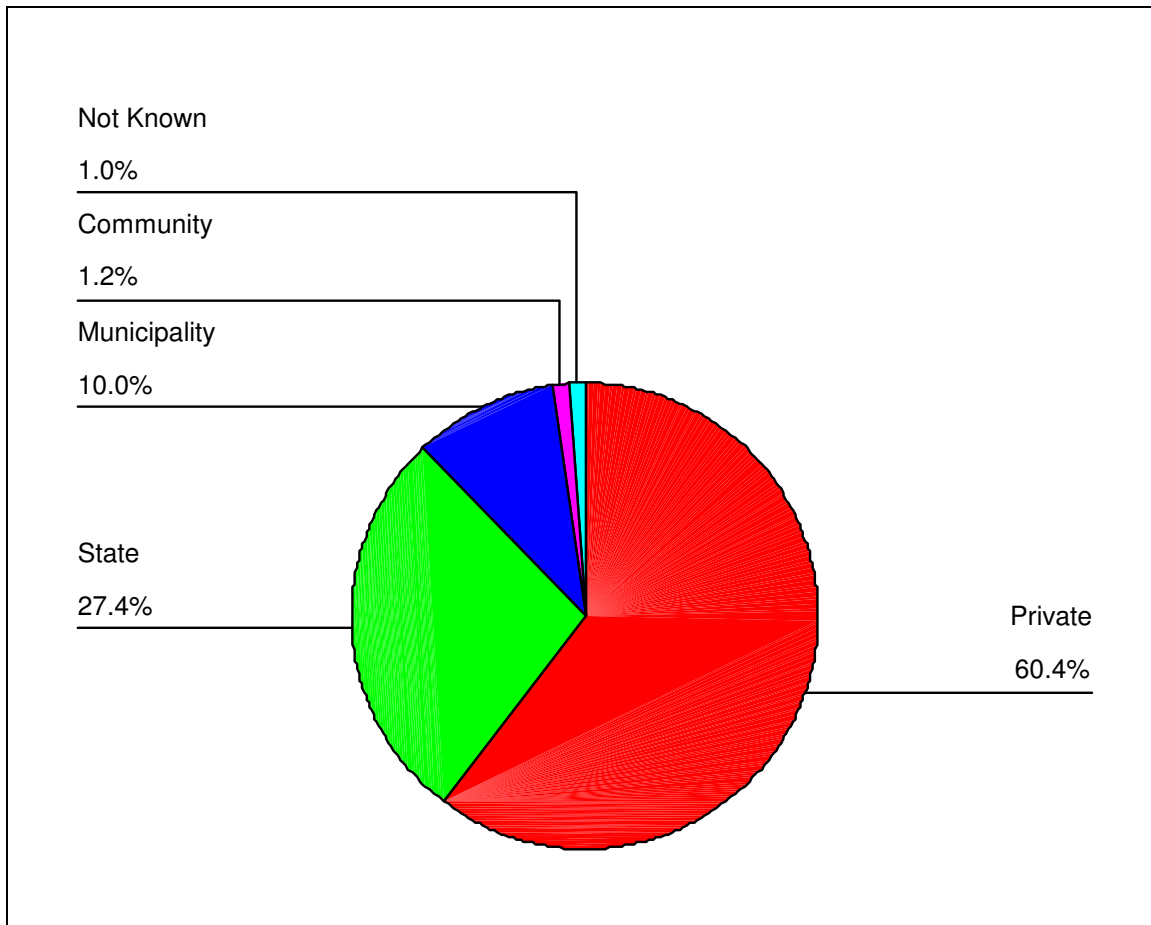


Figure 8: Area distribution of forest land by ownership

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 communities).

#### IV.2 Other Wooded land area by ownership

For the other wooded land area, we consider the three classes: Private class, Public class (in which the State, municipality and community classes are merged 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)
<b>Private</b>	65	80.0	0.09	0.18	21.8	86,702
<b>Public</b>	65	13.8	0.087	0.172	114.0	14,956
<b>Not Known</b>	65	6.2	0.035	0.07	291.6	6,720
<b>Total</b>		<b>100</b>				<b>108,378</b>

Table 12: Estimates of other wooded land area by ownership

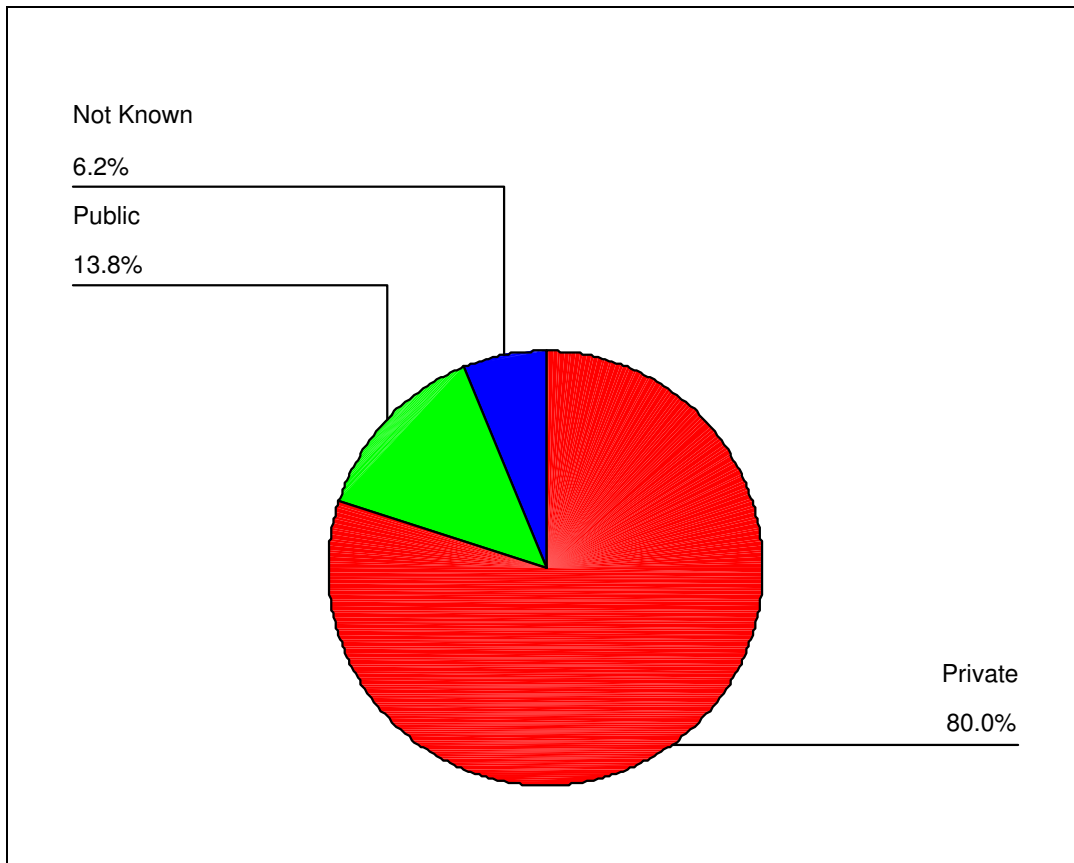


Figure 9: Area distribution of other wooded land by ownership

In Lebanon, ownership by private individuals is by far the most important ownership category, with more than 80% of OWL area. Relatively small areas (13.8%) are under public ownership (mainly state, municipalities and communities).

### IV.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)
<b>private</b>	203	88.2	0.41	0.081	9.2	703,088
<b>public</b>	203	11.0	0.04	0.078	69.6	87,687
<b>Not Known</b>	203	0.8	0.01	0.02	333.3	6,377
<b>Total</b>		<b>100</b>				<b>797,152</b>

Table 13: Estimates of Other Land use area by ownership

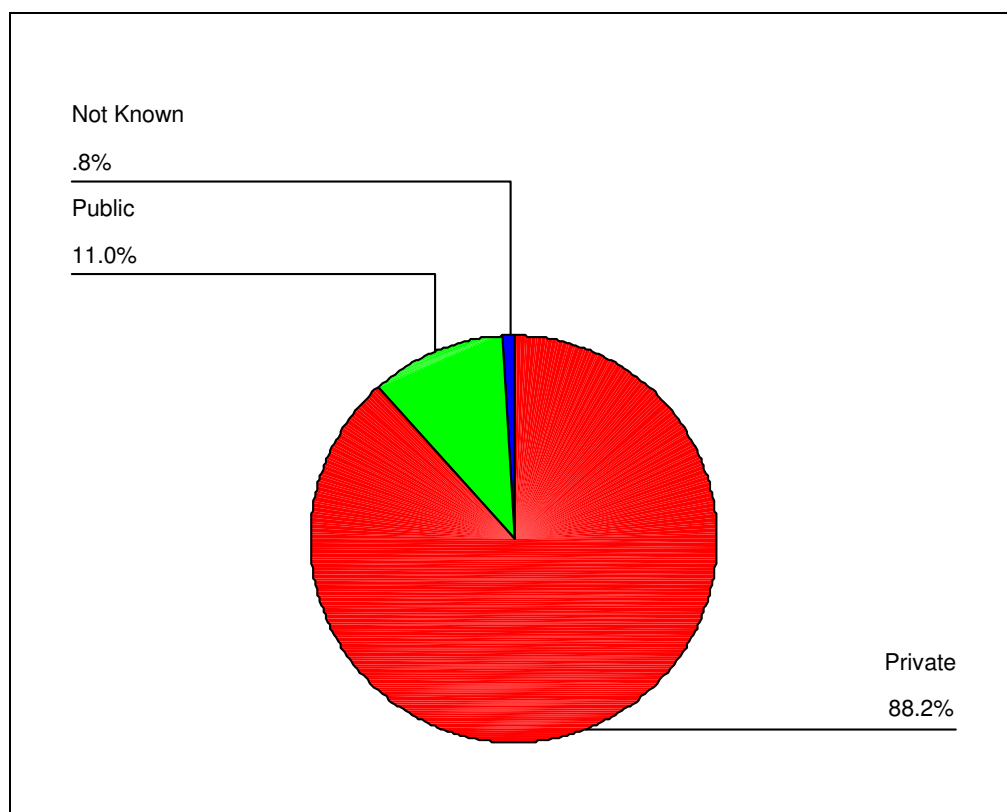


Figure 10: Area distribution of Other Land use area by ownership

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%). Relatively small areas (11 %) are under public ownership (mainly state, municipalities and communities).

The large share of private property is linked to the old history of human presence in Lebanon and the high density of population, compared to the recent concept of an independent state. It should be noted that the private ownership class includes the properties of the church. Thus, a successful forest policy or management plan should have a participatory approach with the private stakeholders.

## V. 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 inventoried accessible area.

## V.1 Forest area by designation/protection status

Based on the above classification, the following distribution of the forest area is obtained:

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

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

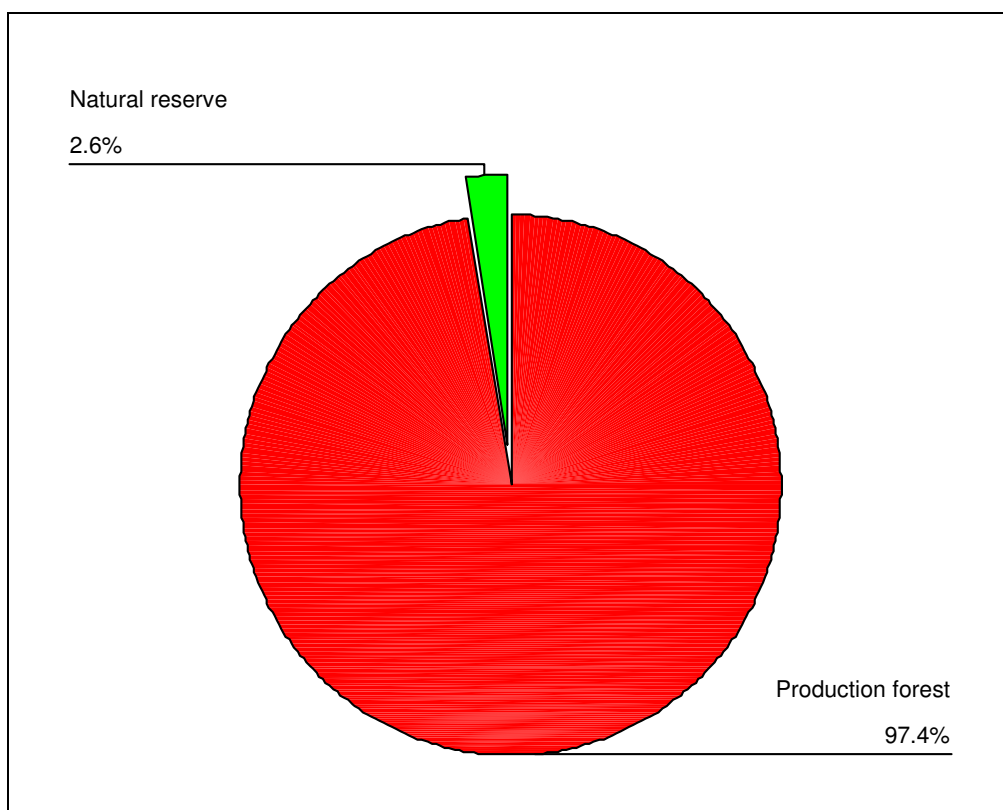


Figure 11: Area distribution of Forest land by Designation/protection status

Only a small proportion of 2.6% of the forest area is in the Natural Reserve class and areas were designated as protection forest. 94.7 % can be considered to be production forest.

## V.2 OWL area by designation/protection status

By using the same classes of the forest area by designation/protection status, the estimates 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)
<b>Production</b>	65	96.9	0.04	0.086	8.87	105,018
<b>Natural reserve</b>	65	3.1	0.04	0.086	277	3,360
<b>Protection</b>	65	0	0	0	0	0
<b>Total</b>		<b>100</b>				<b>108,378</b>

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

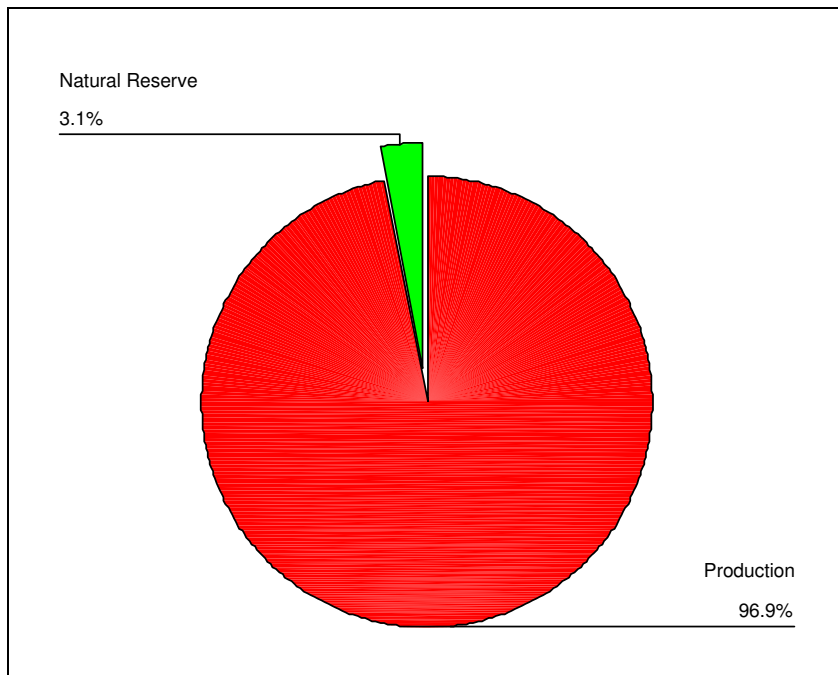


Figure 12: Area distribution of OWL by Designation/protection status

Figure 12 shows that the OWL area is mainly classified in the production class and like the case was for forest only a very small proportion of the area is in the Natural reserve class.

### V.3 OL area by designation/protection status

The same study is applied to the Other Land Area. The results are illustrated below:

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

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

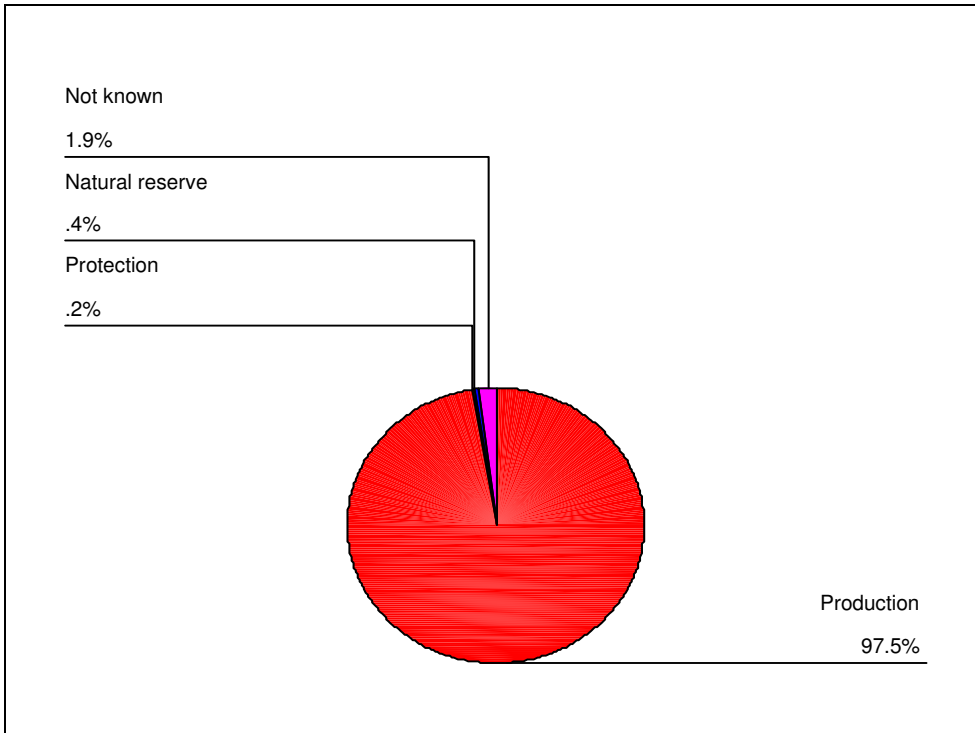


Figure 13: Area distribution of OL area by Designation/protection status

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

Natural reserves cover a modest part of forests, OWL and OL, because private land covers most of the valuable forests. The actual natural reserves are found on state, communal and municipal lands, evenly distributed between forests, OWL and OL and cover almost 10200ha or 1% of the country. This area is not accurate, especially that there is no clear definition for the existing protection status in Lebanon. The percentage of natural reserves is not expected to be raised easily in a country where demographic pressure is high.

## VI. DBH Distribution

Tree diameter is measured over bark in whole centimeters, at 1.3 meters above the ground (Diameter at breast height or DBH).

The trees in forest and outside forest are divided into 9 diameter classes of 5 cm intervals. Table 17 shows the percentage of trees and their number per hectare in each distribution of the diameter classes in forest and trees outside forest.

DBH Distribution	% of trees numbers in forest (total= 4762)	Forest Numbers of trees/ Ha	% of trees numbers in TOF (total= 12228)	TOF Numbers of trees/ Ha
[10,15[	42	3	53.4	3
[15,20[	16	3	22.4	3
[20,25[	11.6	3	10.6	3
[25,30[	8.5	3	5.4	3
[30,35[	8	2	3	3

[35,40[	6.4	2	1.7	2
[40,45[	3.6	2	1.2	2
[45,50[	1.8	2	0.7	3
[50,+[	2.1	2	1.6	2

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

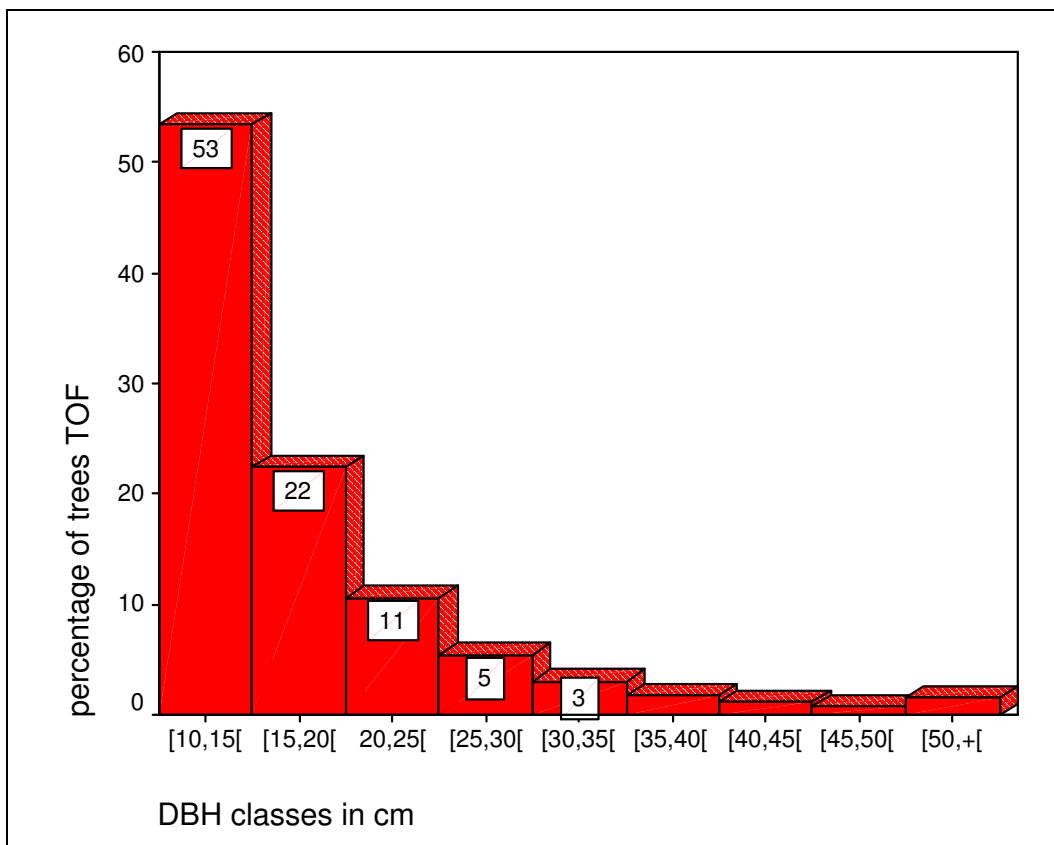
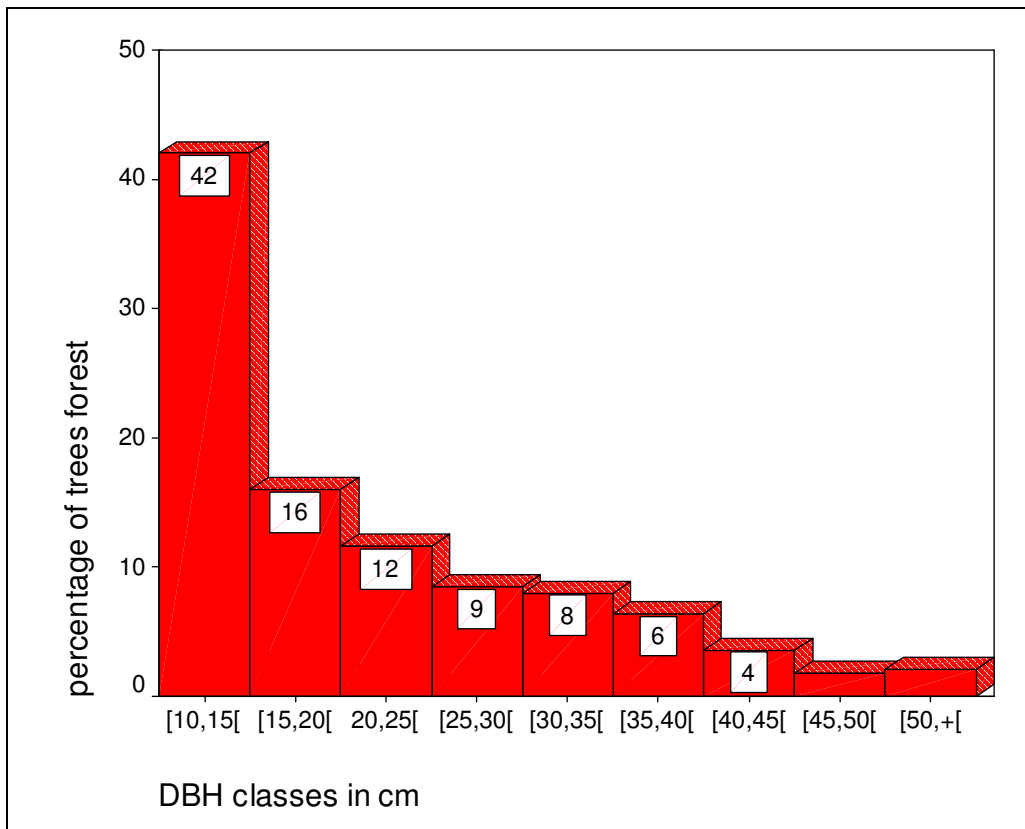


Figure 14: Tree DBH distribution in forest and outside forest (TOF)

The bar diagrams 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 percentage are less half of this class.

The high frequency of trees with small diameters is illustrated by the relative youth of the stands. Most of these trees are found in broadleaved coppices that are cut periodically and regeneration of burned *Pinus brutia* stands. The same pattern is seen for TOF, mainly in orchards, where we measured the branches found at breast height were measured, since the main trunk or stem is below this height. Conifers having an average age of 80 years, have an average trunk of 25-35cm DBH. Trees outside forest within this classes of DBH, are mainly ornamental trees found in urban areas, or trees found in woodlots or along rivers. Trees with bigger diameter in forests, are mainly those who are found in protected areas or in old stands (cedar, juniper, oak). Outside forests, big trees are mainly old junipers in grasslands with trees, big riparian trees along rivers or old olive trees. The relative low diameter for conifers is related to the absence of silvicultural practice (selective felling) since coniferous forest exploitation is still prohibited.

## VII. 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:

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

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 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 volume per hectare is obtained by the sum of the tree stem volumes.

The estimation of the total volume (in m<sup>3</sup>) 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 <sup>3</sup> /ha)	S <sub>x</sub>	SE	SE%	Total Volume (m <sup>3</sup> )
<b>Forest</b>	61	35.64	8.5	6.7	46.88	4,967,361
<b>Other Wooded land</b>	65	5.08	1.65	3.241	63.7	550,777
<b>Other land</b>	149	3.74	1.001	1.96	52.44	2,984,537
<b>Total</b>						8,502,675

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

## VIII. 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:

$$SB = GS \times WD$$

$$AGB = SB \times BEF$$

$$BGB = AGB \times R$$

Where

SB	Stem biomass (tonnes)
AGB	Above-ground biomass (tonnes)
BGB	Bellow-ground biomass (tonnes)
GS	Growing stock (volume) over bark (m <sup>3</sup> )
WD	Wood density (Dry weight/green volume expressed in tonnes/m <sup>3</sup> )
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 Broadleaved species are assumed to equal 0.4 and 0.5 respectively. 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 Broadleaved.

The Root-shoot ratio used is 0.27, as we consider Lebanon as the subtropical dry forest.

### VIII.1 Biomass of forests species

Type	GS (million)	AGB (million tones)	BGB (million tones)
<b>Quercus cerris</b>	0.96	0.78	0.21
<b>Pinus Pinea</b>	1.55	0.62	0.22
<b>Pinus brutia</b>	1.3	0.68	0.18
<b>Cedrus libani</b>	0.31	0.16	0.04
<b>Juniperus excelsa</b>	0.29	0.15	0.04
<b>Juniperus drupacea</b>	0.09	0.05	0.01
<b>Quercus Infectoria</b>	0.186	0.15	0.04
<b>Quercus calliprinos</b>	0.177	0.14	0.04
<b>Ostrya carpinifolia</b>	0.016	0.01	0.003
<b>Platanus orientalis</b>	0.019	0.013	0.004
<b>Others species</b>	0.06	0.04	0.01
<b>Total</b>	<b>4.967</b>	<b>2.793</b>	<b>0.797</b>

Table 19: Calculation of living Biomass of forest species

Biomass in forest areas is influenced by several factors: the abundance of the species and its capacity to produce biomass within a period of time, as well as the extent of exploitation, occurrences of fire, rate of decomposition etc. To a large extent the factors are controlled by forest dynamics and forest management/exploitation. For instance, *Quercus calliprinos*, although is the most common measured tree in forests, has a lower biomass than *Quercus infectoria* which is less frequent, but fast growing. The latter is the most common species in deciduous

broadleaved forests, has a lower biomass than *Quercus cerris*. This could be attributed to the fact that *Quercus cerris* growing stock is overestimated because the measured single stem trees were found mainly in old well-managed stands. *Q. Calliprinos* and *Q. infectoria* are found mainly in coppices that are periodically cleared for charcoal and fuel wood production (every 15-25 years). Coniferous trees are of bigger size, and more than 70 years old in general, except for *Pinus brutia* which is exposed to frequent forest fires. Thus, we find that cedar and juniper stands have a significant biomass although their areas are small. Pines are fast growing, and have the largest area among coniferous trees, which makes them the main contributor to biomass of forest species.

Further studies should focus on reviewing the different factors and formulas used for the calculation of volume, biomass and carbon stock in order to get accurate data and there is also a need for studies of increment. These studies should concern the ten species cited above as well as *Abies cilicica* (which was not found as dominant species in any tract, but is an important species in North Lebanon). Those species have the best potential for wood production in forest areas.

## VIII.2 Biomass of Other Land area

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

Table 20: Calculation of living Biomass of other land species

Biomass of OL is composed mainly by the biomass provided by fruit trees (olive, citrus, etc) and by trees found in woodlots and in urban areas (*Pinus pinea*, *Quercus calliprinos*, *Quercus infectoria*). Since trees grown as wind breaks, or along roads or rivers, have good growth conditions, they provide an important share of the biomass growing stock (*Eucalyptus spp.*, *Casuarina equisetifolia*, *Cupressus sempervirens*, *Platanus orientalis*).

### VIII.3 Biomass of other wooded land

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

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

The most important species in biomass growing stock in OWL is Juniper trees, which accounts for almost half of the stock. The large trunk that characterize this tree found in higher altitudes shows its importance, and the need to encourage its plantation to preserve the stock and ensure the demand of fuelwood in those cooler zones. *Populus alba*, which is much less frequent produces a significant biomass if compared to the other species. The plantation of this species in OL is important; especially because it is fast growing.

### VIII.4 National table of the Biomass

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

Table 22: calculation of the total living biomass

### VIII.4 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 tones)	Carbon of Below-ground biomass (million tones)	Total (million tones)
<b>Forest</b>	1.3965	0.3985	1.795
<b>OWL</b>	0.1625	0.041	0.2035
<b>OL</b>	1.206	0.3245	1.5305

Table 23: Calculation of the Carbon stock

National stock of biomass and carbon of the Lebanese forests and OWL is rather low. This is related to the relatively degraded/unmanaged state of the forest resource, the fact that many natural forest types in Lebanon are open and therefore moderately stocked and due to a modest forest area. The class Other Land contains Fruit orchards which make up a large part of the total growing biomass and carbon stock, which to a certain extent helps in decreasing the pressure on the forest resources.

## IX. Disturbances of the forest

### IX.1 Estimation of forest area by disturbance levels

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 (app. 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% of the forest area (62,033 hectares), 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
<b>Not Disturbed forest</b>	14.9	20,767
<b>Disturbed forest</b>	85.1	118,609

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

Table 24: Estimates of forest area by disturbance levels

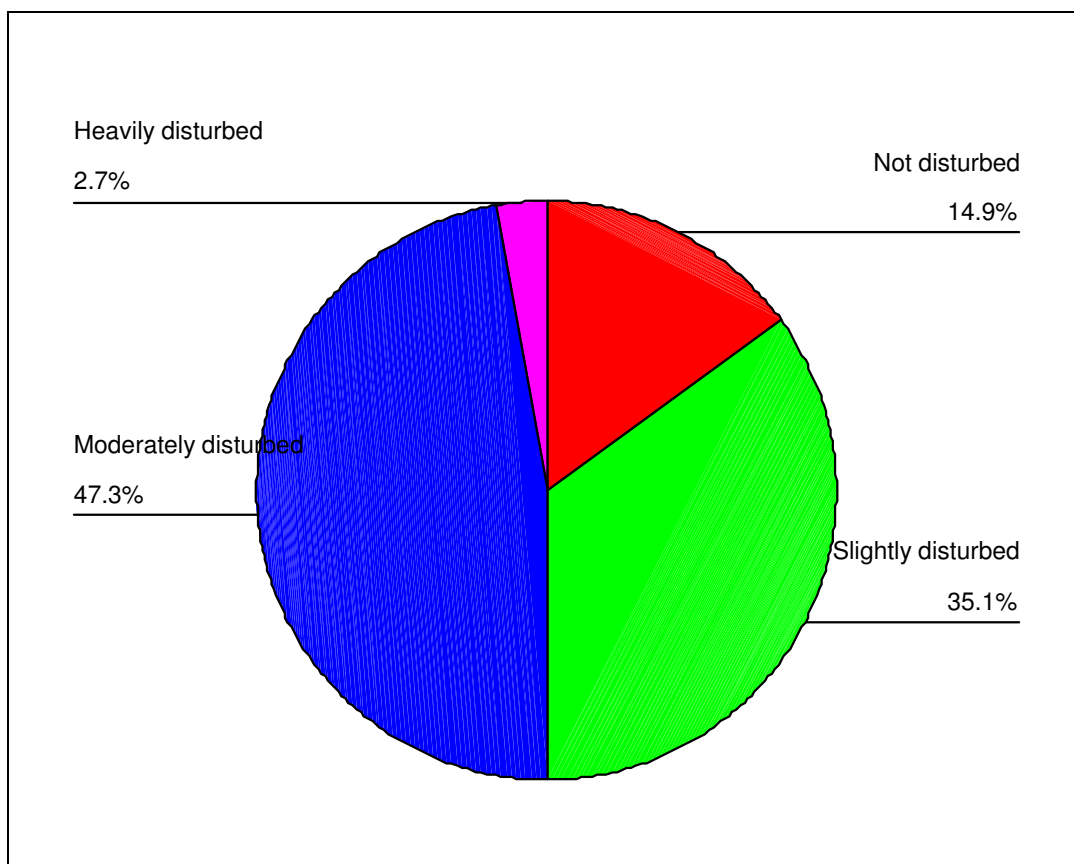


Figure 14: Distribution of forest area by disturbance level

To have more information about the disturbance on the forest area, level 2 sub-class of the forest classification (Coniferous, Broadleaves, and Mixed forest) is analyzed. The results show that all sub-classes are disturbed to a similar degree: 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 disturbance of the three sub-classes is shown in table 25:

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

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

Undisturbed forests are areas that do not show any damage or symptom of human activities. In general, such forests are those which are not used for production purposes and they are limited to inaccessible and protected areas.

Disturbed forests include all forests having a production status. Since forest utilization is normally not associated with any defined management that ensures the sustainability of the natural resources and the land use, those forests are considered slightly or moderately disturbed in the field survey. This explains the even distribution of percentages between the three types of forests.

Heavily disturbed forests are areas showing severe degradation in the tree health, or the accompanying vegetation (fires, insect outbreaks, landfills, quarries, water and soil pollution, intensive urban activities, etc). The susceptibility of coniferous trees to such influences and

the encroachment of mixed forests by urban areas explain the higher percentage of heavily disturbances in coniferous and mixed forests. Another reason is that *Pinus pinea* and *Pinus brutia* are not a typical vegetation formation of the Mediterranean coastal zone of Lebanon, which is more represented by the evergreen broadleaved coppices. The first is widely planted by man for its nuts production, and the later spreads faster from the degraded coppice after induced fires.

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

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

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

The percentage of the forest area affected by fire is about 14.1 % (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). No evidence of fire was registered 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.

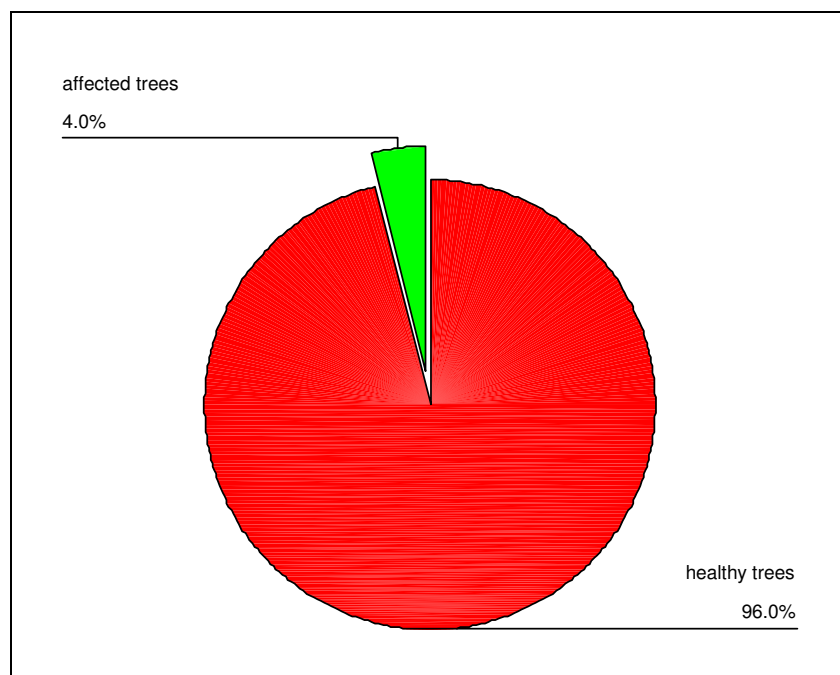


Figure 15: Distribution of trees by Health Status

According to FRA definitions affected trees are trees that show damages in their wood and bark. In many cases, the symptoms are only slightly visible during there early stages of attack

causing agents are hidden and attack first the canopy cover, giving earlier but less important symptoms. For this, the percentage of affected trees is underestimated. A good example is *Tomicus spp.* which attacks the buds of *Pinus pinea* and slowly leads to its death. Stands which seemed to be healthy during the field work now show several dead trees and yellowish canopy on others. The percentage of affected trees is therefore assumed to be underestimated by the survey.

To find the most important cause of disturbance in forest, we have to consider for all unhealthy trees the causing agent like: disease, fire, insect, animals and others. The presence of causing agents on the 192 affected trees (4% of 4775 measured trees) is illustrated in figure 16:

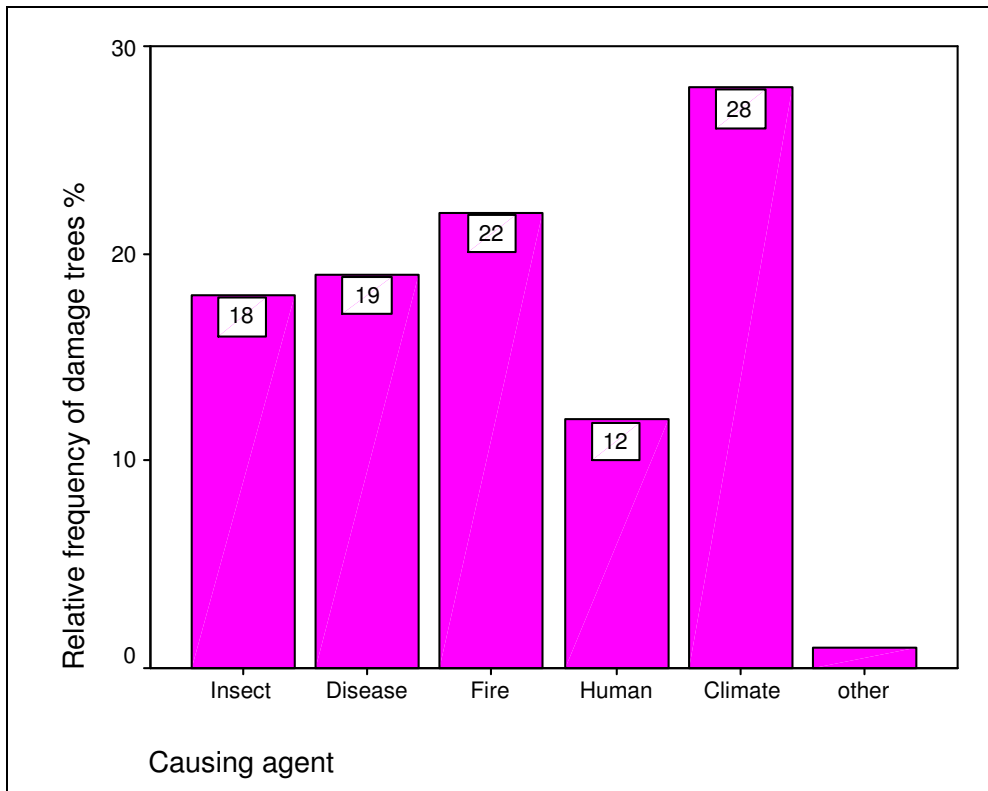


Figure 16: Relative frequency of damage trees by causing agent

Figure 16 shows that the most common causing agent in damaging the health of the trees in Lebanon are climatic factors ( Winds, snow, lightning, etc..) with 28% of the affected trees. Fire, insects and diseases each accounted for around 20% of the damaged trees, while human induced damages only were observed on 12% of the damages trees.

Insects and diseases form together the major causing agent of disturbances inside forests (37%). In Lebanon, almost all forest fires are started by man. Fire can therefore be considered a damage induced by humans. Human induced actions are therefore the second most important disturbing agent in forests (34%). It can therefore be concluded that 71% of the disturbance is caused in a way or another by the mismanagement of forests. As previous tables show that almost all fires are in coniferous forests, we can identify the main causing agents of disturbances as follow:

- Uncontrolled forest fires in *Pinus pinea* stands. Theses fires are induced by farmers to eliminate the lower layers of vegetation, since it is more cost-effective than pruning or cutting. The charcoal prohibition before September 2004 eliminated the only incentive for farmers to cut the broadleaved layer instead of burning it, and burning the pine trees above.
- Uncontrolled forest fires in *Pinus brutia* stands. These fires are mostly unintentional, and occur in areas of encroachment of pine forests with urban and agricultural areas in Mount

Lebanon and North Lebanon. Again, the absence of any economical interest that could be driven from such forests leads to the absence of pruning and clearing, which exposes the forest to an increasing risk of fire.

- The prohibition of coniferous trees felling, even if they are burned accelerated insect outbreaks and fungi dissemination from old and weak trees to younger ones. Among them, *Tomicus spp.* widely affecting *Pinus pinea*, *Thaumetopea spp.* affecting different conifers and oaks and *Cephalcia tannourinensis* affecting the cedar forest of Tannourine.

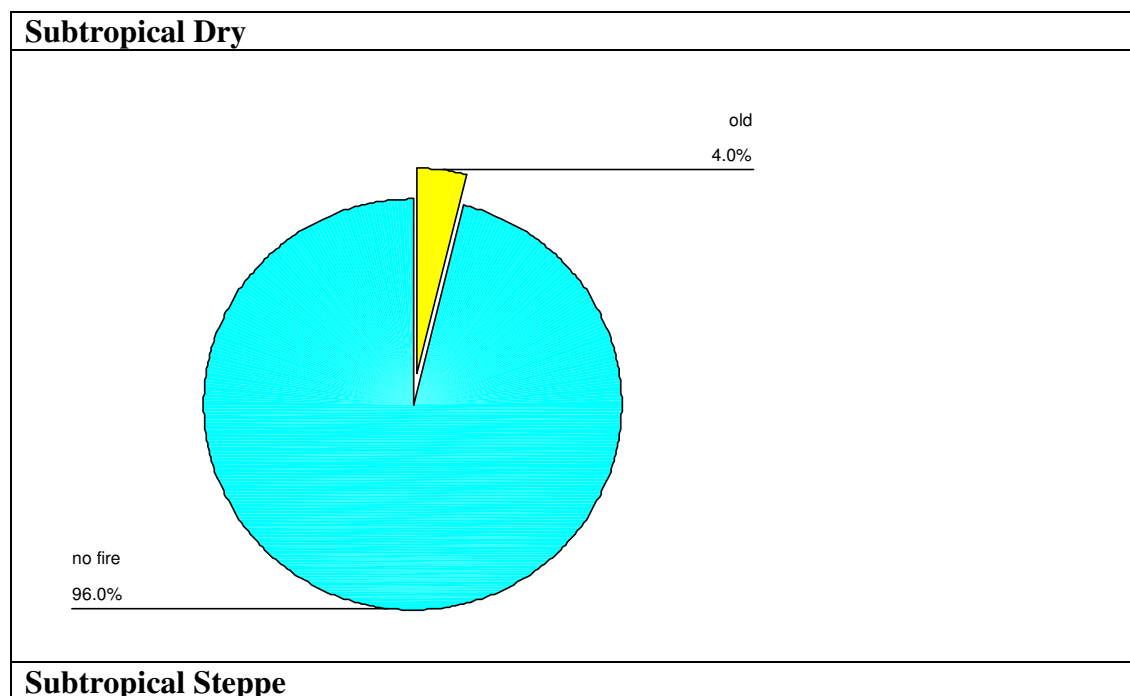
## IX.2 Disturbances of the forest according to GEZ

One of the disturbance types of the forest in Lebanon is that caused by fire. We calculate the relative area of forest affected by fires and the presence of fires in the forest type according to the Global Ecological zone;

	Dry forest ( 53,102 Ha )		Steppe Forest (19,373 Ha)		Mountain forest (66,901 Ha)	
	%	SE%	%	SE%	%	SE%
<b>No evidence of fire</b>	96	38	100	0	78.2	25.6
<b>Recent fire</b>	0	0	0	0	0	0
<b>Old fire</b>	4	227	0	0	21.8	188

Table 27: Relative forest area of fire occurrences by GEZ forest type

The fire area is about 4% in the dry forest and 21.8% in the mountain. No recent fire found in the study. We can show it by the following figures:



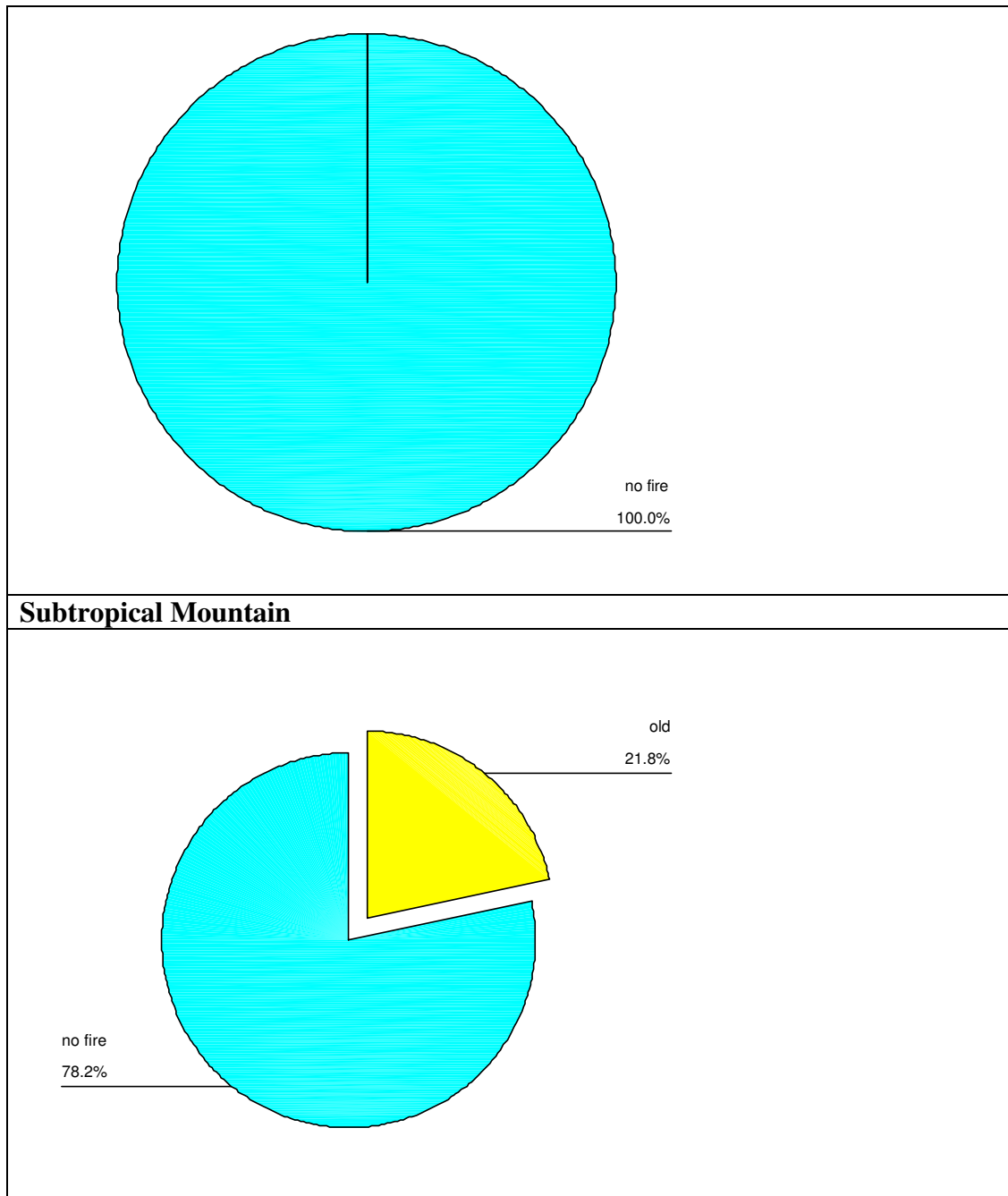


Figure 17: Relative frequency of disturbances type of forest according to the GEZ area

The frequency of fire according to ecological zones as shown by statistics does not reflect reality and other data. In the Mediterranean area, the frequency of fire is higher in the subtropical dry forest, due to vegetation type (Pine forests, evergreen broadleaved dense coppice) and a high level of human activity. In subtropical dry mountain zone (over 1000m) the vegetation is in general less prone to fires (cedar, juniper, fir and deciduous broadleaved forests). The absence of a clear definition for each ecological zone may have resulted in a misallocation of ecological zones.

The NFA recorded no fire in the subtropical steppe, which is characterized by open vegetation, with the absence of a lower layer of vegetation, and the frequency of grazing. The absence of recent fires is attributed to the season of field work which started in November and was achieved in July, while forest fire season in Lebanon starts in August and ends with the first rains of autumn.

## X. Biodiversity

### X.1 Broadleaved tree species diversity in forest area

Lebanon has specific forest types determined by exposition, altitude and proximity to the coast. The country comprises a large range of broadleaved species (oaks, maple, etc.). The most common inventoried broadleaved trees were *Quercus* species as shown in table 28:

Scientific name in Broadleaved	Relative frequency (%) of measured tree species ( Total Number of trees = 2389) <sup>2</sup>	Endemic species
<i>Quercus calliprinos</i>	40.94	
<i>Quercus infectoria</i>	31.6	
<i>Quercus cerris (undetermined local subspecies) &amp; var.pseudocerris</i>	14.06	X
<i>Ostrya Carpinifolia</i>	4.27	
<i>Prunus ursina</i>	1.381	
<i>Quercus brantii var. Look</i>	1.298	X
<i>Platanus orientalis</i>	1.214	
<i>Arbutus andrachne</i>	1.172	
<i>Pyrus syriaca &amp; var. boveri</i>	1.046	X
<i>Ceratonia siliqua</i>	0.628	
<i>Cercis siliquastrum</i>	0.46	
<i>Acer syriaca</i>	0.419	
<i>Ficus carica</i>	0.293	
<i>Prunus amygdalis agrestis</i>	0.251	X
<i>Prunus amygdalis communis</i>	0.251	
<i>Styrax officinalis</i>	0.209	
<i>Quercus cerris X infectoria</i>	0.084	
<i>Rhamnus alaternus</i>	0.084	
<i>Celtis australis</i>	0.084	
<i>Acer tauricolum</i>	0.084	
<i>Malus trilobata</i>	0.042	
<i>Sorbus torminalis var. pinnatifida</i>	0.042	X
<i>Alnus orientalis</i>	0.042	
<i>Populus nigra</i>	0.042	

Table 28: Percentage of broadleaved tree species and their number per hectare

According to the list of endemic species in Lebanon, two species were found in the broadleaved forest area, *Malus trilobata* and *Prunus amygdalis agrestis*. No species belonging to the red list of the country were found.

<sup>2</sup> The relative frequency of each trees per species type

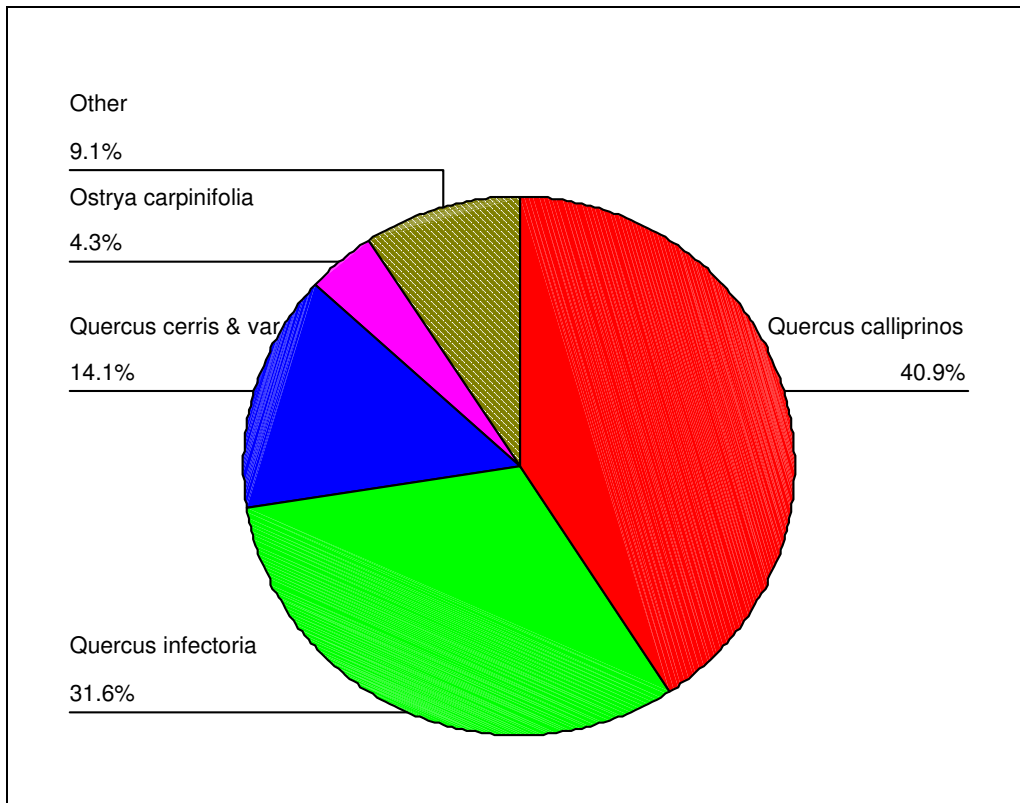


Figure 18: Relative frequency of broadleaved tree species

*Quercus calliprinos* is the most common species in broadleaved areas. It thrives in all ecological zones up to 1500 m. Like almost all broadleaved species it subsists mainly as a coppice. It is considered the most common species in Lebanon. *Quercus infectoria* follows in its relative frequency. It is found between 200 and 1700m, mostly on relatively deep soils. It is less frequent because its area has been decreasing due to land reclamation, since it is found on more fertile soils. *Quercus cerris* with its endemic local subspecies comes in the third place, although it is usually a single stem tree, because one tract includes the most important pure stand of this species in North Lebanon. *Ostrya carpinifolia* is characteristic of the humid areas of subtropical mountains is found in the northern part of the western slopes of Mount Lebanon. It is overestimated by the FRA, because one tract includes one of its important coppice stands in Mount Lebanon.

*Quercus brantii* spp. *Look* which is an endemic tree found in the southern part of Mount Lebanon and Mount Hermon above 1300 m, is well represented. Another endemic species is *Malus trilobata*, which is found sporadically in mixed and deciduous forests of the subtropical mountain zone.

The remaining species are less frequent either because they are localized in one ecological zone (e.g. *Sorbus* spp., *Acer* spp., *Ceratonia siliqua*) or because they require special edaphic conditions (e.g. *Platanus orientalis*, *Populus* spp., *Alnus orientalis*). Many species, although they thrive in more than one ecological zone, are modestly represented. This could be attributed to the fact that most of them are found in young coppices, with few trees reaching 10cm DBH (e.g. *Rhamnus alaternus*, *Styrax officinalis*, *Cercis siliquastrum*.). Some species occasionally seen during the field work were not measured since they did not reach 10 cm DBH or were found outside the plots (e.g. *Fraxinus ornus*, *Sorbus flabellifolia*, *Rhamnus libanotica*, *Ribes orientalis*, *Prunus mahaleb*).

Many rare species mentioned by some references were not found or maybe not identified within the studied tracts (e.g. *Quercus ithaburensis*, *Quercus pinnatifida*, *Quercus cedrorum*, *Quercus libani*, *Cornus australis*, *Rhamnus catharica*, *Amelachier ovalis*).

Endemism in tree species is only represented by *Malus trilobata* and *Amygdalis agrestis*. At subspecies level *Quercus brantii* ssp *Look*, *Pyrus syriaca* var. *Boveii*, *Sorbus torminalis* var.

*pinnatifida*, and an undetermined subspecies of *Quercus cerris* are represented. In general, trees thriving on the edge of their natural geographical area have different morphological traits such as smaller leaves, fruits and flowers. This leads in certain species to a differentiation classified as subspecies or cultivar. This is the case of species growing normally in humid ecological zones.

## X.2 Coniferous tree species diversity in forest area

Scientific name of coniferous trees	Relative frequency (%) of measured tree species (Total number of trees = 2344)	Endemic species
<i>Pinus brutia</i>	43.77	
<i>Pinus pinea</i>	35.84	
<i>Juniperus excelsa</i>	9.73	
<i>Cedrus libani</i>	4.44	
<i>Juniperus drupacea</i>	3.71	
<i>Cupressus sempervirens pyramidalis</i>	1.62	
<i>Juniperus oxycedrus</i> & var. <i>refuscens</i>	.68	X
<i>Cupressus sempervirens horizontalis</i>	.21	

Table 29: Relative frequency of coniferous tree species and their number per hectare

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*). No species in the coniferous forest area belonged to the endemic list of the country. A subspecies could be endemic: *Juniperus oxycedrus ssp. refuscens*.

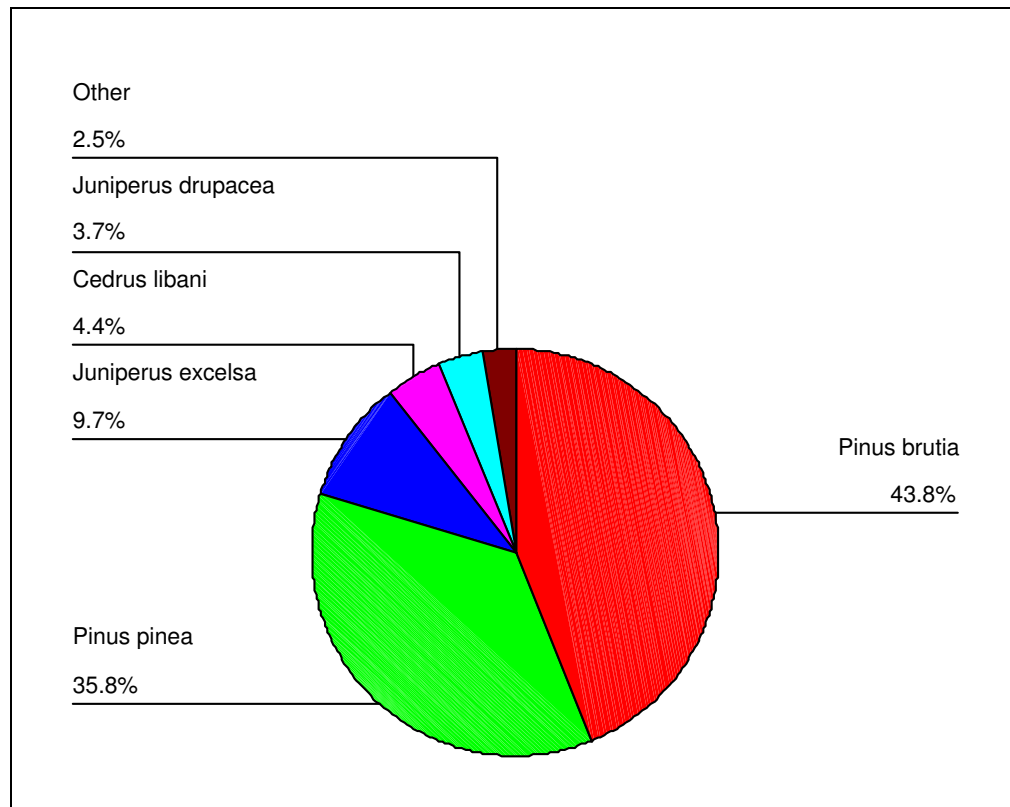


Figure 19: Relative frequency of coniferous tree species

Relative frequency of tree species and their respective areas are correlated, except for Juniper species since they are not found in dense populations. *Pinus brutia* is the most frequent species, in coniferous and mixed forests, due to forest fires and to its plasticity of growth in all ecological zones. It is followed by *Pinus pinea* which is widely planted for production of pine nuts.

*Abies cilicica* and *Juniperus foetidissima* have their southern geographical area limits in Lebanon. *Abies cilicica* has few stands in North Lebanon where it is the dominant species, and *Juniperus foetidissima* is one of its accompanying species. Unfortunately, those stands are outside the studied tracts. *Abies cilicica* is also found as an accompanying species to the cedar and juniper in North Lebanon.

*Cupressus sempervirens* is rarely found in pure stands, but mostly mixed with *Pinus brutia* in some parts of Lebanon.

*Pinus halepensis* is found sporadically in South Lebanon, and is not found inside the studied tracts.

### X.3 Tree diversity outside forest area

Outside forest another tree species composition was found. These species were mainly dominated by olives and orchard species as shown in table 30:

Scientific name	Relative frequency (%) of measured tree species (Total number of trees=12250)	Endemic species
<i>Olea europea</i>	39.49	
<i>Citrus sp</i>	15.87	
<i>Quercus calliprinos</i>	5.37	
<i>Malus communis/Malus domestica</i>	5.13	
<i>Prunus armeniaca</i>	5.01	
<i>Juniperus excelsa</i>	2.83	
<i>Prunus amygdalis agrestis</i>	2.18	X
<i>Ficus carica</i>	1.95	
<i>Cupressus sempervirens</i>	1.73	
<i>Quercus infectoria</i>	1.67	
<i>Pinus pinea</i>	1.65	
<i>Prunus amygdalis communis</i>	1.36	
<i>Diospyros kaki</i>	1.32	
<i>Prunus ursina</i>	1.30	
<i>Pyrus syriaca &amp; var. boveri</i>	1.25	
<i>Pinus brutia</i>	1.18	
<i>Prunus avium</i>	.87	
<i>Casuarina equisetifolia</i>	.80	
<i>Eucalyptus spp.</i>	.79	
<i>Juglans regia</i>	.76	
<i>Morus alba/Morus nigra</i>	.70	

<i>Platanus orientalis</i>	.69	
<i>Pistacia terebintus ssp. palaestina</i>	.68	
<i>Malus trilobata</i>	.58	X
<i>Prunus amygdalis</i>	.58	
<i>Persea americana/Persea gratissima</i>	.42	
<i>Pyrus communis</i>	.35	
<i>Melia azedarach</i>	.33	
<i>Ceratonia siliqua</i>	.24	
<i>Juniperus oxycedrus</i>	.24	
<i>Cupressus sempervirens pyramidalis</i>	.21	
<i>Populus tremulla</i>	.21	
<i>Populus nigra</i>	.20	
<i>Acer syriaca</i>	.16	
<i>Alnus orientalis</i>	.14	
<i>Populus alba/bolleana</i>	.13	
<i>Eryobotrium japonica</i>	.12	
<i>Tilia spp</i>	.11	
<i>Crateagus monogyna</i>	.11	
<i>Prunus domestica</i>	.11	
<i>Prunus amygdalis korschinskii &amp; orientalis</i>	.10	
<i>Accacia mimosa/albida/farnesiana</i>	.07	
<i>Juniperus drupacea</i>	.07	
<i>Prunus cerasifora</i>	.07	
<i>Pinus halepensis</i>	.07	
<i>Punica granatum</i>	.07	
<i>Laurus nobilis</i>	.06	
<i>Pinus canariensis</i>	.06	
<i>Prunus persica</i>	.06	
<i>Ziziphus jujuba</i>	.06	
<i>Prunus cerasia</i>	.05	X
<i>Quercus brantii var. Look</i>	.05	X
<i>Eleagnus angustifolia</i>	.04	
<i>Quercus cerris (local ssp) &amp; var.pseudocerris</i>	.04	X
<i>Castanea sativa</i>	.04	
"Not known"	.03	
<i>Celtis australis</i>	.02	
<i>Cercis siliquastrum</i>	.02	
<i>Rhus coriaria</i>	.02	
<i>Cedrus libani</i>	.02	
<i>Rhamnus alaternus</i>	.02	

<i>Robinia pseudoaccacia</i>	.02	
<i>Salix acmophylla</i>	.02	
<i>Vitis sp</i>	.02	
<i>Arbutus andrachne</i>	.01	
<i>Cornus australis</i>	.01	
<i>Crataegus azerolus &amp; sinaica</i>	.01	
<i>Jacaranda mimosifolia</i>	.01	
<i>Juniperus foetidissima</i>	.01	
<i>Myrtus communis</i>	.01	
<i>Phillyrea media</i>	.01	
<i>Salix australior &amp; dinsmorei</i>	.01	
<i>Salix libani</i>	.01	
<i>Styrax officinalis</i>	.01	
<i>Ulmus minor</i>	.01	

Table 30: Relative frequency of tree species outside forest and their number per hectare

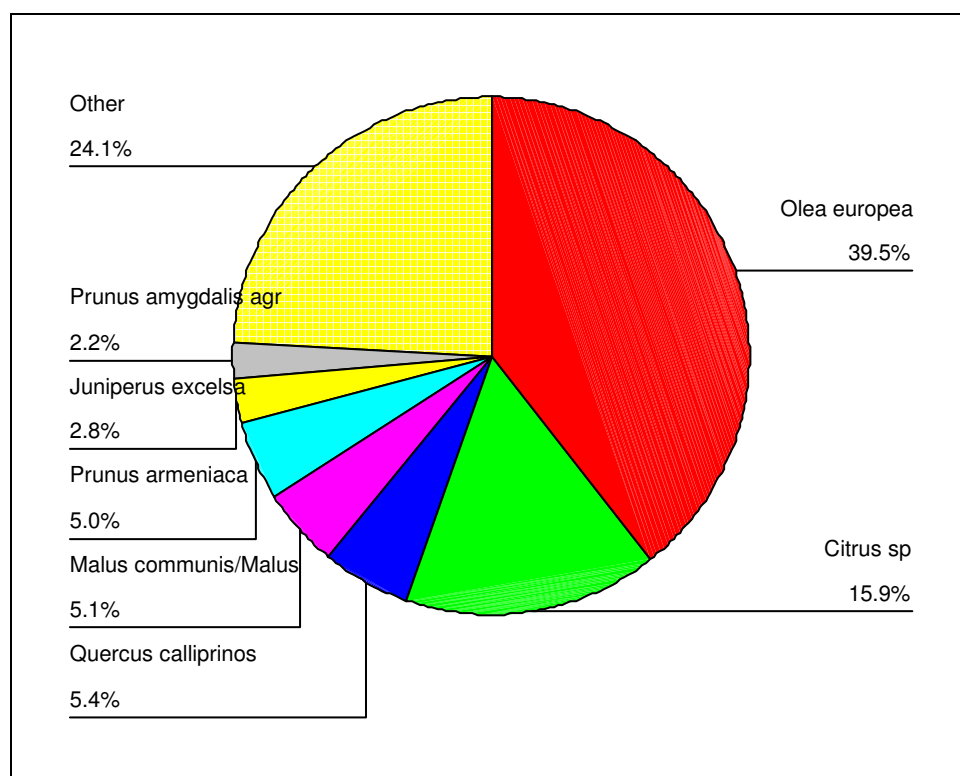


Figure 20: Relative frequency of tree species outside forest

Tree species found outside forest are mostly fruit species in agricultural lands. Olive, citrus, apple, apricot, almond and fig figure among the most frequent. Forest trees are found in OWL and fragmented woodlots, frequent in the surrounding suburbs to big cities (e.g. *Quercus calliprinos*, *Quercus infectoria*, *Pinus pinea*.). Evergreen oak, stone pine, laurel, nettle tree and cypress are also frequent in urban areas, and as isolated trees planted near churches, cemeteries, roadsides, monasteries and houses.

Many species are mostly found as accompanying species to oak in OWL (e.g. *Arbutus andrachne*, *Rhus coriaria*, *Phillyrea media*, *Rhamnus alaternus*, *Myrtus communis*, *Styrax officinalis*, *Crataegus spp.*, *Acer syriaca*, *Laurus nobilis*.) and rarely reach 10 cm DBH in such formations, which explains their relatively low frequency.

Other species are more frequent in grasslands with trees (e.g. *Juniperus spp*, *Prunus ursina*, *Pyrus syriaca*, *Ceratonia siliqua*, *Malus trilobata*, *Amygdalus spp.*, *Crataegus spp.*). This could be explained by the residues of the agri-silvo-pastoral system that preserved wild fruit trees near agricultural and pastoral lands.

Riparian species are found along rivers or near water springs (e.g. *Populus spp.*, *Platanus orientalis*, *Salix spp.*, *Eleagnus angustifolia*, *Alnus orientalis*).

Introduced species are few, among them *Tilia spp.*, *Eucalyptus spp.*, *Acacia spp*, and *Casuarina equisetifolia*. The latter is planted as a wind breaking curtains while the others along roadsides. Others are planted as ornamentals in house yards like *Jacaranda mimosifolia*. Few coniferous species have been introduced for reforestation purposes, among them *Pinus canariensis*.

Endemism is rare within the species, but is more frequent in sub-species or cultivars. Among species we find *Prunus cerasia* cited by Mouterde. It is a local plum tree that has a non-identified origin and that has become very rare in the orchards. As for sub-species and cultivars we mention *Populus bolleana*, *Salix alba var. micans* or *libanotica*, *Pyrus syriaca var. bovei* (in Anti Lebanon), and *Prunus ursina* forma *leioclada*, all of them found outside forests, in general.

#### X.4 Relative area per stand structure per forest type

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 21.

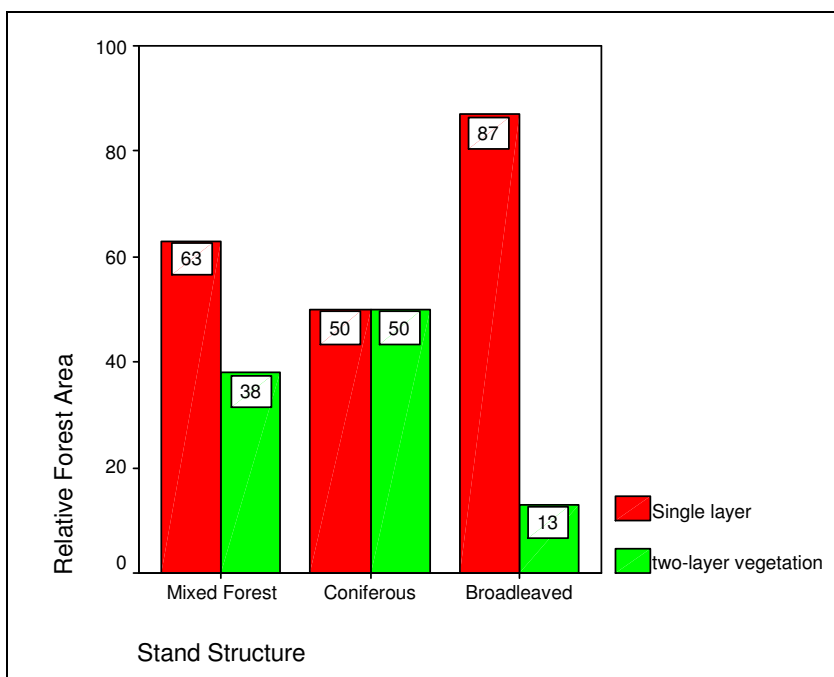


Figure 21: Stand structure by relative area of forest type

We should note that the frequency of two layers of trees is rare in Lebanon. In most cases, the lower layer is made of shrubs. Two layers vegetation is a frequent in *Pinus pinea* stands. Pine trees are pruned and allow sun rays to reach the ground, which enables other species to thrive. *Pinus pinea* is planted and most of the lower layer is composed of broadleaved species. When pine forest is not maintained, the lower layer forms a second layer of trees and woody vegetation.

The frequency of fire in mixed forests of *Pinus brutia* and broadleaved species in the subtropical dry forest enhances the regeneration of the fast growing *Pinus brutia*, and degrades the broadleaved tree species, that will only create a lower layer of shrubs. If the canopy cover of *Pinus brutia* trees is not dense, and the broadleaved trees layer is more than 25%, they are mixed forests, but the team leaders would also see them as a second lower layer during fieldwork. This explains also the high percentage of double layers in mixed forests.

In coniferous dense stands and evergreen broadleaved stands, there is only one single layer. A second layer may occur in open coniferous stands and deciduous broadleaved stands, where the light intensity allows a lower layer of different trees, shrubs and ferns to develop (e.g. *Quercus spp.*, *Rosa spp.*, *Myrtus spp.*, *Pistacia spp.*, *Styrax officinalis*, *Lonicera spp.*, *Cistus spp.*). Stands with two layers exist only in the dry subtropical and subtropical mountain ecological zones. Thus, on the eastern slopes of Mount Lebanon, the Bekaa and Anti-Lebanon, only forests with single stands exist. It could be interesting to make further study and link the frequency of 2 layers with the forest type, silvicultural practices, frequency of fire and canopy coverage.

## XI. 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 other wooded land and other land.

### XI.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 sustainable forest utilization and for policy perspective. Non-wood forest products (NWFPs) play an important role in the daily life as source of food and income, especially in rural areas. The area where each product is exploited and used is expressed according to the relative total country area (1,045,200 ha) in each land use classes.

Wood and Non wood products	% Land Use Area			% country area
	Forest	OWL	OL	
Fuel wood	38	26	4	10.84
Plant food	11	17	36.3	30.91
Honey, wax	5.7	6	1	2.13
Plant medicines	3	0	0.5	.80
Timber	2	0	0.3	.50
Charcoal	2	0	0	.27
Ornamentals	1.2	0	2.4	1.96
Fodder	1	3.5	14	11.17
Bush meat	0.7	1	0	.20
Soap	0.2	0	1.5	1.16

Table 31: Relative forest, OWL, OL products area, and the relative total country area

The area relative to the total Country area for each Land Use class in which the Product/Service (P/S) was exploited/ used is represented in the figure 22.

The results show that plant food is the most common P/S in and it is exploited /used in 31% of the total country area. Fuel wood is the product most commonly provided by the forest area.

Plant food products occupy the largest area of the country, which is mainly found in the agricultural areas (27% of the total surface of the country) and stone pine forests (more than 7000 ha). It is followed by fodder products, also cultivated or found in grasslands and some OWL. Considering the area of grassland (more than 50% of the country) and the area exploited for fodder extraction (14% of the country), fodder extraction seems to be either underestimated or mixed up with grazing which is classified also among the services. Fuel wood occupies the third place in surface area. It is evenly extracted from forests, OWL and OL. Such distribution is related to the prohibition of forest exploitation and the high rate of orchard renovation which leads to the use of fruit tree wood as fuel wood.

The remaining services are more or less similar and have limited areas of extraction because of the limited area of forests and woodlands (13% and 10% respectively).

Honey extraction cannot be estimated by area of extraction since the frequency of bee hives is different from the area of bee activity.

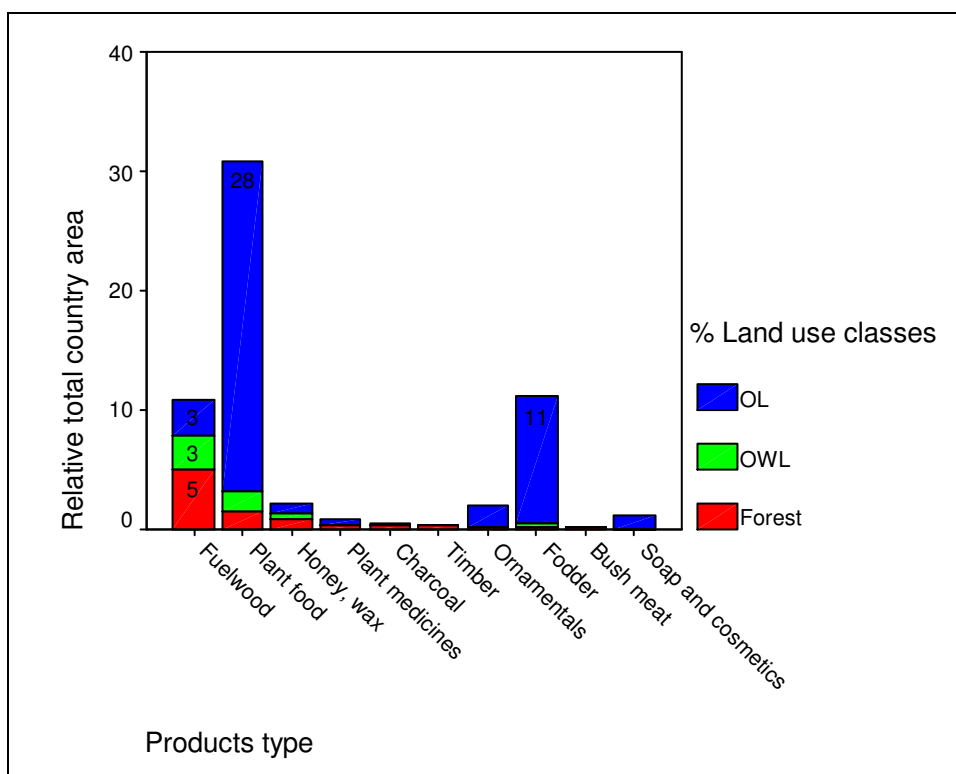


Figure 22: Wood and non wood products by relative total country area

### ***XI.1.1 Ranking of exploited products***

The rank of products according to their percentage of exploitation is compiled based on the results of interviews of key informants on the three modalities: product of high importance, products of medium and products of low importance. The results are shown below separately for the three categories: forest, other wooded land and other land use.

#### **XI.1.1.1 Exploitation of Wood and Non-wood forest products**

The highest ranked product is fuelwood which was collected in 38% of the forest area. Plant food is the second highest ranked collected in 11% of the forest area.

Wood and Non wood products	% by forest Area	% Area Rank			SE	SE%
		Total	High	Medium		
Fuel wood	38	23	13	2	0.242	57
Plant food	11	5	6	0	0.135	132.3
Honey, wax	5.7	1.2	3.3	1.2	0.091	211.6
Plant medicines	3	0	2	1	0.041	350
Timber	2	0	2	0	0.214	2675
Charcoal	2	2	0	0	0.057	400
Ornamentals	1.2	1.2	0	0	0.047	391
Fodder	1	0	1	0	0.017	425
Bush meat	0.7	0	0.7	0	0.025	416
Soap and cosmetics	0.2	0	0.2	0	0.007	350

Table 32: Exploitation of Wood and Non-wood forest products (ranked) presented as relative forest areas in which the products are exploited

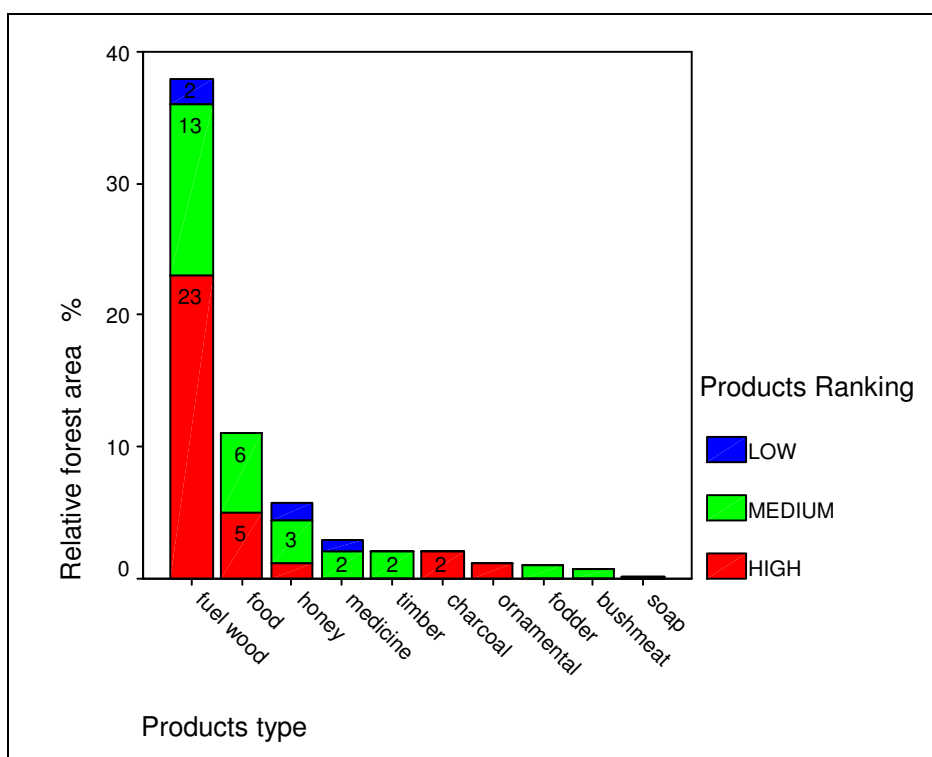


Figure 23: Exploitation of Wood and Non-wood forest products (ranked) presented as relative forest areas in which the products are exploited

### XI.1.1.2 Exploitation of wood and non-wood products from Trees in other wooded land

Wood and Non wood products	% by OWL Area	% Area Rank	SE	SE%
----------------------------	---------------	-------------	----	-----

	Total	High	Medium	Low		
Fuel wood	26	18	6	2	0.188	93
Plant food	17	6	10	1	0.164	103.7
Honey, wax	6	1	2	3	0.1	196
Plant medicines	0	0	0	0	0	0
Timber	0	0	0	0	0	0
Charcoal	0	0	0	0	0	0
Ornamentals	0	0	0	0	0	0
Fodder	3.5	3	0	0.5	0.056	311
Bush meat	1	0	1	0	0.016	400
Soap and cosmetics	0	0	0	0	0	0

Table 33: Exploitation of Wood and Non-wood OWL products (ranked) presented as relative OWL areas in which the products are exploited

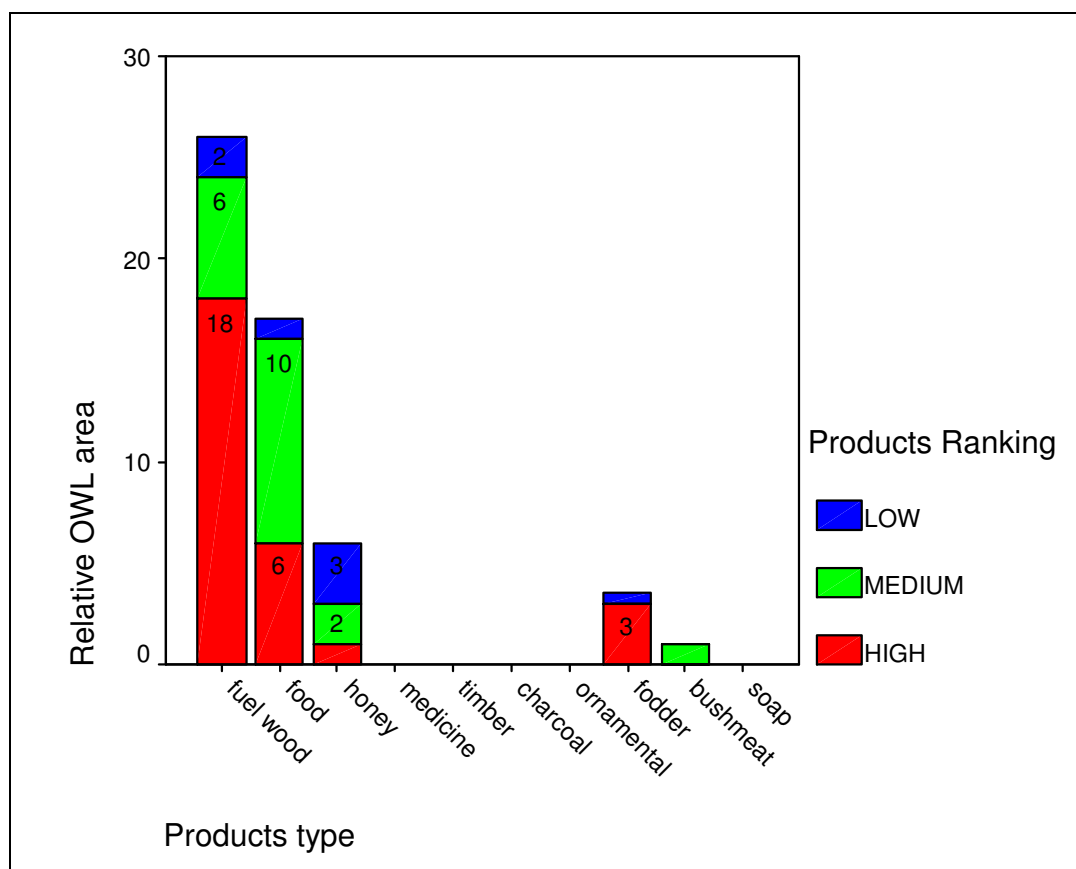


Figure 24: Exploitation of Wood and Non-wood OWL products (ranked) presented as relative OWL areas in which the products are exploited

The figure 24 shows that the overall highest ranked product from the other wooded land is also fuelwood which is collected in 26% of the OWL area.

### XI.1.1.3 Exploitation of products from other land trees

Wood and Non wood products	% by OL Area	% Area Rank	SE	SE%
----------------------------	--------------	-------------	----	-----

	Total	High	Medium	Low		
Fuel wood	4	1.5	2.5	0	0.036	86
Plant food	36.3	34	2	0.3	0.109	29
Honey, wax	1	0.3	0.7	0	0.023	191
Plant medicines	0.5	0.4	0	0.1	0.015	250
Timber	0.3	0.3	0	0	0.01	250
Charcoal	0	0	0	0	0	0
Ornamentals	2.4	1.5	0.5	0.4	0.032	139
Fodder	14	12.5	1	1.5	0.083	70
Bush meat	0	0	0	0	0	0
Soap and cosmetics	1.5	1	0.5	0	0.022	169

Table 34: Exploitation of Wood and Non-wood OL products (ranked) presented as relative OL areas in which the products are exploited

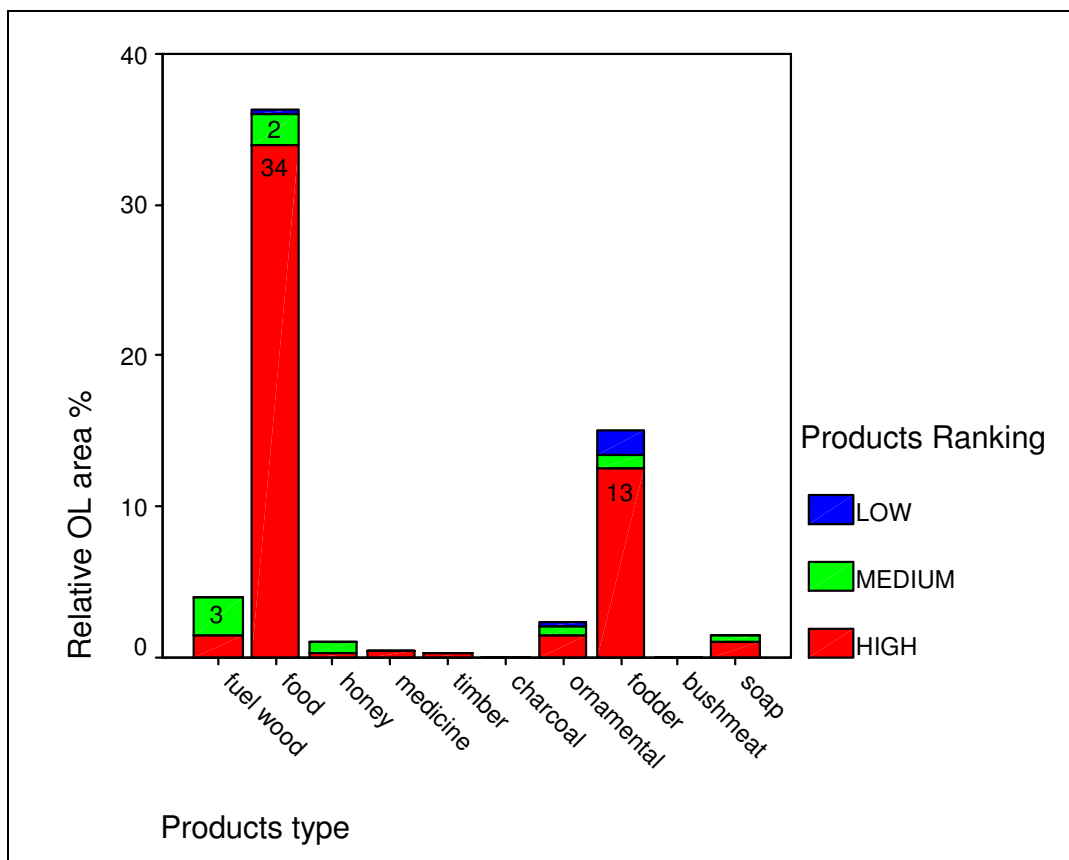


Figure 25: Exploitation of Wood and Non-wood OL products (ranked) presented as relative OL areas in which the products are exploited

The highest ranked product from the other land is plant food which is collected in 36% of the OL area.

Fuel wood is the major product in forests and OWL. Timber and charcoal production are prohibited and the modest production found is seen as an illegal production. This fact might change with the law amendments that are taking place since September 2004, which will encourage charcoal production in broadleaved forests and maybe timber exploitation in riparian groves and coniferous forests. Fuelwood is also significantly extracted from torn out trees and pruned trees found in OL (orchards).

Plant food is the major product that is taken from OL and ranks second in forests and OWL. In OL plant food is provided mainly by agricultural zones, in forests by pine and carob trees, while in OWL it is provided by carob trees, laurel, sumac and wild plants. This product ranks high in forests, because *Pinus pinea* forests are planted in the purpose of pine nut production.

Honey production is significant in Lebanon, and widely distributed in all land uses. The number of bee hives is around 120000 all over the country which makes an average of 12 hives/km<sup>2</sup> or 12 hives per tract, i.e. a significant frequency of bee hives.

Plant medicines are more frequently extracted from forest areas, rather than OWL or OL. The major product is sage which cutting is regulated by the State. Other species are extracted and used in local infusions (mainly *Eleagnus angutifolia* and *Crataegus spp.*, from tree species and an undetermined number of wild plants). Many species found in grassland in high altitudes have medicinal properties and many of them are endemic (i.e. *Ferula hermonensis*). The values of such products are still underestimated in Lebanon. Also many species are cultivated for aromatic and medicinal use (*Rosa damascena* and *sentifolia*, *Sambucus nigra*, *Laurus nobilis*...).

Fodder extraction is more frequent in OWL than in forest, because the shepherds have easier access to these areas. Fodder in OL is mostly cultivated or extracted from grasslands.

Ornamentals are planted in OL where their extraction is the most frequent. The wild vegetation in forests and OWL seems to be of lower importance (ferns, flowers, shoots of *Myrtus communis*, *Ceratonia siliqua*...).

Bush meat (wild boar, badger, rabbit) and products used for soap and cosmetics industries are almost negligible in Lebanon, except for soap production from olive oil (OL zones).

### ***XI.1.2 Demand for and Supply of products***

In this part, we present the list of forest, other wooded land and other land products with the different categories of the products demand during the last five years and according to the supply / demand trends during the 5 years prior to the field interviews.

#### **XI.1.2.1 Demand and Supply trends for Wood and non-wood products from forest**

The results in table 35 show the relative forest area trends in the demand and supply of different forest products.

<b>Wood and non wood forest products</b>		<b>Demand Trend</b>		
<b>Supply Trend</b>		<b>Increasing</b>	<b>Stable</b>	<b>Decreasing</b>
<b>Increasing</b>	Charcoal	100	0	0
	Fodder	100	0	0
	Honey, wax	100	0	0
	Plant food	50	50	0
	Fuel wood	22	50	28
<b>Stable</b>	Honey, wax	100	0	0
	Timber	59	0	41
	Fuel wood	9	87	4
	Plant food	3	68	29
	Soap and cosmetics	0	100	0
	Ornamentals	0	100	0
<b>Decreasing</b>	Plant medicines	0	100	0
	Honey, wax	100	0	0
	Fuel wood	61	17	22
	Plant food	53	47	0

Table 35: Supply and demand trends for forest products presented as relative forest areas in which the products are exploited

### XI.1.2.2 Demand and Supply trends for Wood and non-wood products from other wooded land

OWL products		Demand Trend		
Supply Trend		Increasing	Stable	Decreasing
Increasing	Fuel wood	0	100	0
	Plant food	0	0	100
Stable	Honey, wax	86	14	0
	Bush meat	0	100	0
	Fuel wood	0	93	7
	Plant food	0	85	15
	Fodder	0	31	69
Decreasing	Plant food	43	56	0
	Fuel wood	23	8	69
	Fodder	0	0	100

Table 36: Supply and demand trends for OWL products presented as relative OWL areas in which the products are exploited

### XI.1.2.3 Demand and Supply trends for Wood and non-wood products from other land

OL products		Demand Trend		
Supply Trend		Increasing	Stable	Decreasing
Increasing	Honey, wax	100	0	0
	Fodder	100	0	0
	Soap and cosmetics	45	0	55
	Plant food	27	38	35
	Timber	0	0	100
	Fuel wood	0	0	100
Stable	Honey, wax	68	32	0
	Plant medicines	67	33	0
	Plant food	2	94	4
	Fuel wood	0	100	0
	Fodder	0	100	0
	Timber	0	100	0
Decreasing	Ornamentals	0	100	0
	Fuel wood	44	16	40
	Plant food	10	13	77

Table 37: Supply and demand trends for OL products presented as relative OL areas in which the products are exploited

Honey is the most demanded product, especially from forest areas, where the type of honey is better, regarding of the supply trend.

Fuel wood and plant food have a stable demand, compared to the supply trend. Still, a tendency for decreasing supply is noted in areas where there is an increasing demand and vice-versa. This can be interpreted to mean that rural population touched by poverty still rely on such products for heating and cooking.

Charcoal demand trend is increasing along with the supply. This could be related to the prohibition of charcoal production until September 2004.

Timber production is prohibited, thus we find that the supply is mainly from fruit trees wood which has a poor quality and makes the demand trend decrease, while in reality Lebanon imports large amounts of industrial wood and timber from other countries.

Fodder demand trend is correlated to the supply trend in forests, OWL and OL. In forest it is mainly composed of young tree shoots that is taken for goats and the supply and demand both appear to be increasing from forests. In contrast in OWL shoots are less important, and thus both the supply and the demand decrease. In OL fodder is taken from planted or spontaneous fodder species such as legumes. The potential of OL seems to be stable.

Plant medicines and ornamentals show a stable supply in forests and OL. The demand is also stable in forests, but in OL, the demand is increasing which could affect the potential of supply in the future. This is the case of numerous plants found on the higher altitudes such as *Ferula hermonenesis*.

### ***XI.1.3 User Conflicts related to the use/collection of products***

#### **XI.1.3.1 User conflicts related to the use/collection of wood and non-wood products from forest**

The relative occurrence of conflicts related to the use/collection of products is evaluated for forest, other wooded land and other land areas. 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 the use/collection of fodder in forest areas has most user conflicts (100%), whereas, for use/collection of soap, bush meat and ornamentals in forest areas no conflicts (0%) were reported.

Wood and Non wood Forest products	User conflicts (% of Forest Area, in which product is used/collected)		
	Existing	Not Existing	Not Known
Fodder	100	0	0
Timber	59	41	0
Charcoal	53	47	0
Fuel wood	6	87	7
Plant medicines	0	62	38
Plant food	0	72	28
Honey, wax	0	82	18
Soap and cosmetics	0	100	0
Ornamentals	0	100	0
Bush meat	0	100	0

Table 38: User conflicts related to the use/collection of forest products presented as relative forest areas in which the products are exploited

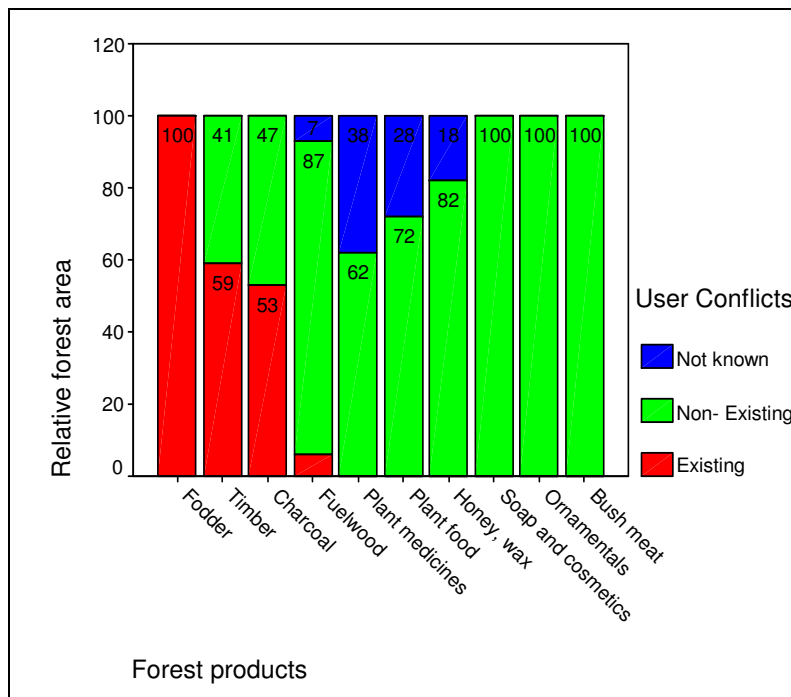


Figure 26: User conflicts related to the use/collecton of forest products presented as relative forest areas in which the products are exploited

### XI.1.3.2 User conflicts related to the use/collecton of wood and non-wood OWL products

The same procedure is done for the other wooded land area to see the conflicts user. The results are illustrated below. In more than 97% of the OWL area no user conflicts over the products were reported. Only in the gathering of plant food (and only in 8% of the other wooded land area) existing user conflicts were reported.

Wood and Non wood OWL products	User conflicts (% of OWL Area, in which product is used/collected)		
	Existing	Not Existing	Not Known
Plant food	8	84	8
Fodder	0	100	0
Bush meat	0	100	0
Honey, wax	0	100	0
Fuel wood	0	90	10

Table 39: User conflicts to OWL products presented as relative OWL areas in which the products are exploited

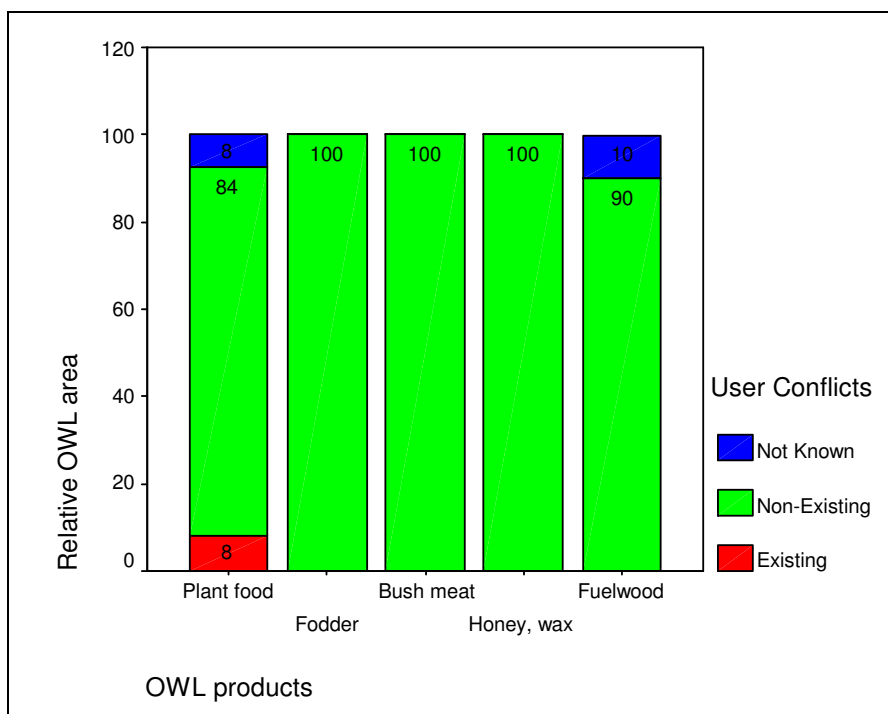


Figure 27: User conflicts related to the use/collection of OWL products presented as relative OWL areas in which the products are exploited

### XI.1.3.3 User conflicts related to the use/collection of wood and non-wood OL products

The results show that the extraction for soap and cosmetics is reported as a source of user conflicts in 45% of the other land use area.

Wood and Non wood OL products	User conflicts (% of OL Area, in which product is used/collected)		
	Existing	Not Existing	Not Known
Soap and cosmetics	45	55	0
Fodder	2	81	17
Plant food	2	98	0
Timber	0	100	0
Fuel wood	0	100	0
Plant medicines	0	100	0
Ornamentals	0	100	0
Honey, wax	0	84	16
Charcoal	0	0	0
Bush meat	0	0	0

Table 40: User conflicts related to the use/collection of OL products presented as relative OL areas in which the products are exploited

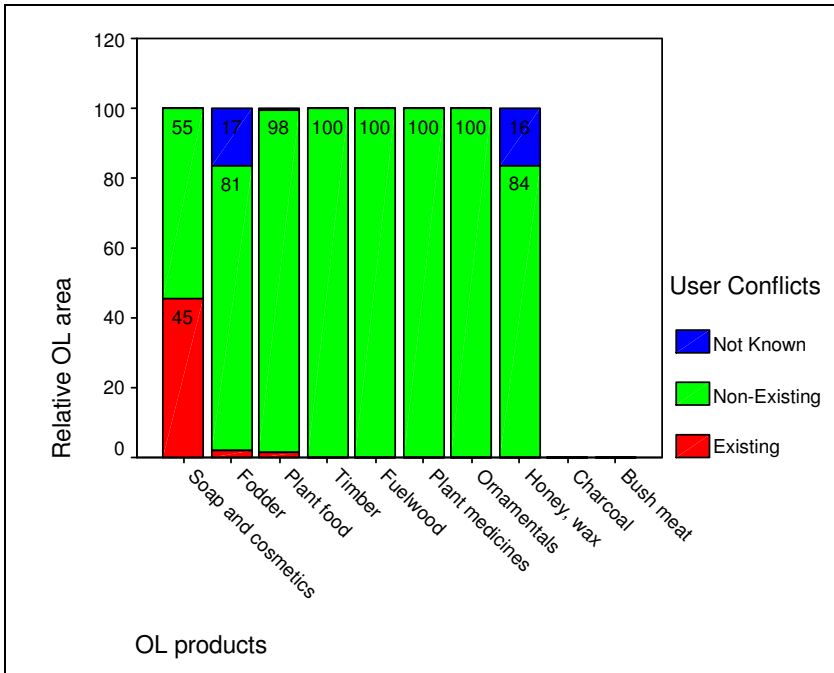


Figure 28: User conflicts related to the use/collection of OL products presented as relative OL areas in which the products are exploited

The questionnaire may not truly reflect all conflicts as the informants may be hesitant to tell the field team who are Government officials about activities that are prohibited. In general, conflicts are always present between land owners and shepherds who come to collect fodder in forests, because in most cases the fodder consists of tree regeneration and tree shoots. In OWL and OL such extraction does not generate conflicts in general, because fodder species are not tree regeneration or tree shoots.

Inside forests, other conflict exists between the State, and land owners and land users for charcoal, timber and fuelwood extraction. The prohibition of forest wood exploitation by the State caused such conflicts, especially in areas where such products are of major importance for the local population to survive.

Since food, aromatic and medicine plants can be a source of conflict between users, land owners and the State, a significant percentage of “unknown” and “existing conflict” exist especially in forests and OWL.

#### ***XI.1.4 User Rights related to the use/collection of products***

To collect/use a wood or non-wood forest product, we find the following users right options: “The use of the product is reserved for the land owner (exclusive)”, “the use of the product is a common right (not exclusive)”, “the use of product is prohibited (no right)” and “not known”.

##### **XI.1.4.1 User rights related to the use/collection of wood and non-wood products from forest**

The user rights to products are estimated from the forest areas from which the products are collected/ used.

Wood and Non wood Forest products	User rights (% of Forest Area, in which product is used/collected)			
	Exclusive	Not Exclusive	No right	Not Known
Fodder	100	0	0	0
Ornamentals	100	0	0	0
Bush meat	100	0	0	0
Fuel wood	84	5	8	3
Plant food	60	40	0	0
Charcoal	53	0	47	0
Timber	41	0	59	0
Honey, wax	40	41	0	19
Plant medicines	0	100	0	0
Soap and cosmetics	0	100	0	0

Table 41: User rights related to the use/collecton of forest products presented as relative forest areas in which the products are exploited

The results show that the use/collecton of fodder, ornamentals and Bush meat in forest areas has reserved for land owner (100%)

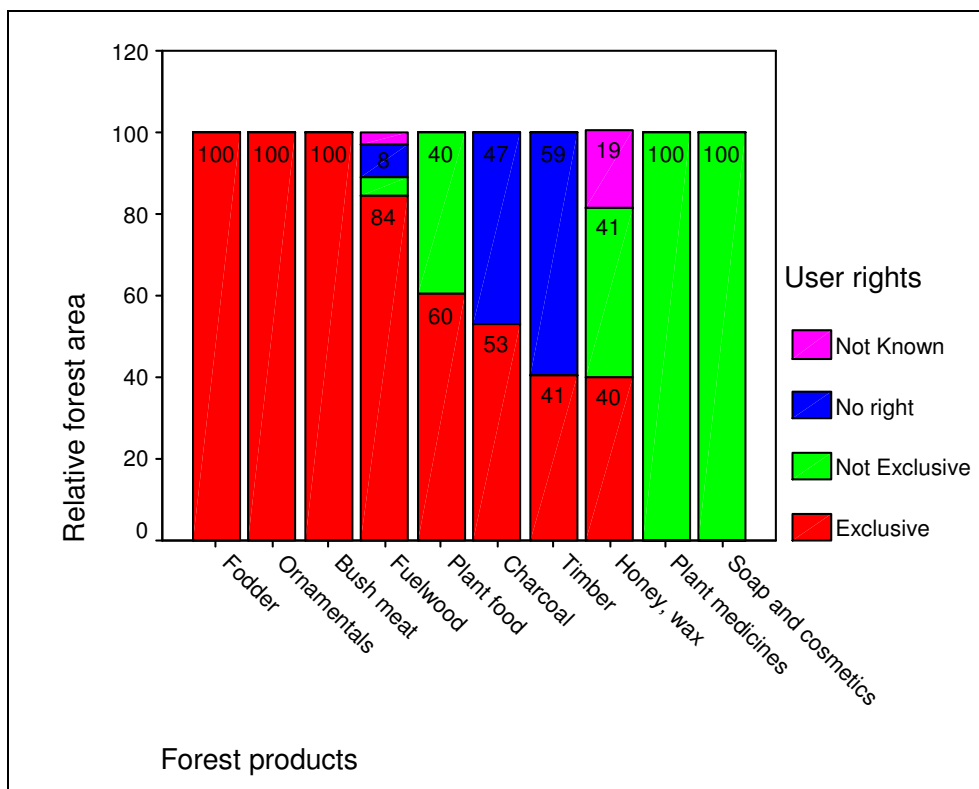


Figure 29: User rights related to the use/collecton of forest products presented as relative forest areas in which the products are exploited

#### XI.1.4.2 User rights related to the use/collecton of wood and non-wood OWL products

The same approach is done for user rights of the other wooded land to exploit trees products by the percentage of OWL area. The results show that 81% of fuel wood is with exclusive right.

Wood and Non wood OWL products	User rights (% of OWL Area, in which product is used/collected)			
	Exclusive	Not Exclusive	No right	Not Known
Fuel wood	81	7	12	0
Fodder	41	18	0	41
Plant food	31	69	0	0
Honey, wax	15	85	0	0
Bush meat	0	100	0	0

Table 42: User rights to OWL products presented as relative OWL areas in which the products are exploited

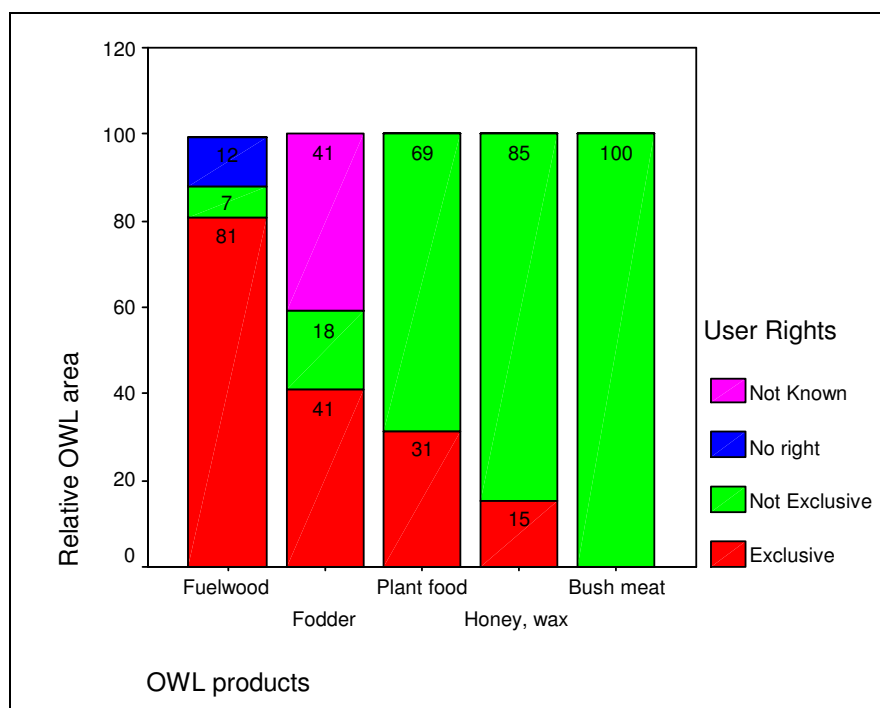


Figure 30: User rights related to the use/collection of OWL products presented as relative OWL areas in which the products are exploited

#### XI.1.4.3 User rights related to the use/collection of wood and non-wood OL products

Wood and Non wood OL products	User rights (% of OL Area, in which product is used/collected)			
	Exclusive	Not Exclusive	No right	Not Known
Timber	100	0	0	0
Plant medicines	100	0	0	0
Soap and cosmetics	100	0	0	0
Plant food	95	5	0	0
Fuel wood	92	8	0	0
Fodder	77	23	0	0
Ornamentals	59	41	0	0
Honey, wax	55	45	0	0

Table 43: User rights to OL products presented as relative OL areas in which the products are exploited

The most important other land areas where the user right is reserved for the land owner is for the timber, plant medicines and soap.

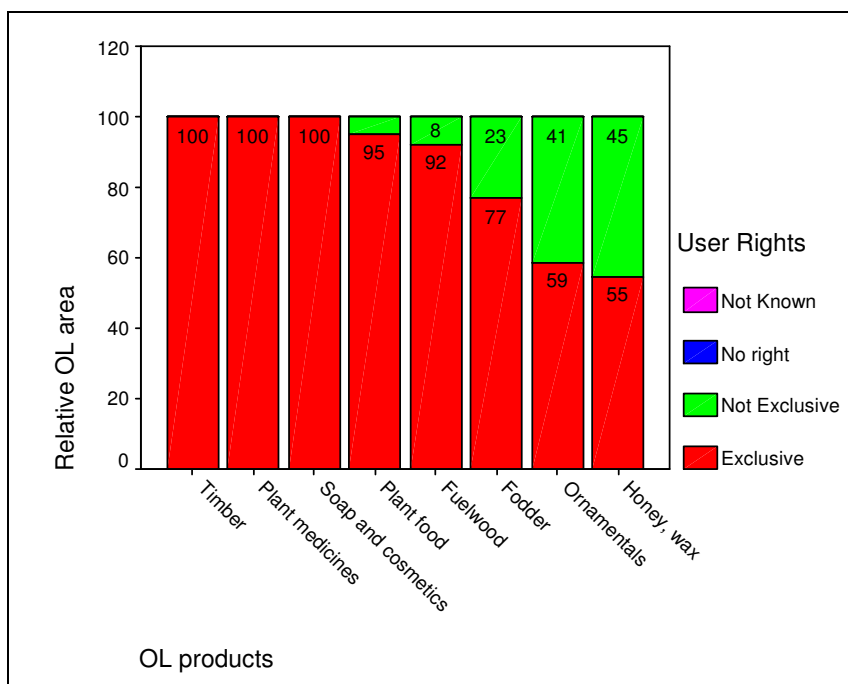


Figure 31: User rights related to the use/collection of OL products presented as relative OL areas in which the products are exploited

User right is in general exclusive to land owner. This is very obvious in OL where agricultural areas are found. But, in forests and OWL, the percentage of exclusivity decreases possibly due to the team leaders mixing between the users/owner’s rights and the attitude of the owner towards any user extracting any product from his (her) land. As an example, bush meat extraction cannot be 100% exclusive in forests while in OWL it is 100% not an exclusive right. In fact owners have the right to stop any user from entering or extracting any product on their land unless the law permits such cases. In general, if the owner is absent, or is not willing to extract any product, users are allowed to extract products freely.

For honey and wax the contradictory percentages between Forest and OWL is due to the fact that some team leaders mention the exclusive right for owners to install beehives in their land, while the bees extract honey from all areas regardless of ownership.

In principle there was no right for extraction of wood for charcoal, timber and fuel wood (from coniferous trees) until September 2004 for charcoal. But many users do not comply with laws, and for so, many owners count on their exclusive right to do what they want in their land, e.g. to produce charcoal.

### ***XI.1.5 Exploitation of products by Gender, Child labor and Enterprise form***

#### ***XI.1.5.1 Exploitation of wood and non-wood forest products by Gender, Child labor and Enterprise form***

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

Products	Gender balance (women labor)			Child labor		Enterprise form	
	>70% of labor area women	30-70% of labor are women	<30% of labor are women	Yes	No	Organised	Spontaneous
Plant food	0	43	57	0	100	22	78
Plant medicines	0	20	80	0	100	0	100
Fuel wood	0	10	90	2	98	29	71
Timber	0	0	100	0	100	0	100
Charcoal	0	0	100	0	100	0	100
Fodder	0	0	100	0	100	0	100
Soap and cosmetics	0	0	100	0	100	.	.
Ornamentals	0	0	100	0	100	0	100
Bush meat	0	0	100	0	100	0	100
Honey, wax	0	0	100	0	100	21	79

Table 44: Exploitation of forest products by gender, child labor and enterprise form presented as the relative forest areas in which the products are exploited

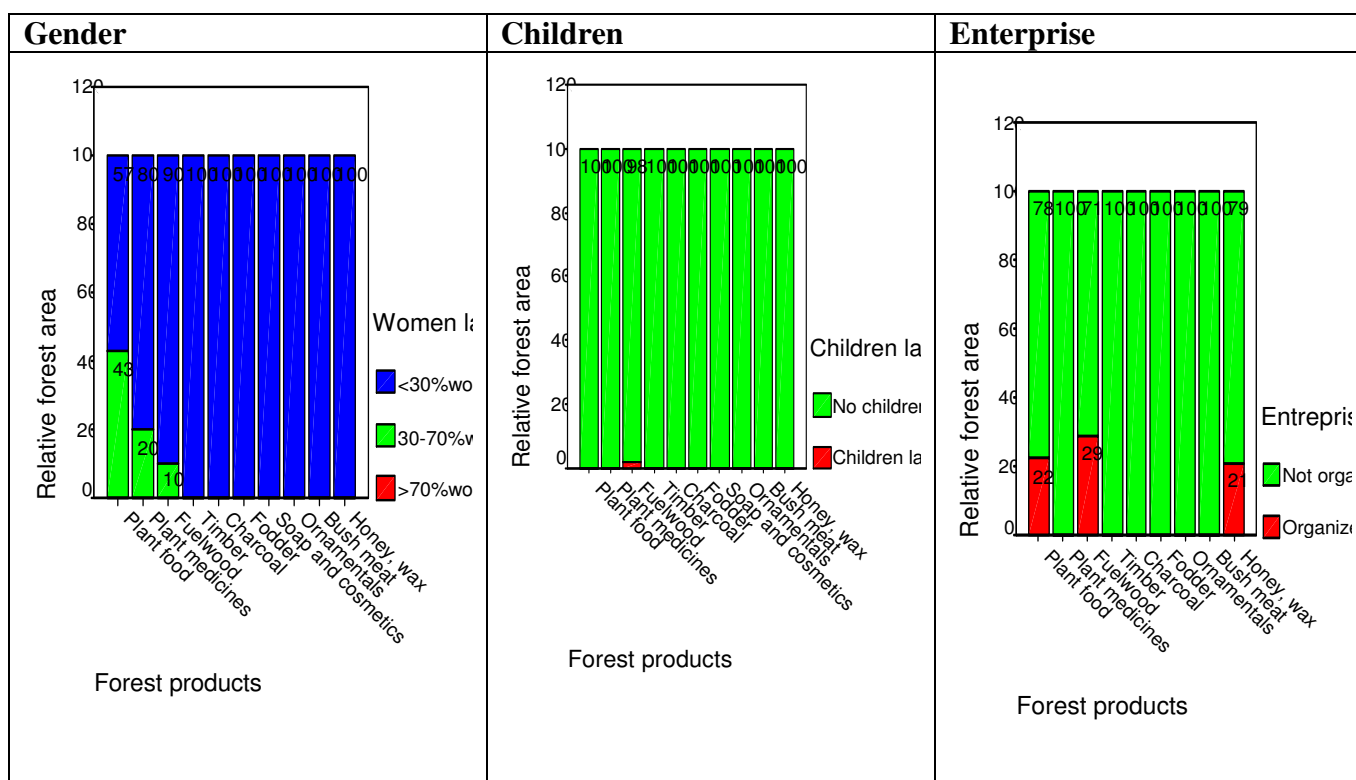


Figure 32: Exploitation of forest products by gender, child labor and enterprise form presented as the relative forest areas

### XI.1.5.2 Exploitation of wood and non-wood other wooded land products by Gender, Child labor and Enterprise form

The exploitation of OWL products by gender, child labor and enterprise form is presented as the relative OWL areas in which the products are collected.

OWL Products	Gender balance (women labor)			Children labor		Enterprise form	
	>70% women	30-70 % women	<30% women	Yes	No	Organised	Spontaneous
Plant food	1	65	34	9	91	34	66
Fuel wood	0	13	87	0	100	32	68
Honey, wax	0	0	100	0	100	0	100
Fodder	0	0	100	0	100	0	0
Bush meat	0	0	100	0	100	0	0

Table 45: Exploitation of OWL products by gender, child labor and enterprise form presented as the relative OWL areas in which the products are exploited

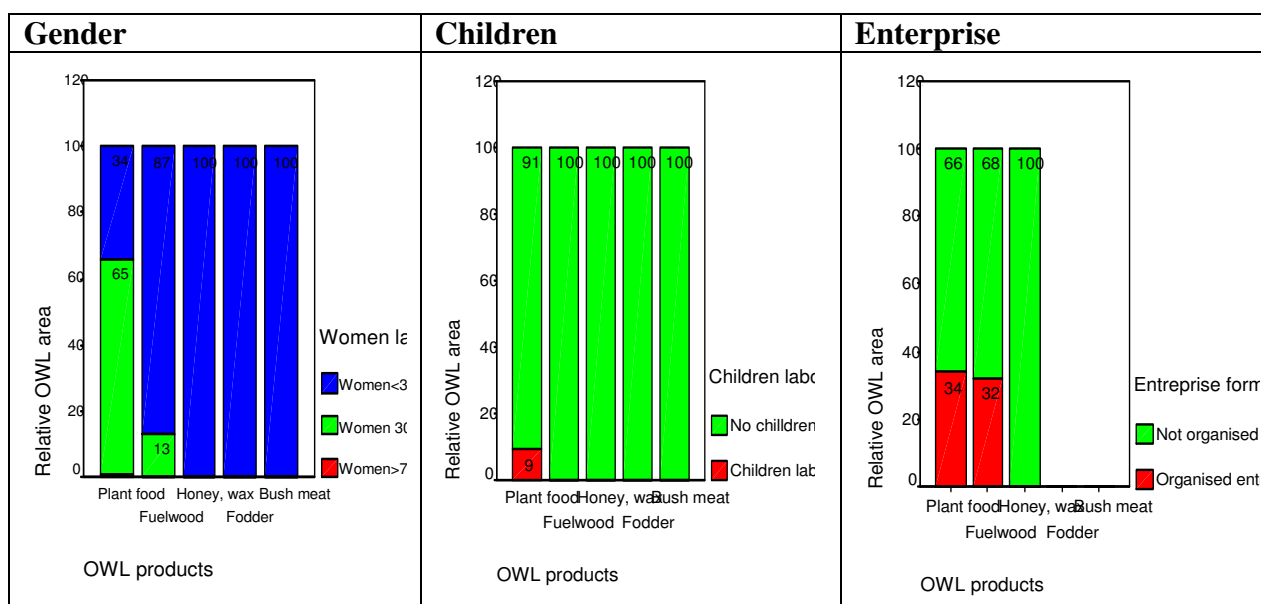


Figure 33: Exploitation of OWL products by gender, child labor and enterprise form presented as the relative OWL areas

### XI.1.5.3 Exploitation of wood and non-wood other land products by *Gender, Child labor and Enterprise form*

The exploitation of OL products by gender, child labor and enterprise form is presented as the relative OL areas in which the products are collected.

OL Products	Gender balance (women labor)			Children labor		Enterprise form	
	>70%	30-70 %	<30%	Yes	No	Organised	Spontaneous
Plant medicines	47	47	6	0	100	0	100
Soap and cosmetics	46	28	26	66	34	100	0
Plant food	3	39	58	4	96	74	26
Ornamentals	0	93	7	0	100	13	87
Timber	0	47	53	9	92	48	52
Fodder	0	14	86	2	98	39	61
Fuel wood	0	12	88	0	100	31	69
Honey, wax	0	6	94	0	100	0	100

Table 46: Exploitation of OL products by gender, child labor and enterprise form presented as the relative OL areas in which the products are exploited

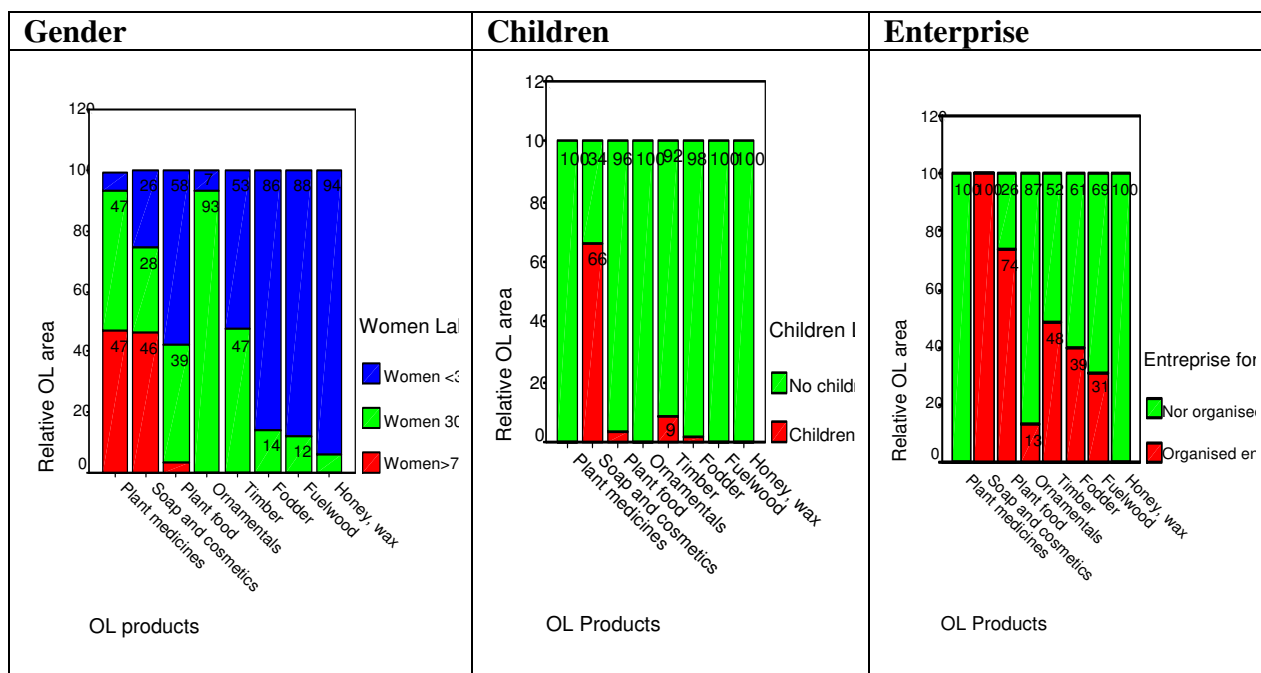


Figure 34: Exploitation of OL products by gender, child labor and enterprise form presented as the relative OL areas

Men do the major part of the exploitation of wood and non-wood forest products. Women and children participate in OWL and mostly OL where the products are physically less demanding to extract (fruit and olive collection, olive and laurel soap fabrication, wild plants collection, ornamentals collection). In few cases women participate in fuel wood and fodder plant extraction. The high percentage of “30-70% women labor” in timber extraction in OL could be due to a misinterpretation by team leaders, since the wood of torn out fruit trees is not used for timber.

Enterprise form is spontaneous in most cases for product extraction inside forests and OWL, except for some cases where pine nuts or fuel wood is managed by municipalities or for some private companies extracting carob molasses, sage distilled water, honey, wax, etc.

In OL, the percentage of organized forms of extraction is higher since all agriculture products (soap and cosmetics, food, fodder, ornamentals) are considered organized enterprises.

## XI.2 Use of Services

The same study of the products is done for the services types provided by forest, other wooded land and other land present in the plot. First the rank order is considered, then the supply and demand types, then user rights and conflicts and finally the type of enterprises.

The area where each service was exploited and used is expressed relative to the total country area which is considered as 1,045,200 Ha in all land use classes.

services	% Land Use Area			% Country area
	Forest	OWL	OL	
Soil and water conservation	47	30	4	12.43
Grazing	20	40	19	21.31
Recreation and tourism	4	0	1	1.30
Hunting (sport)	2	6	1	1.65
Source for employment (paid)	2	0	0.2	.42
Windbreaks	1	0	1	.90
Conservation	1	0	0	.13
Shade	0	1	5	3.92

Table 47: Relative forest, OWL, OL services area, and the relative total country area

Figure 35 shows that the most important service is grazing which is reported provided by 21% of the country area.

Soil and water conservation is the most common service reported provided by the forest land areas (47%) and grazing is the most common service reported provided by the other wooded land areas (40%).

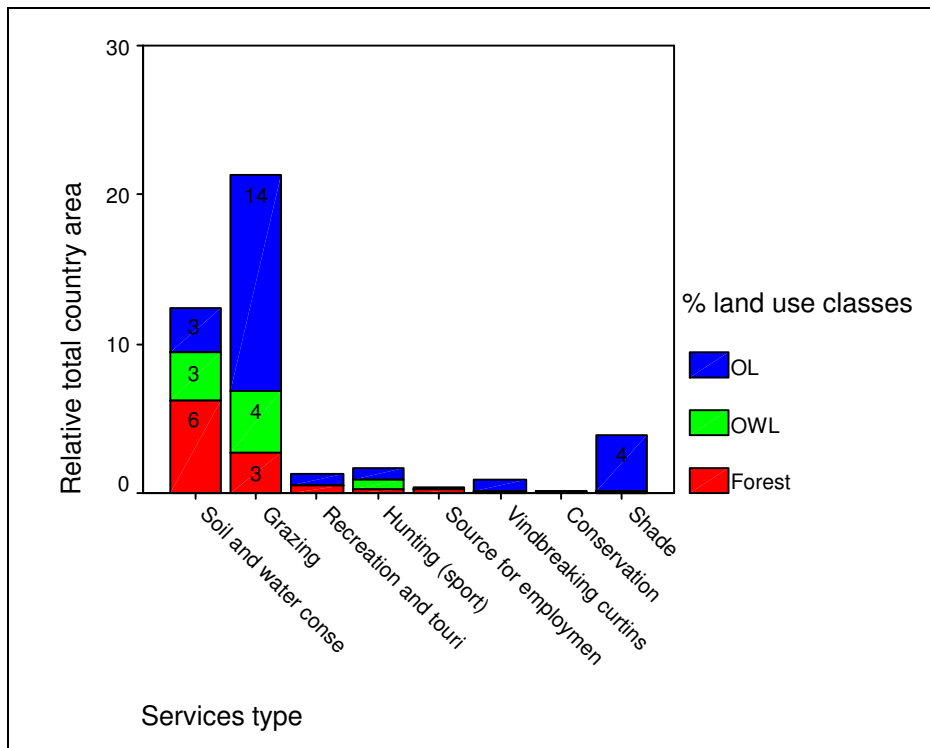


Figure 35: Services by relative total country area in each land use classes

It should be noted that the percentage of land use area and the percentage of the country area show the percentage of the frequency of the occurrence of the services as reported by the NFA. The team leaders did not rank all products and services, but estimated the 3-5 most important products and services and filled them in succession according to their importance which may have caused minor products and services to be omitted.

## XI.2.1 Exploitation of Services Ranking

### XI.2.1.1 Use of Forest services

services	% by forest Area	% Area Rank			SE	SE%
		High	Medium	Low		
Soil and water conservation	47	29	9	9	0.215	55
Grazing	20	13	5	2	0.165	102
Recreation and tourism	4	1	2	1	0.074	284
Hunting (sport)	2	1	0	1	0.036	277
Source for employment (paid)	2	0	1	1	0.068	400
Windbreaks	1	0	1	0	0.013	433
Conservation	1	1	0	0	0.026	288

Table 48: Use of forest services (ranked) presented as the relative forest areas in which the services are used

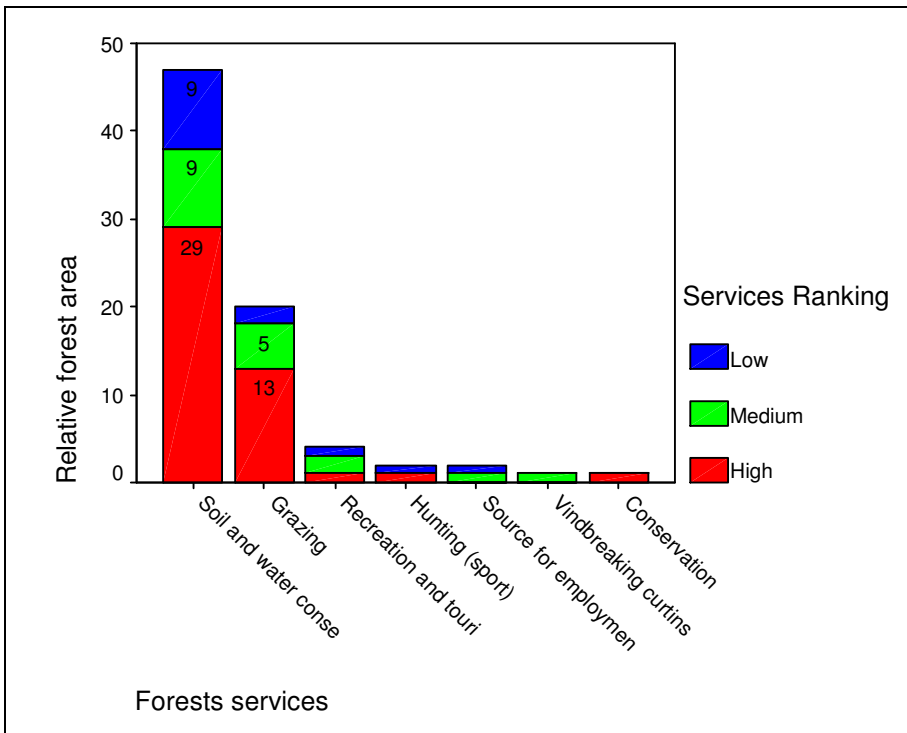


Figure 36: Use of forest services (ranked) presented as the relative forest areas in which the services are used

Soil and water conservation is the most important service. Grazing has the second high importance of the services provided by the forest areas.

### XI.2.1.2 Use of OWL Services

In OWL, grazing is the most important service, recorded as high ranked in 30% of the OWL area.

Services type	% by OWL Area	% Area Rank			SE	SE%
		High	Medium	Low		
Grazing	40	30	9	1	0.225	64
Soil and water conservation	30	17	9	4	0.226	56.6
Hunting (sport)	6	2	1	3	0.076	200
Shade	1	0	1	0	0.02	400
Windbreaks	0	0	0	0	0	0
Source for employment (paid)	0	0	0	0	0	0
Conservation	0	0	0	0	0	0

Table 49: Use of OWL services (ranked) presented as the relative OWL areas in which the services are used

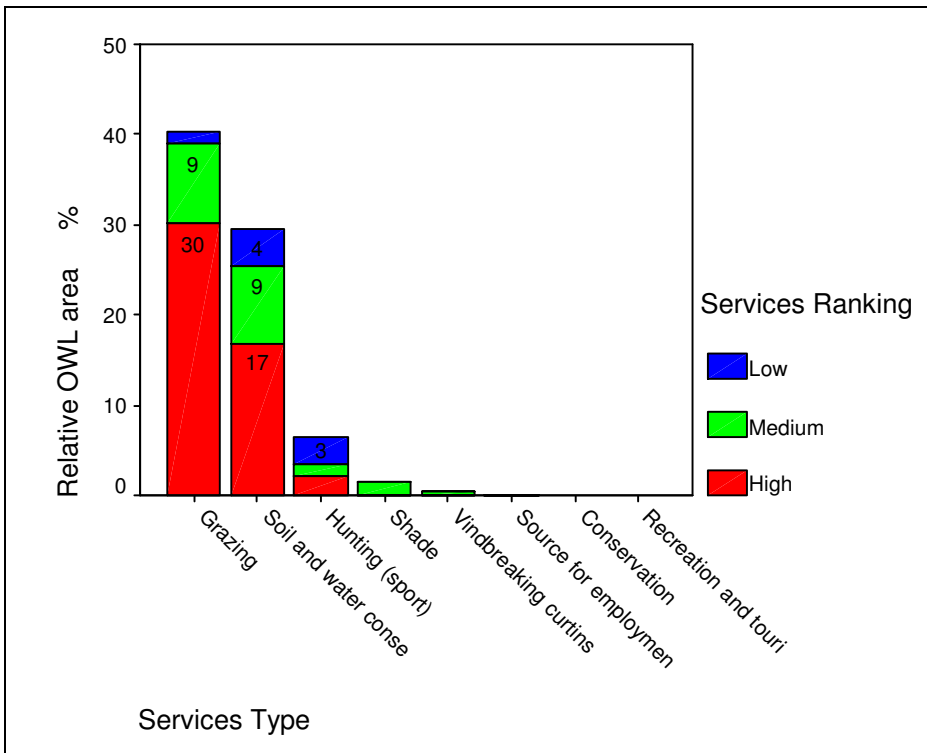


Figure 37: Use of OWL services (ranked) presented as the relative OWL areas in which the services are used

### XI.2.1.3 Use of OL Services

Services type	% by OL Area	% Area Rank			SE	SE%
		High	Medium	Low		
Grazing	19	18	1	0	0.091	51.1
Shade	5	1.6	3	0.4	0.042	84
Soil and water conservation	4	1	2	1	0.051	89.4
Windbreaks	1	0.8	0.2	0	0.026	173
Hunting (sport)	1	0.5	0	0.5	0.021	191
Recreation and tourism	1	0.5	0	0.5	0.023	191.6
Source for employment (paid)	0.2	0	0	0.2	0.011	367
Conservation	0	0	0	0	0	0

Table 50: Use of OL services (ranked) presented as the relative OL areas in which the services are used

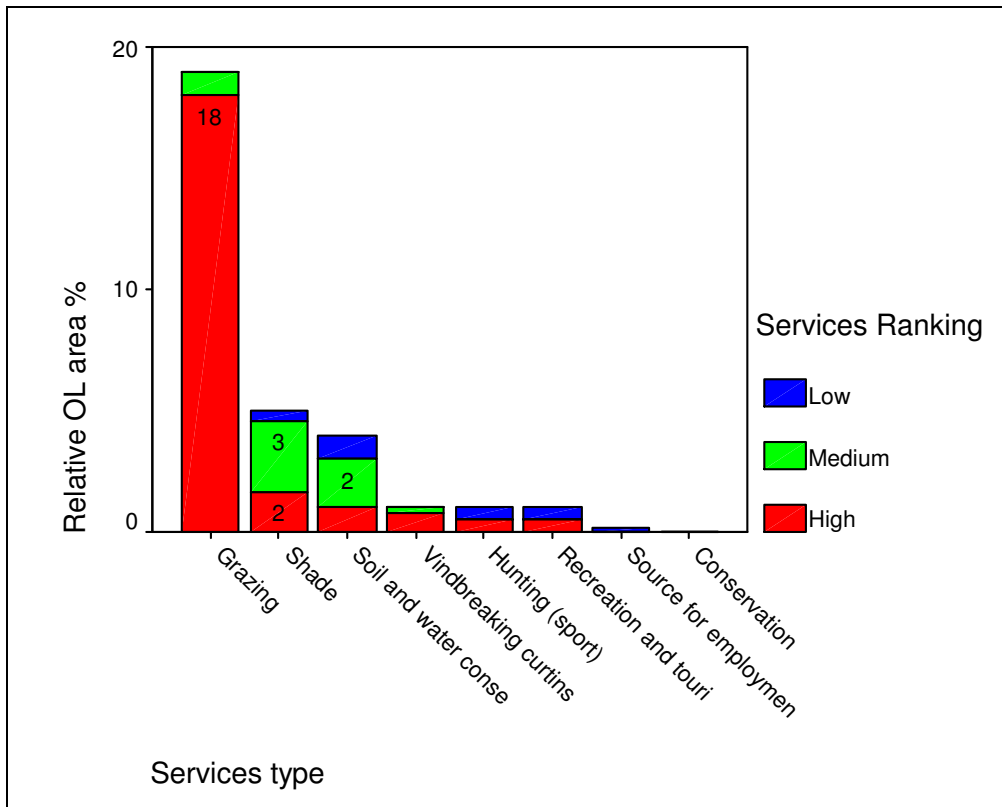


Figure 38: Use of OL services (ranked) presented as the relative OL areas in which the services are used

Soil and water conservation is the most important service provided by the forest in Lebanon. It is ranked in the second place in OWL. This due to the fact that most forests are situated on steep slopes, where soil and water conservation is a priority, and where other services cannot compete due to difficult access. This is also due to the limited valorization of other services (conservation, hunting, recreation and tourism). It also figures in OL in the third rank in woodlots, grassland with trees, or in some urban areas where trees are present.

Grazing shows an opposite picture; it is first ranked in OL, mainly grasslands and some agricultural lands, which constitute the main areas of OL. In OWL, grazing also ranks first.

The open nature of the woods makes grazing easier and fodder species are more frequent, and at the same time, the presence of grazing animals (especially goats) reduces tree regeneration and tree height which degrades the forest into OWL. In forest area, soil and water conservation is followed in ranking by grazing. This activity is more frequent in open non-protected forests where animals can find fodder plants to graze. The big discrepancy between “soil and water conservation” and “grazing” means that the latter service is becoming more and more restricted in forest areas due to the protection of forests against exploitation and grazing. It would be interesting to compare the frequency of fire with the frequency of grazing and forest exploitation. Recreation and tourism ranks third inside forests which illustrates the growing importance of such activities in Lebanon. This is due to the wish of the urban population to escape into natural areas for leisure and relaxation.

Hunting is a prohibited activity, it is however reported present, probably due to the absence of a clear law for hunting. Inside the forest and in OWL most hunters are after bush meat (wild boar, badger, etc) and birds.

Source of employment seem to be an underestimated service. Pine nut and charcoal producers, guides and forest guards, handicraft workers were not ranked in the first three places, and from the other hand in most cases, they live outside of the tracts/plots.

## XI.2.2 Demand and Supply for services

### XI.2.2.1 Demand and supply trends for forest services

For the services demand and stock/supply of services during the five years prior to the field work, the relative forest area of each category of supply and demand for the different type of service is listed below:

forest services		Demand Trend		
Supply Trend		Increasing	Stable	Decreasing
Increasing	Grazing	100	0	0
	Recreation and tourism	100	0	0
Stable	Grazing	43	57	0
	Soil and water conservation	0	100	0
Decreasing	Grazing	40	45	16

Table 51: Supply and demand trends for forest services presented as relative forest area in which the products are used.

### XI.2.2.2 Demand and supply trends for OWL services

OWL Services		Demand Trend		
Supply Trend		Increasing	Stable	Decreasing
Increasing	Grazing	48	52	0
Stable	Grazing	18	82	0
	Soil and water conservation	0	100	0
Decreasing	Grazing	68	32	0
	Hunting (sport)	0	100	0

Table 52: Supply and demand trends for OWL services presented as relative OWL area in which the products are used.

### XI.2.2.3 Demand and supply trends for OL services

OL products		Demand Trend		
Supply Trend		Increasing	Stable	Decreasing
Increasing	Grazing	95	0	5
	Recreation and tourism	77	0	23
	Hunting (sport)	0	0	100
Stable	Recreation and tourism	100	0	0
	Grazing	3	94	3
	Soil and water conservation	0	100	0

	Hunting (sport)	0	100	0
	Shade	0	100	0
	Windbreaks	0	100	0
<b>Decreasing</b>	Hunting (sport)	88	12	0
	Grazing	73	24	3

Table 53: Supply and demand trends for OL services presented as relative OL area in which the products are used.

The supply for the grazing service varies from one location to another, but was not studied within this report. But the demand trend is mostly increasing, especially when the supply increases. Where the supply is stable or decreasing, the demand is either increasing or stable, which could be a serious threat on the sustainability of the resources. We should note that the demand for grazing is not directly for the grazing area, but reflects more the demand on the products that can be taken out from this service (meat, dairy products, leather, etc.). A more accurate indicator could be added to see if there is really a need for the grazing area, and if it can be replaced by fodder.

Recreation and tourism show increasing supply and demand in forest areas. Rural population realized the advantage of this service to profit from the forest, especially when it is associated with other attractions and interests (archeological and cultural sites, leisure activities, organic and traditional food products, etc.).

### ***XI.2.3 User Conflicts related to the use/collection of services***

#### **XI.2.3.1 User conflicts related to the use of forest services**

In table 54, the existence of user conflicts related to the use of forest services is presented. There are relatively few user conflicts related to forest services. Grazing is the service with most user conflicts, recorded in 9% of the grazed forest area.

Forest services	User conflicts (% of Forest Area, in which service is used)		
	Existing	Not- Existing	Not Known
Grazing	9	59	32
Soil and water conservation	0	94	6
Source for employment (paid)	0	100	0
Conservation	0	100	0
Wind breaks	0	100	0
Recreation and tourism	0	57	43
Hunting (sport)	0	44	56

Table 54: User conflicts related to the use of forest services presented as relative forest areas in which the services are used

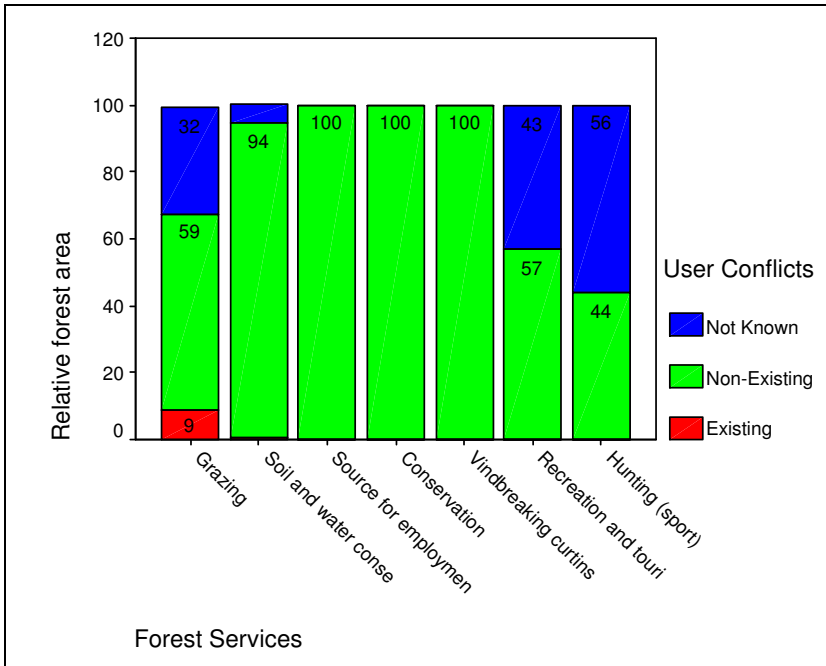


Figure 39: User conflicts related to the use of forest services presented as relative forest areas in which the services are used

### XI.2.3.2 User conflicts related to the use of OWL services

OWL services	User conflicts (% of OWL Area, in which service is used)		
	Existing	Not-Existing	Not Known
Grazing	5	78	17
Soil and water conservation	4	94	2
Hunting (sport)	0	100	0
Wind breaks	0	100	0
Shade	0	100	0

Table 55: User conflicts related to the use of OWL services presented as relative OWL areas in which the services are used

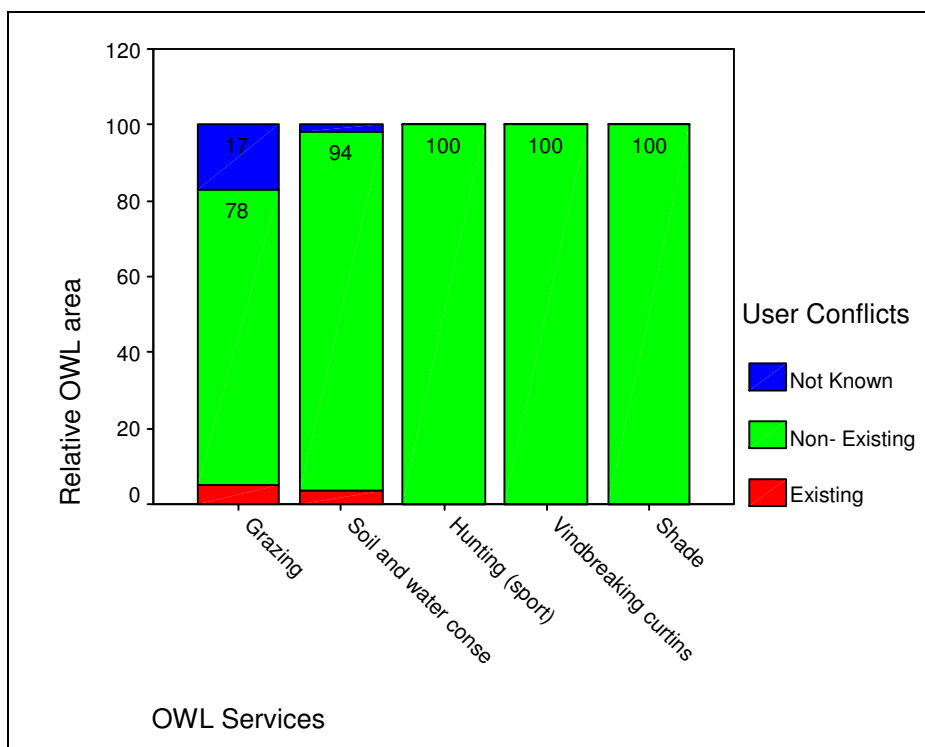


Figure 40: User conflicts related to the use of OWL services presented as relative OWL areas in which the services are used

### XI.2.3.3 User conflicts related to the use of OL services

OL services	User conflicts (% of OL Area, in which service is used)		
	Existing	Not-Existing	Not Known
Grazing	3	80	17
Source for employment (paid)	0	100	0
Hunting (sport)	0	100	0
Soil and water conservation	0	100	0
Shade	0	99	1
Wind breaks	0	96	4
Recreation and tourism	0	91	9

Table 56: User conflicts related to the use of OL services presented as relative OL areas in which the services are used

User Conflicts reported by the NFA are almost “absent” or “unknown” in Lebanon. This may be because they are judged as instant events localized to the concerned plot and not as historical events over a greater area. Hidden conflicts exist between the State and the population. Among these conflicts figures hunting because it is prohibited by law. A major conflict on grazing activity between land owners and users exist. Statistics show a higher percentage of conflicts inside forests because owners are keen to protect their forests from grazing.

The conflicts related to soil and water conservation in OWL could be explained by the illegal cutting of trees, urban activities, induced fires and overgrazing in areas where owners or other persons aim to conserve trees or shrubs from further degradation. The interview techniques or possibly reluctance of the interviewed informant to inform on conflicts and

illegal activities may well result in a general underestimation of the amount of conflicts related to the various land uses.

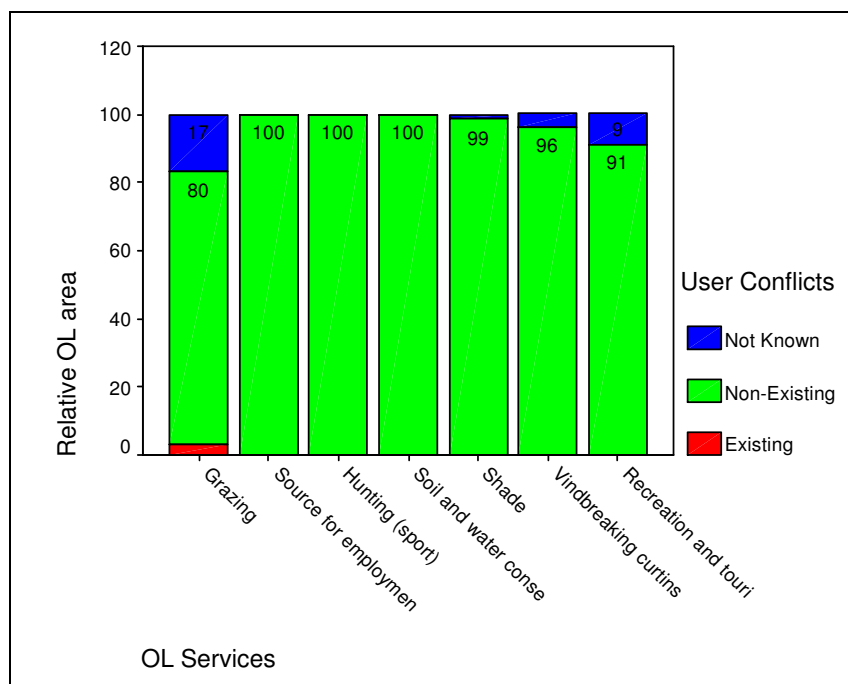


Figure 41: User conflicts related to the use of OL services presented as relative OL areas in which the services are used

#### ***XI.2.4 User Rights related to the use/collection of services***

##### **XI.2.4.1 User rights related to the use of forest services**

The most important services forest area in which reserved for the land owner is for employment, grazing and Wind breaks.

Forest services	User rights (% of Forest Area, in which service is used)			
	Exclusive	Not Exclusive	No right	Not Known
Source for employment (paid)	100	0	0	0
Grazing	100	0	0	0
Wind breaks	100	0	0	0
Conservation	88	12	0	0
Soil and water conservation	72	22	0	6
Hunting (sport)	56	44	0	0
Recreation and tourism	49	0	0	51

Table 57: User rights related to the use of forest services presented as relative forest areas in which the services are used

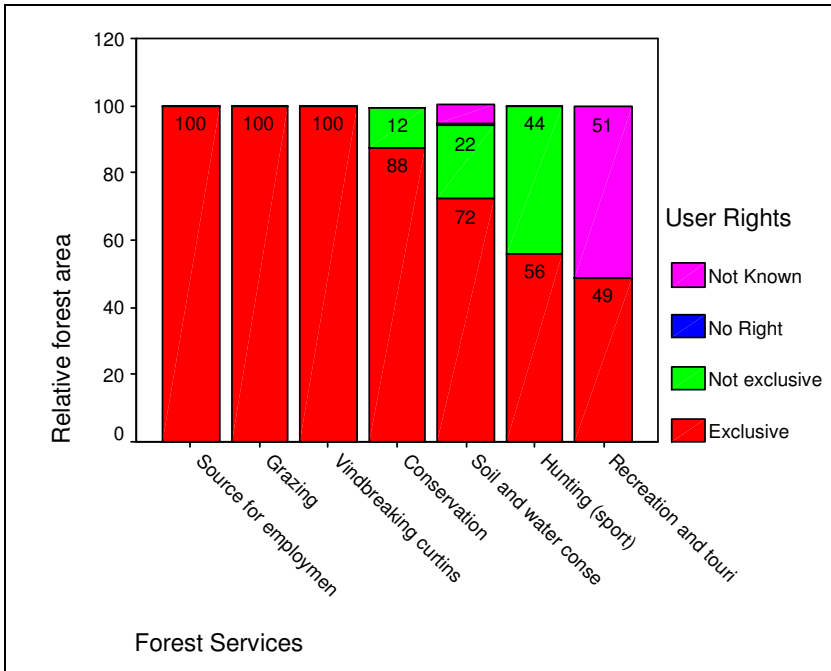


Figure 42: User rights related to the use of forest services presented as relative forest areas in which the services are used

#### XI.2.4.2 User rights related to the use of OWL services

OWL services	User rights (% of OWL Area, in which service is used)			
	Exclusive	Not Exclusive	No right	Not Known
Shade	100	0	0	0
Grazing	89	11	0	0
Soil and water conservation	39	59	0	2
Wind breaks	0	100	0	0
Hunting (sport)	0	85	15	0

Table 58: User rights related to the use of OWL services presented as relative OWL areas in which the services are used

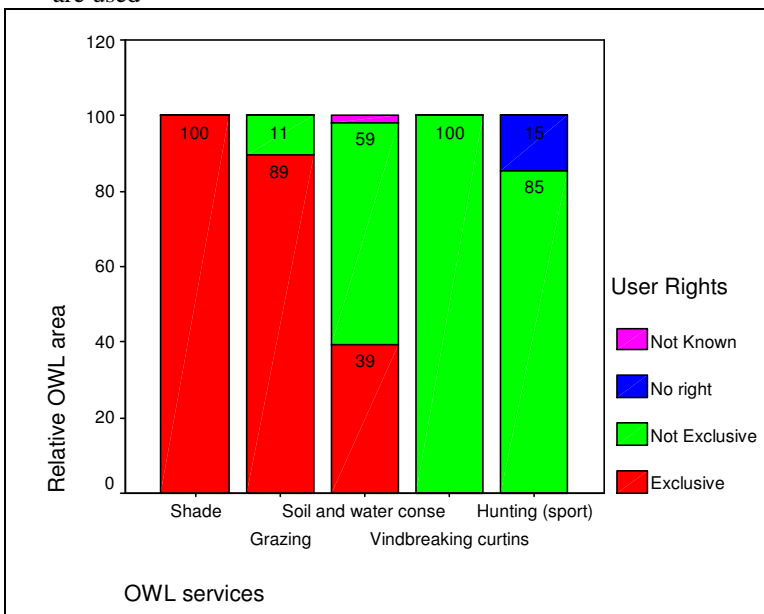


Figure 43: User rights related to the use of OWL services presented as relative OWL areas in which the services are used

### XI.2.4.3 User rights related to the use of OL services

OL services	User rights (% of OL Area, in which service is used)			
	Exclusive	Not Exclusive	No right	Not Known
Source for employment (paid)	100	0	0	0
Wind breaks	91	6	0	3
Shade	72	27	0	1
Recreation and tourism	65	12	0	23
Grazing	64	31	0	5
Hunting (sport)	37	49	13	1
Soil and water conservation	14	86	0	0

Table 59: User rights related to the use of OL services presented as relative OL areas in which the services are used

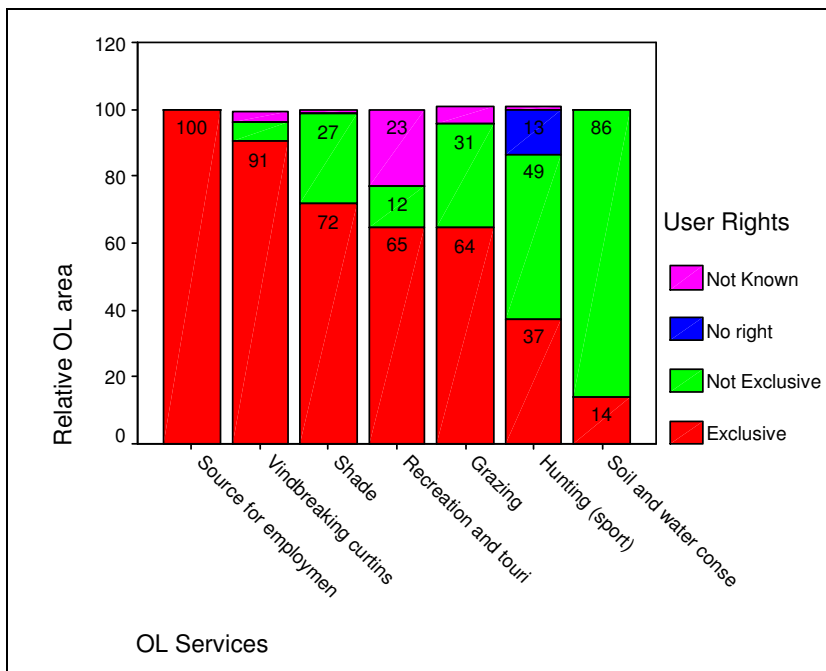


Figure 44: User rights related to the use of OL services presented as relative OL areas in which the services are used

Soil and Water conservation should not figure within user rights, because it generates a common benefit to all the population, and is not controlled by the land owner.

Activities such as source of employment, grazing, wind breaks, conservation, recreation and tourism and shade have an exclusive right for the land owner, a common right in communal and State lands. But the figuring percentages for a non-exclusive right for some of these activities could be related to the fact that the team leaders confuse between user right and people who would benefit from the activity. For instance a neighbor could benefit from the shade of a tree, but the owner of the tree has the exclusive right to keep the tree (shade) or not.

Most of the owners would allow activities such as grazing, recreation and tourism in their land, because of their hospitality and because of the relatively small size of their land which do not allow them to get a significant income by renting it to spontaneous users. Such activities could be forbidden only if the land owner considers them to cause harm to his land and/or wellbeing.

In this issue, the exclusive right of grazing, recreation and tourism occurs mainly when such activities are organized, and in big land parcels (i.e. farms, communal lands, skiing stations, etc). Hunting should in fact only figure in the “no right” category because it is prohibited by law in Lebanon. But since there is no law enforcement, this activity follows the same situation as recreation and tourism.

### XI.2.5 Exploitation of services by Gender, Children labor and Enterprise form

#### XI.2.5.1 Exploitation of wood and non-wood forest services by Gender, Child labor and Enterprise form

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

Forest Services	Gender balance (women labor)			Children labor		Enterprise form	
	>70 %	30-70 %	<30%	Yes	No	Organised	Spontaneous
Recreation and tourism	0	100	0	0	100	63	37
Grazing	0	0	100	6	94	44	56
Hunting (sport)	0	0	100	0	100	0	100
Soil and water conservation	.	.	.	0	100	0	100
Source for employment (paid)	.	.	.	0	100	.	.
Conservation	.	.	.	0	100	.	.
Wind breaks	.	.	.	0	100	.	.

Table 60: Exploitation of forest services by gender, child labor and enterprise form presented as the relative forest areas in which the services are exploited

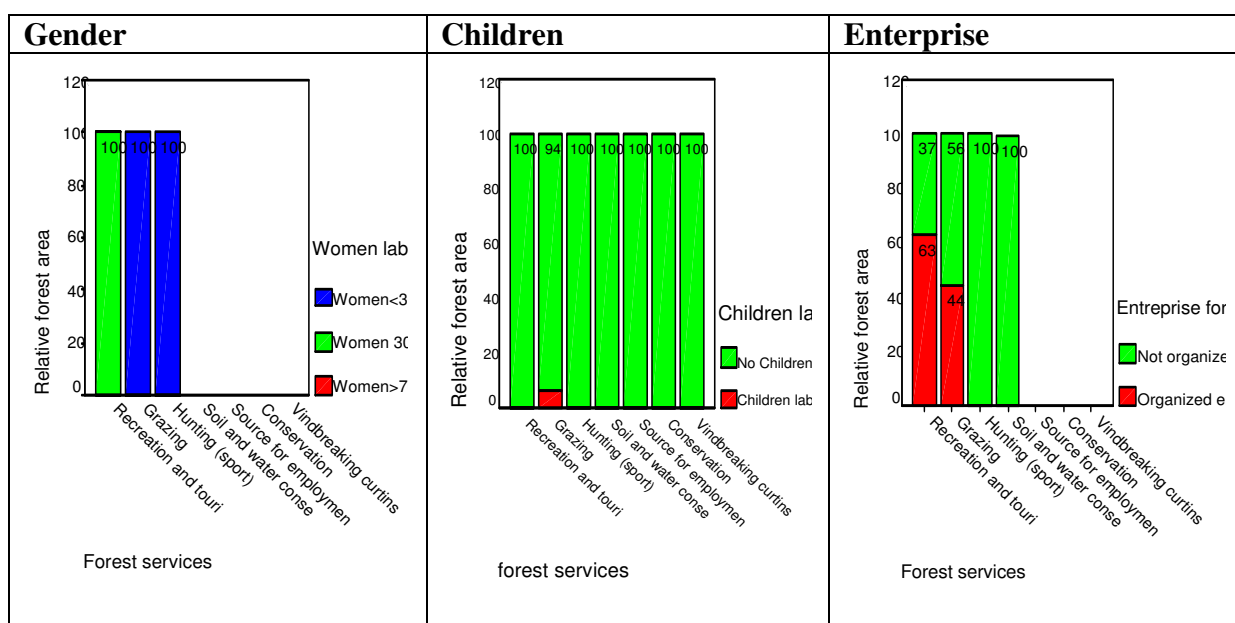


Figure 45: Forest services by gender, child labor and enterprise form presented as the relative forest areas

### XI.2.5.2 Exploitation of wood and non-wood other wooded land services by Gender, Child labor and Enterprise form

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

OWL Services	Gender balance (women labor)			Children labor		Enterprise form	
	>70%	30-70 %	<30%	Yes	No	Organised	Spontaneous
Wind breaks	0	100	0	0	100	0	100
Grazing	0	8	92	6	94	48	52
Soil and water conservation	0	0	100	0	100	100	0
Hunting (sport)	0	0	100	0	100	0	100
Shade	.	.	.	0	100	.	.

Table 61: Exploitation of OWL services by gender, child labor and enterprise form presented as the relative OWL areas in which the services are exploited

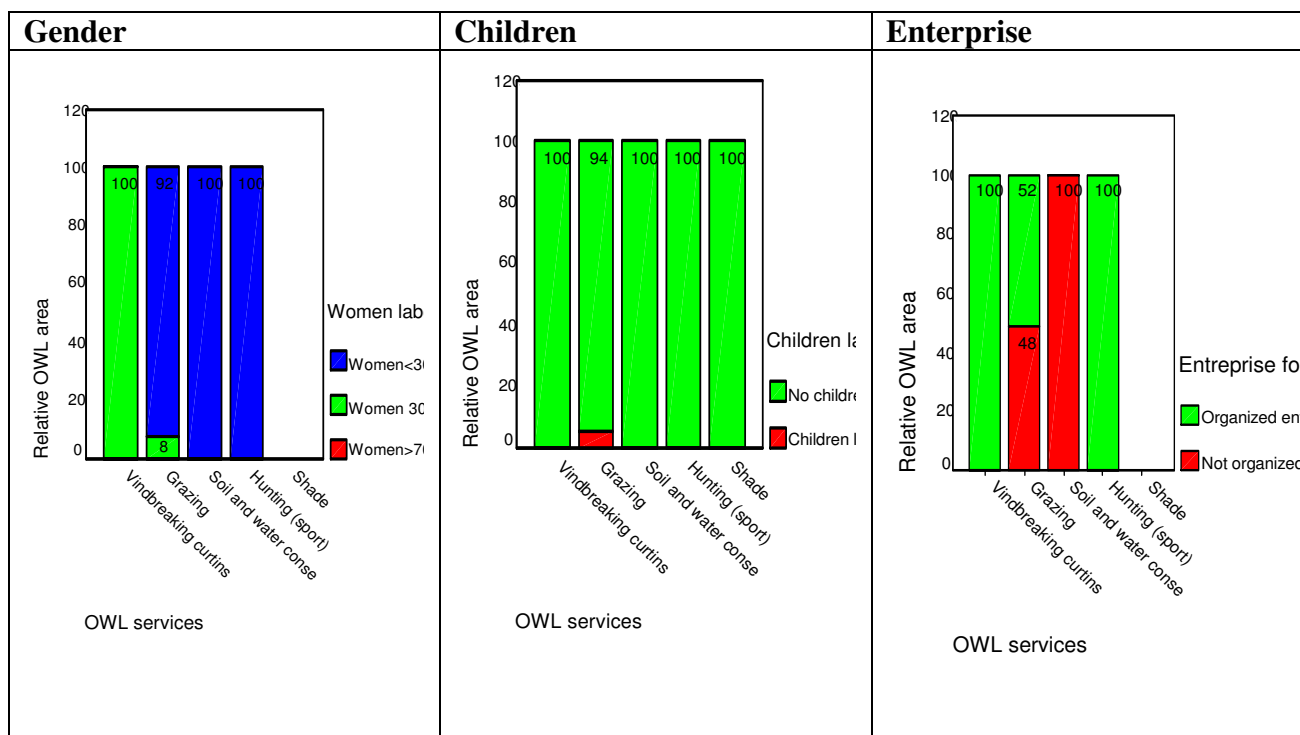


Figure 46: OWL services by gender, child labor and enterprise form presented as the relative OWL areas

### XI.2.5.3 Exploitation of wood and non-wood other land services by Gender, Child labor and Enterprise form

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

OL Services	Gender balance (women labor)			Children labor		Enterprise form	
	>70%	30-70%	<30%	Yes	No	Organised	Spontaneous
Hunting (sport)	9	0	91	7	93	9	91
Recreation and tourism	8	89	3	7	93	63	37
Grazing	0	15	85	3	97	64	36
Shade	0	100	0	0	100	10	90
Wind breaks	0	100	0	0	100	0	100
Source for employment (paid)	.	.	.	0	100	.	.
Soil and water conservation	.	.	.	0	100	.	.

Table 62: Exploitation of OL services by gender, child labor and enterprise form presented as the relative OL areas in which the services are exploited

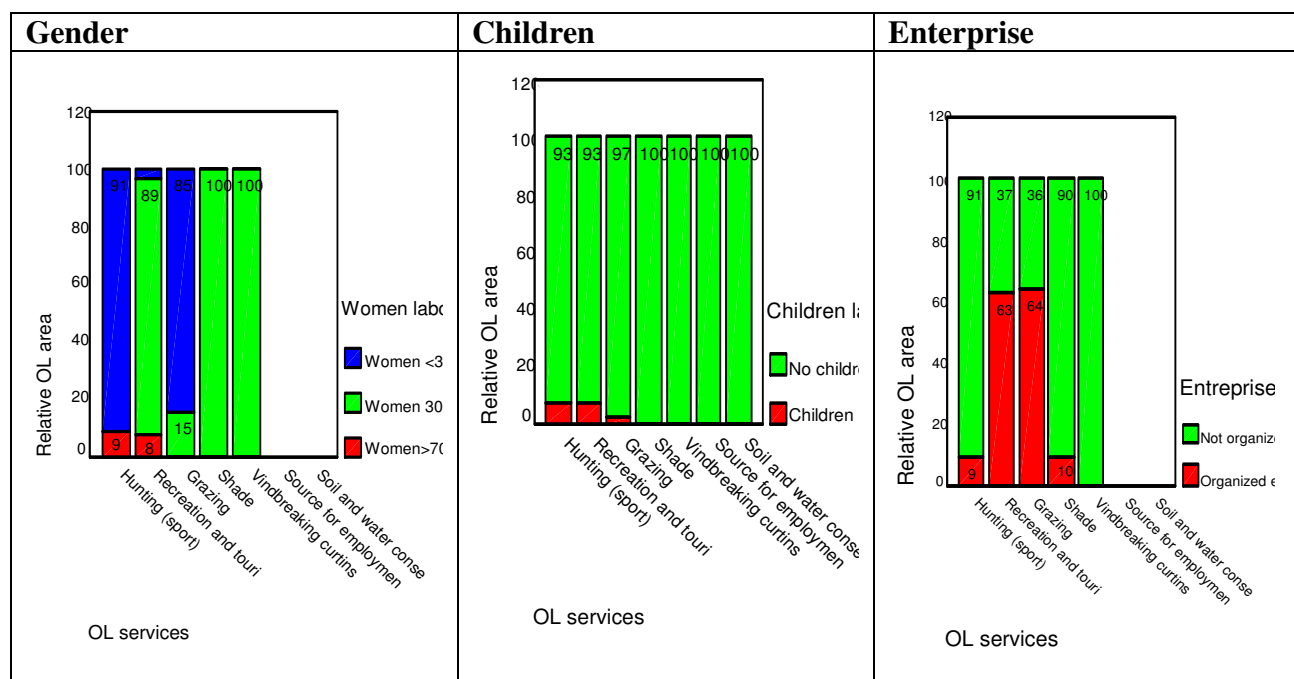


Figure 47: OL services by gender, child labor and enterprise form presented as the relative OL areas

Services such as shade, conservation, wind breaks and soil and water conservation do not generate any direct employment according to the survey.

Seasonal labour is needed to maintain trees outside forests and harvest their products (e.g. planting, pruning, irrigating, spraying, harvesting, etc). Forests provide a source of employment in protected areas (forests guides, guards, scientists, etc), and for wood and non-wood products exploitation (charcoal, timber, pine nuts, sage etc.) and the data collected during the survey do not reflect these employment opportunities.

Hunting is mostly performed by men and in some cases children accompanying their parents. This activity is spontaneous, and rarely organized by an enterprise.

Grazing is an activity that requires mostly men as shepherds to watch the animals, collect fodder and milk them. Women are responsible for milk processing. Children participate sometimes in this family business, when manpower is not enough. Grazing is mostly a spontaneous activity in forests and other wooded land. It could be an organized enterprise in OL, where modern farms exist, and in pastures owned by municipalities where grazing is an organized activity by the municipality. The relatively high percentage of organized activity in forest and OWL can possibly be attributed to subjective perception of team leaders during the field work.

Recreation and tourism implicates all categories of the society as clients, but is not implicating children in eco-tourism enterprise. When eco-tourism enterprises, NGOs and Community Based Organisations (CBOs) are involved, the activity should be considered organized, otherwise it is spontaneous. The activity should be cleared to team leaders in order to get a homogeneous perception.

## **XII. Local population**

### **XII.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.

<b>Settlement History</b>	<b>Percentage</b>
Land Tenure Change	1.8
Wars/Armed conflicts	9.2
Socio-economical crisis	11
Agricultural contraction	20
Urban expansion	21.1
Agricultural expansions	36.7
Total	100

Table 63: Relative distribution of settlement history presented for the populated parts of the country

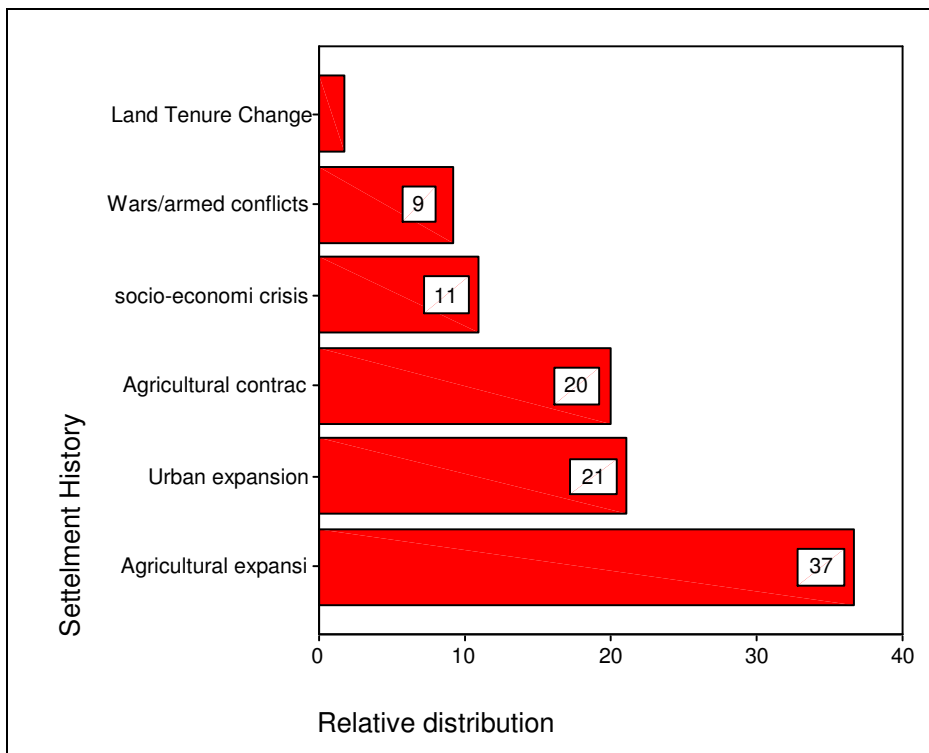


Figure 48: Relative distribution of settlement history presented for the populated parts of the country

The history of settlements in Lebanon is as old as the Neolithic era. Some cities figure among the oldest in the World (i.e. Byblos). In general, settlements occurred first on the coastal area, then in the Bekaa valley. The mountains were the place of hunters, carpenters and shepherds until the 4<sup>th</sup> century A.D. Mount Lebanon became the shelter of different communities escaping from persecution. Between the 17<sup>th</sup> and the 19<sup>th</sup> century, agricultural expansion all over the country increased the number of villages. From late 19<sup>th</sup> century until the end of the First World War, many settlements were abandoned due to conflicts and economical crisis, and rural population migration was very intense. Between 1920 and 1975, agriculture expansion in irrigated zones fixed and developed many settlements in rural areas, while big cities expanded their surfaces due to agriculture contraction in rain fed zones. Since 1975 urban expansion increased dramatically in the areas that hosted displaced populations during the war.

## XII.2 Population main activities

The *Main Activity* is the main income generation and employment source of the permanent population living within tract. 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.

Population Main activity	Percentage
Tourism	1.8
Forestry	2.8
Live stock	9.2
Urban or semi urban	27.5
Agriculture	57.8
Not Known	0.9
Total	100

Table 65: Relative distribution of the population's main activities

The trend of the size population that lives in or close to the tract, in the past five years is shown in figure 49. We find that 59.6% of the populated country area had increasing population size during the last five years.

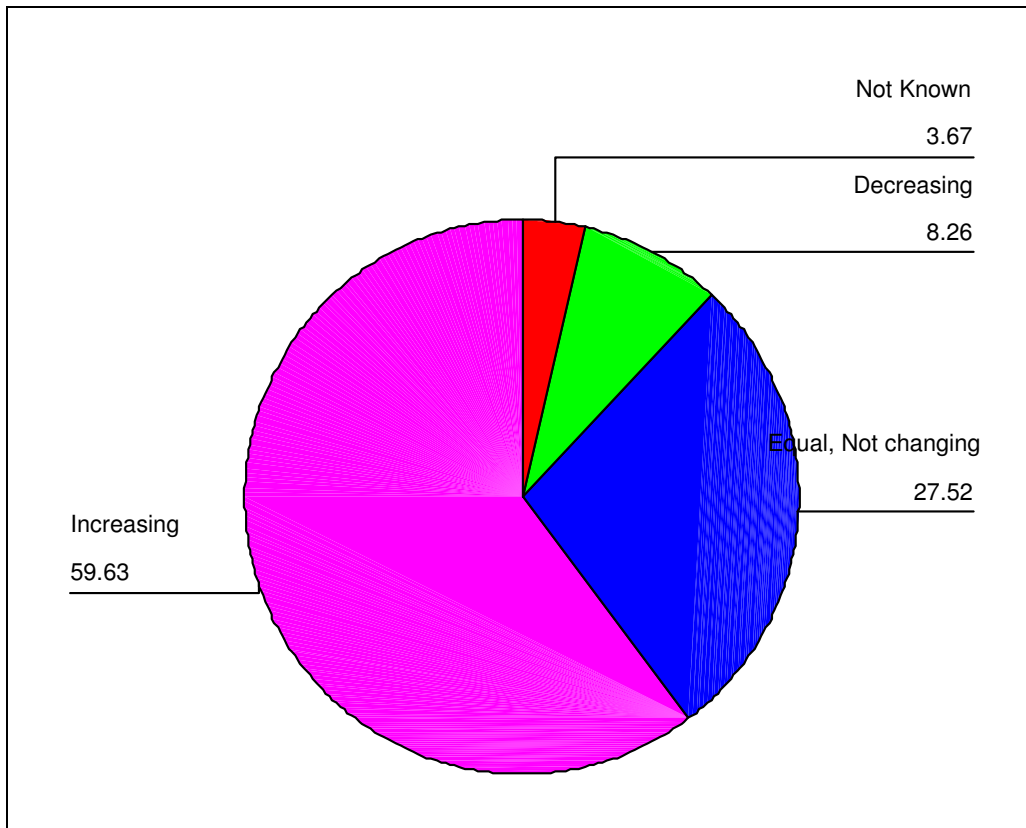


Figure 49: Relative distribution of the population dynamics within the last five years

Since the tracts are mostly outside the big cities (Beirut, Tripoli, Saida, Zahleh, etc.), the major activity found within tracts is agriculture. Nevertheless, urban and semi urban activities have an important share which illustrates the important centralization and urban sprawl in Lebanon. Livestock activities are represented especially in tracts found in high altitudes in Mount Lebanon and Anti-Lebanon, while forestry is much localized to tracts found in *Pinus pinea* forests.

### XII. 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 66: Relative distribution of the population dynamics by the permanent population's main activity (107 tracts)

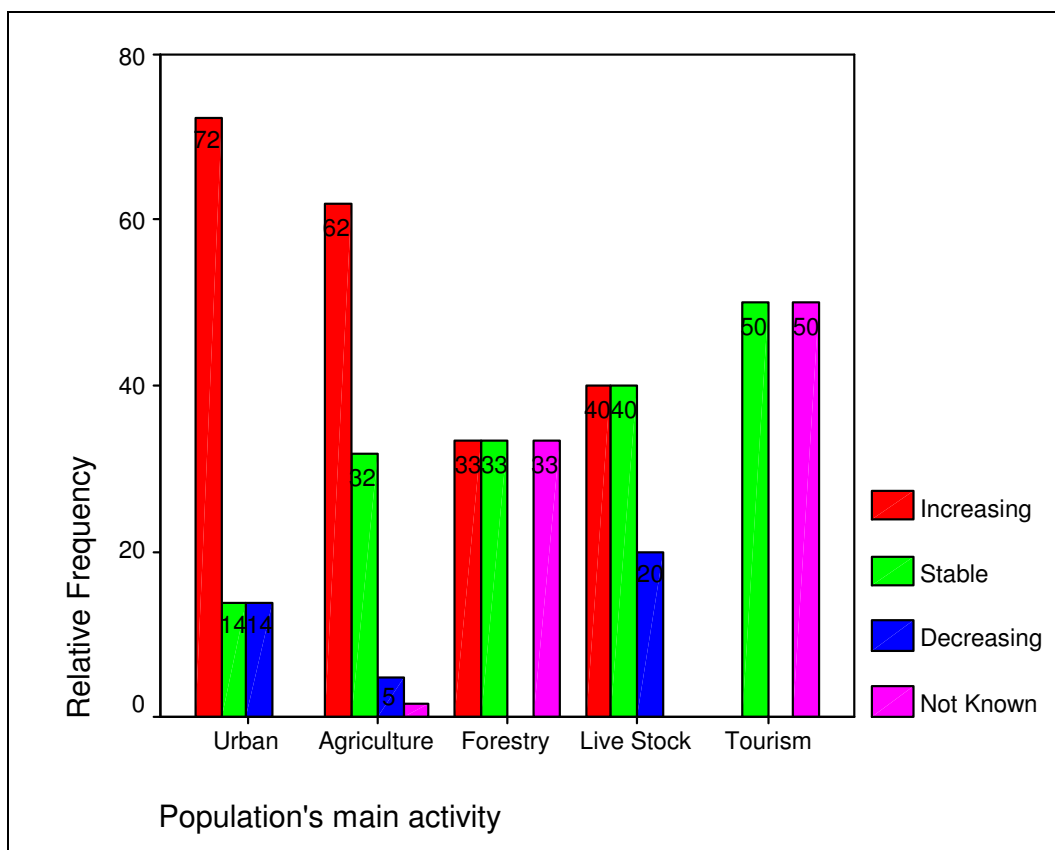


Figure 50: Relative distribution of the population dynamics by the permanent population's main activity (107 tracts)

## XII.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 67: Relative distribution of the population dynamics by the total population's main activity (107 tracts)

The charts concerning population dynamics in both total and permanent population main activities show that the population having urban activities is increasing the most. This is due to demographical increase and also to the fact that in Lebanon the sector of trade and services consists of more than 70% of the GDP, and integrates most of the manpower and is attracting almost all the investments. The significant decrease in population dynamics even when urban activity is a main activity is due to the migration from rural areas towards the cities or outside the country and also people living in rural areas but working in towns which is pronounced due to small size of country and good infrastructure..

The stable population dynamics is an important part of agriculture, livestock, forestry and tourism activities. Such situation means that most of the rural population demographic

growth is equalized by rural migration and the abandon of such activities towards more profitable ones.

We should note that forestry and tourism activities do not show any decrease in the population dynamics which could be related to the fact that the population is having an important additional income from other activities (agriculture, urban).

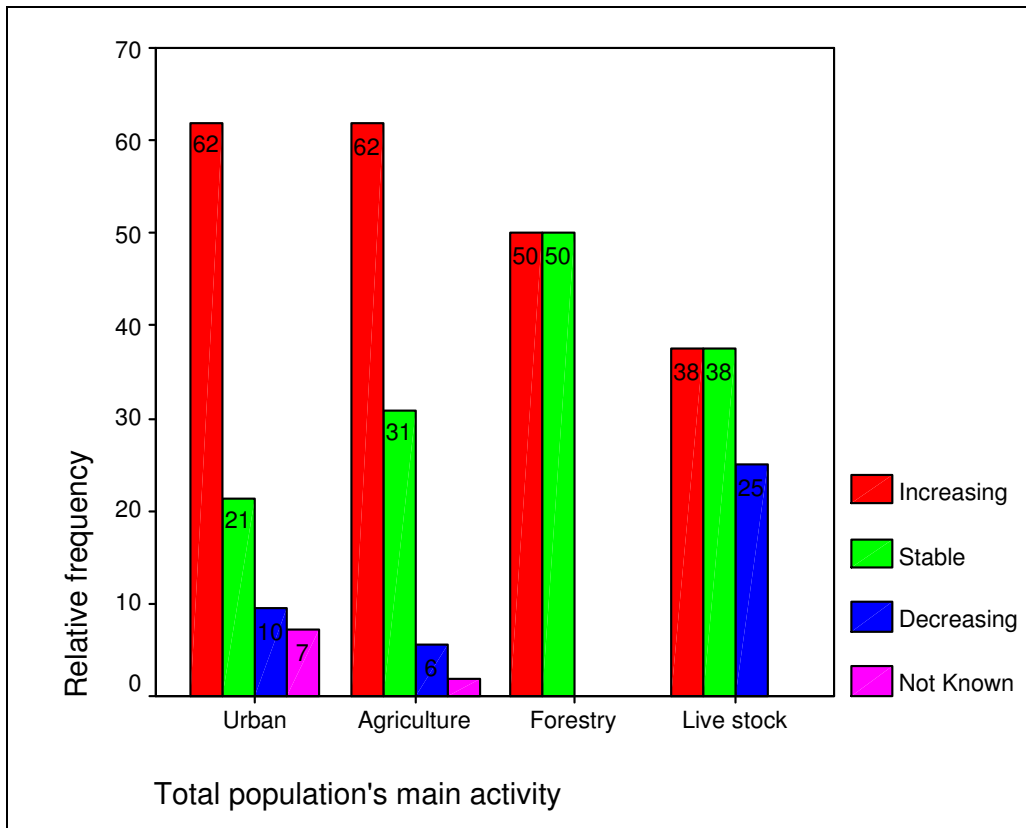


Figure 51: Relative distribution of the population dynamics by the permanent population's main activity (107 tracts)

### XIII. Accessibility

It's important to consider the accessibility to the tracts. The distance from tract centre to different services as; hospitals, schools, settlements, markets, roads, etc was registered. The distances are classified in 2,5km classes. The histograms show if there is a normal distribution and the averages and the standard deviation of each distance can be found.

#### XIII.1 Accessibility to hospitals and schools

The accessibility to hospitals is shown in figure 52 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.

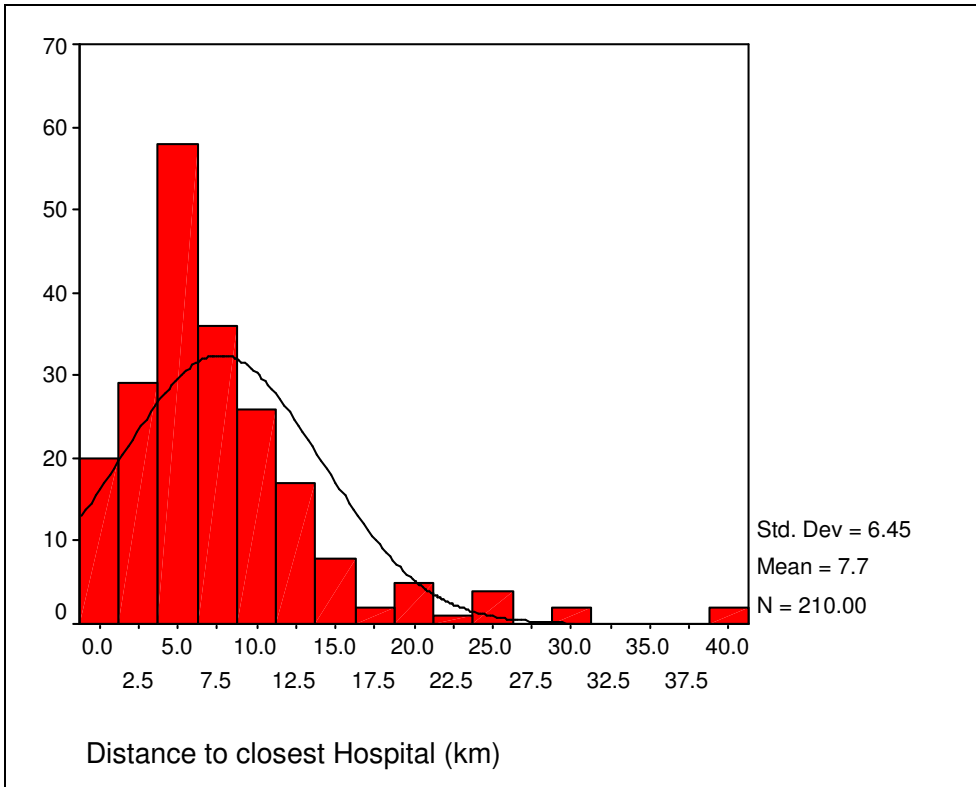


Figure 52: Distance from tract centre to closest hospital

The accessibility to schools is shown in figure 53 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.

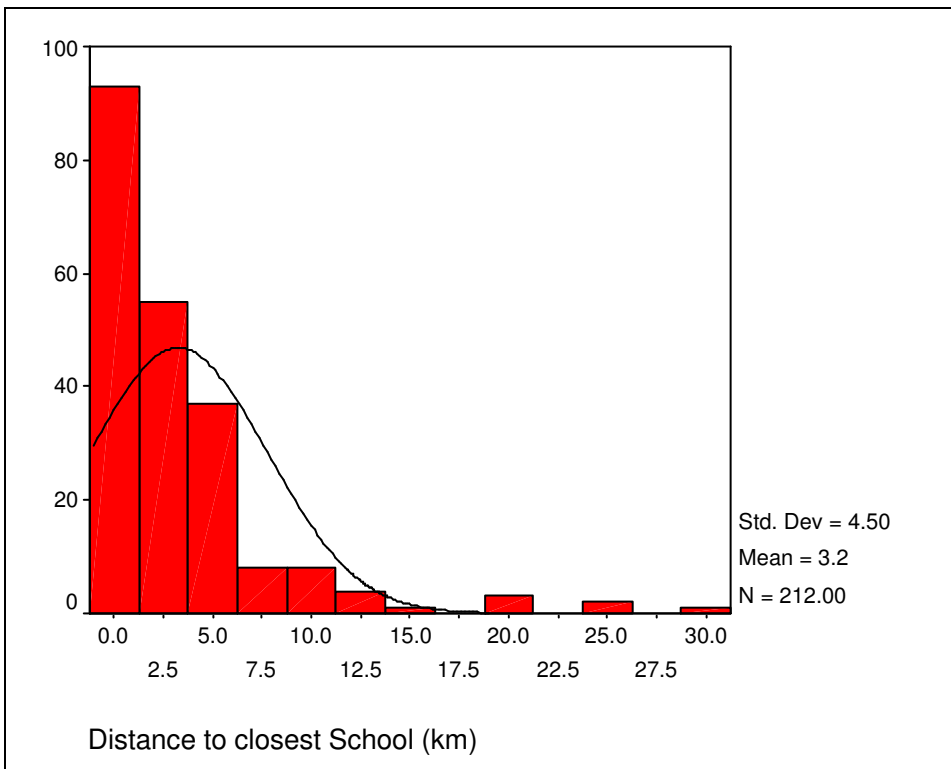


Figure 53: Distance from tract centre to closest school

### XIII.2 Accessibility to the Settlements and Markets

The accessibility to markets is shown in figure 54 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.

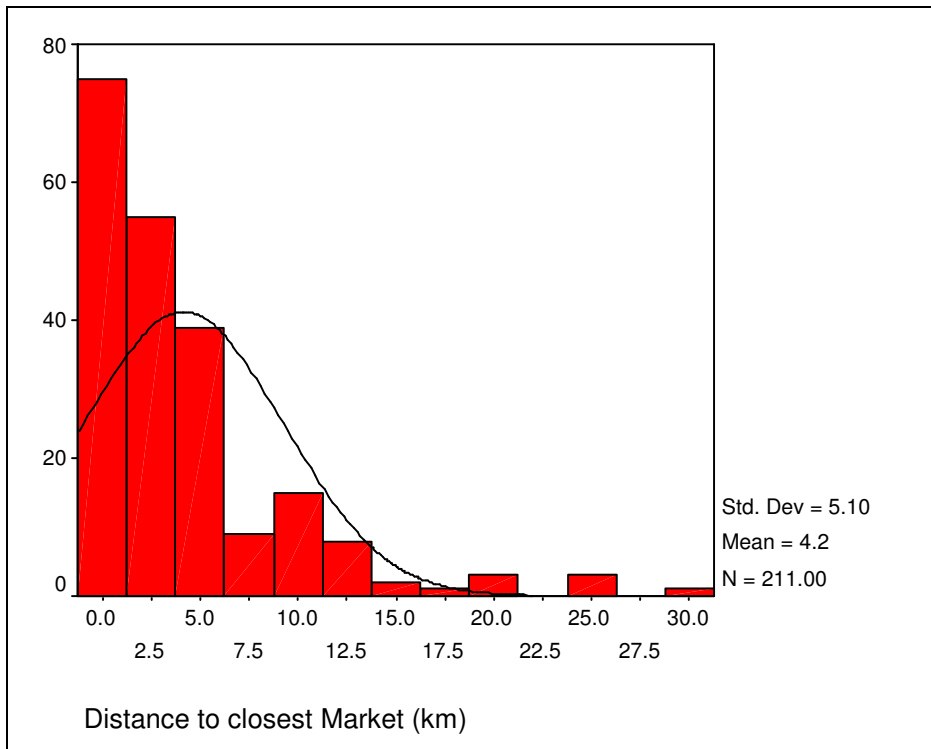


Figure 54: Distance from tract centre to closest market

The accessibility to settlements is shown as staples in figure 55 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.

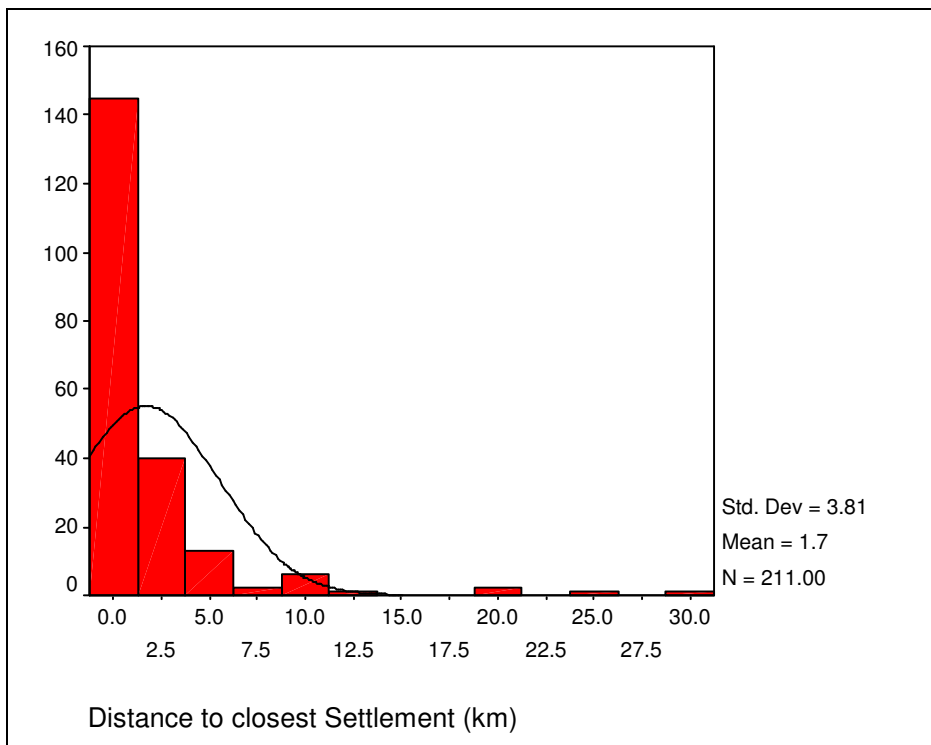


Figure 55: Distance from tract centre to closest settlement

### XIII.3 Accessibility to the all weather road and Seasonal road

The accessibility to all-weather roads is shown as staples in figure 56 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.

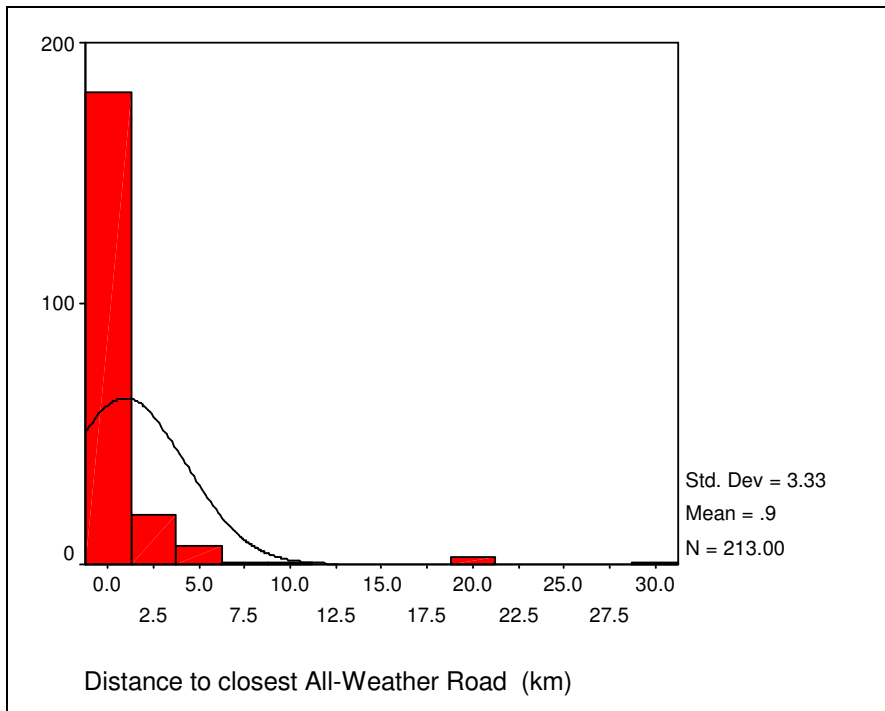


Figure 56: Distance from tract centre to closest all-weather road

The accessibility to seasonal roads is shown in figure 57 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.

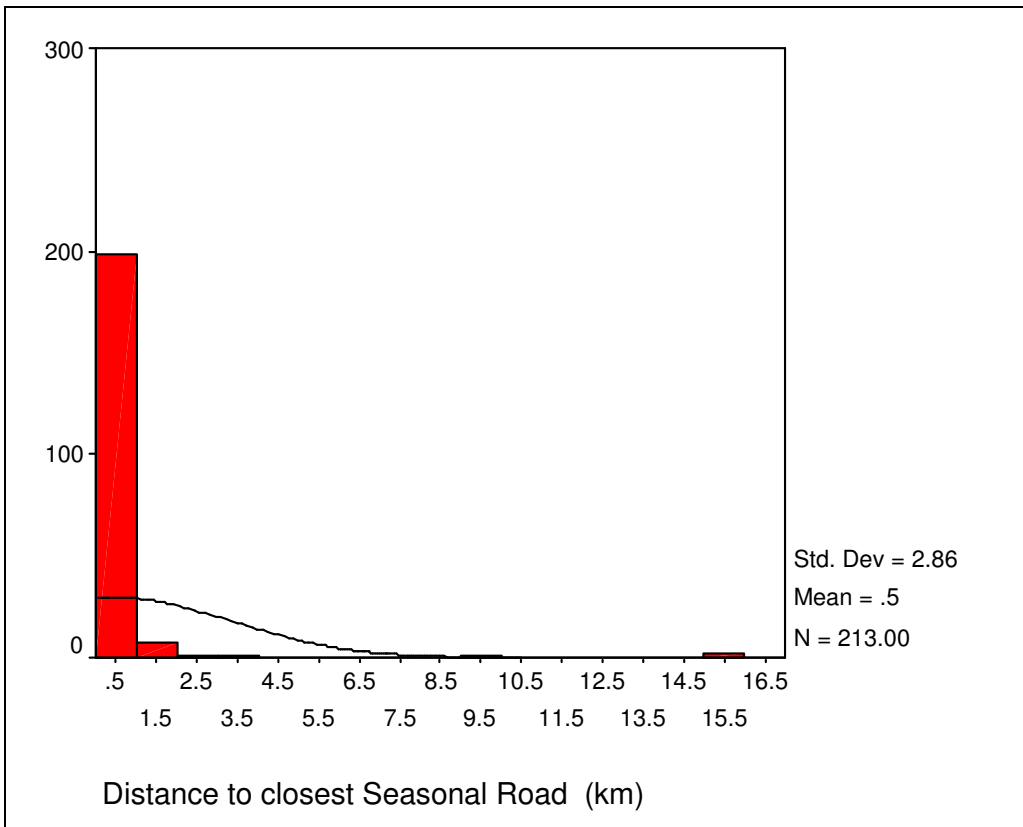


Figure 57: Distance from tract centre to closest seasonal road

The distance to hospitals, schools, markets, and settlements is relatively short in Lebanon. This is mainly due to the high density of the population, all over the country, and to the urbanization level. Population density is over 400 inhabitants/km<sup>2</sup>, while the percentage of urban population is 88%. These two factors make the road network density very high, and thus the distance from tract centers to all weather roads and seasonal roads has an average of less than 1 km.

This characteristic is an important advantage that improves field work conditions and facilitates the accessibility and localization of the plots.

Finally, this report provides important information on forest and tree resources in Lebanon. The collected data can provide more elaborated information, especially sheet number 4 from the field form which concerns the circular subplots. As mentioned throughout this report, many linkages can be done between several types of data in order to understand more the factors and indicators that affect forest and tree resources.

Several statistical analysis and charts could be exposed in a way to response to the criteria and indicators for various purposes e.g. reporting.

The collected data should be homogenized in order to get a more accurate and valuable analysis. Therefore, reviewing of the field manual and training team leaders and the team responsible for data entry is a key issue.

In conclusion, this assessment should be periodically done in order to get precise information about forest and tree resources management and exploitation and to better monitor these resources, to provide a good foundation for developing a well defined forest and tree resources policy.

## Appendix I

Many of, the measured variables depend on the size of the area over which it is measured. For these variables Ratio estimates are used.

The following functions are used:

### Ratio estimate

$$\mathbb{R} = \frac{\bar{x}}{\bar{y}} = \frac{\frac{1}{n} \sum_1^n x_i}{\frac{1}{n} \sum_1^n y_i} = \frac{\sum_1^n x_i}{\sum_1^n y_i}$$

### Standard deviation of population

$$(\text{Sd}) = \sqrt{V} = \sqrt{\frac{\sum_1^n (x_i)^2 + \frac{(\sum_1^n x_i)^2}{(\sum_1^n y_i)^2} * \sum_1^n (y_i)^2 - 2 \frac{\sum_1^n x_i}{\sum_1^n y_i} \sum_1^n x_i y_i}{n-1}}$$

### Standard error of Ratio estimate

$$(\text{S}_R) = \sqrt{V_R} = \sqrt{n * \frac{\sum_1^n (x_i)^2 + \frac{(\sum_1^n x_i)^2}{(\sum_1^n y_i)^2} * \sum_1^n (y_i)^2 - 2 \frac{\sum_1^n x_i}{\sum_1^n y_i} \sum_1^n x_i y_i}{(\sum_1^n y_i)^2 * (n-1)}}$$

### Sampling error

$$(\text{SE}_R) = t * S_R = t \sqrt{n * \frac{\sum_1^n (x_i)^2 + \frac{(\sum_1^n x_i)^2}{(\sum_1^n y_i)^2} * \sum_1^n (y_i)^2 - 2 \frac{\sum_1^n x_i}{\sum_1^n y_i} \sum_1^n x_i y_i}{(\sum_1^n y_i)^2 * (n-1)}}$$

By assuming a normal distribution for the ratio we use normal deviate  $t_{\frac{\alpha}{2}}=1.96$  with a significance level  $\alpha=5\%$

### Rel. Sampling error

$$(\text{SE}_R \%) = 100 \frac{SE_R}{R} = 100 t \sum_1^n y_i \sqrt{\frac{n * \sum_1^n (x_i)^2 + \frac{(\sum_1^n x_i)^2}{(\sum_1^n y_i)^2} * \sum_1^n (y_i)^2 - 2 \frac{\sum_1^n x_i}{\sum_1^n y_i} \sum_1^n x_i y_i}{\sum_1^n x_i * \sqrt{(\sum_1^n y_i)^2 * (n-1)}}}$$

**For the strata, we have:**

### Total sample of population, total sample size

$$(\mathbf{n}_T) = n_1 + n_2 + \dots + n_{226}$$

And  $n_k=2$  ha , for every  $k=1, \dots, 226$

**Total population size**  $(N_T) = N_1 + N_2 + \dots + N_{226}$

And  $N_k = 4625$  ha, for every  $k=1, \dots, 226$

So that the weight for each stratum Ration estimate is  $1/226$

**Estimate of overall Ratio estimate**

$$(\mathbf{R}_T) = \frac{\sum_{j=1}^k (N_j * R_j)}{N} = \frac{\sum_{j=1}^k \left( N_j * \frac{\sum_1^n x_{ji}}{\sum_1^n y_{ji}} \right)}{N} = \sum_{j=1}^{226} \frac{\sum_1^n x_{ji}}{\sum_1^n y_{ji}} = R$$

**Estimated Total**

$$(\mathbf{X}_T) = N_T * R_T = \sum_{j=1}^k (N_j * R_j) = \sum_{j=1}^k \left( N_j * \frac{\sum_1^{n_j} x_{ji}}{\sum_1^{n_j} y_{ji}} \right) = N_T * R$$

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