FAO KOSOVO FOREST INVENTORY PROJECT
(OSRO/KOS/105/NOR)

INVENTORY DOCUMENT

December 2003

Norwegian Forestry Group (NFG)

1. Introduction

Following the 1999 conflict, returning foresters compiled available information on forest resources in Kosovo. These data stemmed from the period before and during first half of 1990. The total forest area was estimated at about 430,000 ha, or approximately 40% of the total land area. Of this area, low forest originating from stool-shoots (coppice) constituted the major part, covering more than 60%. High forest was estimated at about 25%. The growing stock in high forest was estimated at about 17-18 million m^3, and total standing volume at approximately 30 million m^3 for all types of forests. 62% of all forest was considered state owned, while the remaining 38% was classified as private or community owned. By the Kosovo Forest Authority, the annual allowable cut was initially estimated at 70,000 m^3 from high forest and 130,000 m^3 from coppice forests.

The previous assessments were carried out by the state forest company Serbia Forest. Since available information was scarce and referred to the situation before the conflict, validation of the data with regard to the present situation could only be done through a new Kosovo-wide forest inventory. Previous assessments were also mainly focusing on State forest, while inventory results from private forests have been negligible or non-existing. In this way, a new Kosovo-wide inventory would be the first one ever or for a very long time that assessed and compiled the data from public and private forests, using the same methodology. Previous assessments were based on the aggregation of data from stand-wise management plans. The new NFI project has been based on a different concept, namely the systematic sample plot inventory. The main objective is to promote a sustainable forest management by assessing the total forest resources and the annual sustainable harvest level.

The current project was started in February 2002 and finalized in December 2003. After a short test period in the autumn of 2002, the major part of the fieldwork took place from March-November 2003.

2. Methodology

2.1 Sampling design

As a first stage, a regular grid of 4x4 km was established for all of Kosovo. In a specifically defined area, the density of the grid was increased to 2x4 km, in order to improve the accuracy of the inventory. This was due to the expected higher proportion of the more valuable high forest. The area with the denser grid constitutes the major part of the following municipalities: Deçan / Decani, Gjakovë / Djakovica, Dragash / Dragash, Istog / Istok, Klinë / Klina, Pejë / Pec, Shtërpcë / Strpce, Prizren / Prizren, Ferizaj / Urosevac and Kaçanic / Kacanik.

Each line intersection of the 4x4 (or 2x4) km grid indicates the centre of the south-western plot of each cluster, consisting of 4 circular sample plots. The sample plots are concentric, with measurements according to the following guidelines:

Inner circle (radius=3.0 m)

- Number of all trees with height equal to, or more than 1.3 m (diameter at breast height 0-6.9 cm) were counted.
- Assessment of number of trees with a height between 0.1 and 1.3 cm (only trees expected to be part of the future stand).

Main circle with radius = 10.0 m

- Measurement of all trees with diameter at breast height >= 7 cm.

Circle with radius=20.0 m

- Assessment of attributes relating to stand conditions (tree species compositions, stand age etc.).

Orthophotos and existing topographic maps were used for an initial classification of the plots. The aim of the initial classification was to identify the forested plots, requiring field measurements, and to produce maps facilitating the navigation to the plots. Another result was to make a preliminary land use classification and a rough classification of forest and other wooded land into a limited number of classes. All sample plots assigned to the classes "forest" or "other wooded land" should in principle be visited in the field for detailed measurements and classifications. From the beginning, it was expected that it would be impossible to visit all the plot locations in the field. Photo interpretation of plots not visited in the field made it possible to establish a total land use class distribution for Kosovo and to assign the forested plots to a specific forest type, thus improving the volume and increment estimates for non-visited plots.

2.2 Inventory work

The field crews, each consisting of two foresters, used a GPS receiver for accurate navigation to the pre-defined plot centre. After reaching the sample plot, they would do an evaluation of the preliminary classification from the photo interpretation (or from the interpretation of topographic maps). If the field workers agreed with the preliminary classification and the plot was located on forest or other wooded land, they carried out the specific measurements and assessements. If not, they were to note down the revised land use classification.

All plots on forest and other wooded land, visited in the field, were permanently installed. That means, in addition to keeping a record of the geographic coordinates for each plot, the plot centres will also be physically recognizable for workers in future inventories. Azimuth and distance from the plot centre to each tree on the sample plots have been recorded, so that changes that will occur in the future can be detected and quantified at later occasions.

The measurements taken, included accurate diameter measurements of all living and dead trees on the sample plots. A subsample of the trees was selected for height measurements, bark measurements and increment boring. Furthermore, the list of attributes comprised the most important ones for assessing the extent, structure and quality of forest resources for international and national purposes. An assessment of the treatment opportunity class was included for the estimation of silvicultural needs in the near future. The assessments also, on a trial basis, included data on some non-wood forest products.

A total of 1205 plots classified as "forest" have been visited and assessed in the field. An additional 244 plots have been classified as "forest" on orthophotos/maps, but have not been visited. The corresponding numbers for "other wooded land" were 49 in the field and 54 only as photo-interpreted.

All field data were noted down on record forms in the field. The separate plot record forms and tree record forms were prepared in Albanian and Serbo-Croatian languages, to be used in the respective areas.

2.3 Data processing

The field data was continuously entered into a database, as the record forms were transferred to the office. A database suitable for the plot and field data was created in Microsoft Access. After entering the data, a number of consistency checks were carried out. The checking was done both as a control of the geographical distribution (GIS), and by analysis of the numerical data (Statistical Analysis System).

In Kosovo, functions for calculation of individual tree volumes were initially not available. The state company Serbia Forests carried out all former data processing for the management plans. The project has not had access to, or detailed knowledge of any of the procedures used for these calculations. For the estimation of individual tree volumes in this project have been used the tables by ***Drinić, Matić, Pavlič, Prolić, Stojanović, Vukmirović and Koprivica: Tablice taksacionih elemenata visokih i izdanačkih šuma u Bosni I Hercegovini.*** In several cases functions to be included in a computer programme, were not directly available. Values were then read from the tables at regular intervals, and regression curves to fit the selected values as closely as possible were calculated. All the statistical analysis and other calculations were carried out by means of SAS (Statistical Analysis System), Version 8.

Volume estimation for high forest has been carried out in two steps: First, former research has established relationships between diameter at breast height and total tree height. For each of the tree species, five such curves have been established, each defining a specific site quality class. Based on the sample trees, where both diameter and height are known, an estimate of the average site quality class for each sample plot was found. When the site quality class of the plot was known, volume could be estimated from functions with only diameter at breast height as independent variable. If the estimated site quality had a value between two of the defined classes, interpolation was used to calculate a more accurate tree volume. If, for some reason, a sample plot did not have any sample tree with height measurement, the site quality class 3 was assigned to this plot.

For this project, the following grouping of the data has been applied:

- Oak species
- Beech and other broadleaved species
- Fir
- Spruce
- Pine and other coniferous species

For broadleaved trees in coppice forest, a somewhat different approach has been applied. The tables and functions based on site quality classes have not been available for this type of forest. However, in the above-mentioned Bosnian publication exist functions for volume of oak and beech, based on diameter at breast height and tree height. These functions could only be directly applied for sample trees with complete set of measurements. Common height curves based on all sample trees in coppice forest were calculated, to make it possible to estimate tree heights and to apply the volume functions also for trees where only diameter was known.

The following grouping of data was used:

- Oak species
- Beech and other broadleaved species

For trees with a diameter at breast height of less than 7 cm, only the total number on each plot has been assessed. The publication lists the volume for small dimensions of trees of different species, by 1 cm diameter classes. For the assessment has been used the average volume for oak of diameter class 3 and 4. This value has been used as an approximation for all trees with a diameter from 0-7 cm.

Basal area increment percentage for individual trees was estimated from the measurements of annual rings on selected sample trees. To compensate for form height increment, 30% was added to the basal area increment. Together the basal area increment and form height increment provide an estimate of the volume increment. Increment percentages were assigned to the trees with no increment boring, using regression methods. The trees were grouped into classes by tree species and stand origin.

The calculated volumes for individual trees, which are also aggregated to the area level, **are total volumes including top, larger branches and bark.**

The area of sample plots was corrected for slope and possible partial plots, and a mean value per hectare for volume, increment etc. calculated for each of the plots. These values were multiplied by the area representation factor (200 or 400) to obtain the total volume or increment represented by the plot.

3. Results

3.1 Accuracy of the results

Only the sampling error of the inventory can be estimated. In addition there will be error components because of inaccurate area classification, tree measurements etc. It has not been possible to quantify the magnitude of the measurement and assessment errors. A check assessment of a smaller sub-sample of plots, revealed some variability among the field workers with regard to the area classification, but fairly accurate tree measurement.

The mean volume has been estimated at 90 m^3/ha for all areas classified as “forest” in the field. The standard deviation of the volume per hectare was at the same time estimated at 175. This gives a coefficient of variation of 194. There is no exact method for calculating the standard error in a systematic sampling, but by applying the standard formula for random sampling, the standard error of volume per hectare has been estimated at $194\%/\sqrt{1205}=5.6\%$. By assuming that the total number of sample plots represents the total area of Kosovo, and that the surveyed forest area constitutes 35% of the total area, the estimated standard error of the surveyed forest area would be about 2.3%. Together these two error components would add up to about 6.1%. The estimates that have been applied for the non-surveyed forest plots will of course be an additional source of errors.

3.2 Annual allowable cut

In the tables presented below, the annual increment of trees with a diameter of more than 7 cm, has been given as 1.165 million m^3. In addition, there is also an estimated 200,000 m^3 on other wooded land and on forested plots not visited in the field. As the non-surveyed forest plots to a large extent are located near minefields and other areas not accessible in the field, it seems reasonable not to include this increment in the basis for annual allowable cut.

A quick estimate of the annual allowable cut can be obtained according to the formula:
$Y=a/z+b/2$
where a is the growing stock of mature and near mature forest, z is the number of years the same trees will be the main resource for the harvest, and b is the annual increment of the same trees. If we consider all trees above 25 cm on high forest, and all trees above 15 cm on low forest as mature or near mature, then assume that the quantity will be harvested over a 40 year period, we will end up with the following estimates of annual allowable cut:

- High forest: 720,000 m^3
- Low (coppice) forest: 215,000 m^3

It is important to be aware that the figures refer to the gross total volumes including bark, large branches, tops and other losses. The merchantable volumes will thus be substantially lower.

3.3 Estimation of bare and degraded land

The Kosovo NFI estimated about 30,000 ha of forest with no current stand, i.e. areas with no trees above 7 cm at breast height. There may still be regeneration or a stocking of smaller trees on some of these areas. Only about 8,000 ha have been indicated as having a need of direct regeneration measures. For 27,000 ha a need of conversion has been recorded, i.e. removal of the existing stand and establishment of a new one. The predominant need of silvicultural intervention seems to be for cleaning-thinning. Especially in coppice forest there are many very dense stands where stocking must be reduced to prevent stagnation and to improve quality. The area of meadows and pastures has been estimated at about 150,000 ha. Some of these areas, especially those located in a clearing in the forest, will revert into forest due to natural regeneration, but could also be subject to planting. It has not been within the scope of this inventory to carry out a more detailed analysis of these areas.

4. Tables

Table 1. Total area of Kosovo by land use classes

Land use class	*Area (ha)*
Forest	460,800
Other wooded land	28,200
Barren land	23,400
Agricultural land	342,400
Meadows and pastures	153,200
Urban areas, built-up land	40,000
Water	4,600
Not classified	41,600
Total	1,094,200

Table 2. Forest area by stand origin and ownership classes (ha).

Stand origin	*Public*	*Private*	*Unknown*	*Sum*
No current stand	21,200	7,600	3,400	32,200
Natural seeding	82,000	74,000	15,200	171,200
Planting or artificial seeding	1,800	400		2,200
Mixed coppice/seeding or planting	17,600	19,000		36,600
Coppice	54,800	44,000	17,000	115,800
Coppice with standards	9,200	10,000	2,000	21,200
No data	1,000	400	80,200	81,600
Total	187,600	155,400	117,800	460,800

Table 3. Forest area by stand origin and altitude (ha).

Stand origin	*200-400*	*400-600*	*600-800*	*800-1000*	*1000-1200*	*1200-1400*	*1400-1600*	*>1600*	*Un-known*
No current stand	1,000	9,000	14,800	5,200	800	800	200		400
Natural seeding	1,000	9,600	58,200	46,000	16,200	15,400	11,600	12,000	1,200
Planting or artificial seeding		1,600		400		200			
Mixed coppice/ seeding or planting	1,000	14,400	5,800	5,400	5,600	2,200	1,400	600	200
Coppice	5,400	17,800	43,400	38,600	4,600	3,600	1,600	400	400
Coppice with standards		600	6,000	10,200	3,200	800			
No data				400					81,600
Total	8,400	53,000	128,200	106,200	30,400	23,000	14,800	13,000	83,800

Table 4. Forest area by tree species structure and stand structure (ha).

Species class	*Under regeneration*	*Even-aged stand*	*Two-storeyed stand*	*Uneven-aged stand*	*Unknown*
Without trees	3,800				
Coniferous		7,200	1,600	10,200	
Broadleaved	7,400	225,800	22,000	98,200	
Mixed		200		2,600	
No data					81,800
Total	11,200	233,200	23,600	111,000	81,800

Table 5. Forest area by age and tree species structure (ha).

Age class	*Without trees*	*Coniferous*	*Broadleaved*	*Mixed*	*Unknown*
0-20	3,800	1,000	121,000		
20-40		4,200	104,800	400	
40-60		5,200	66,600	1,400	
60-80		4,200	36,800	800	
80-100		2,000	11,800	200	
100-120		1,000	5,400		
120-140		1,200	4,200		
140-160					
160-180			200		
180-200			200		
No data	4,200	200	2,400		77,400
Total	8,000	19,000	353,400	2,800	77,400

Table 6. Forest area by treatment opportunity and stand structure (ha).

Treatment class	*No current stand*	*High forest*	*Coppice or mixed*	*Unknown*	*Sum*
No treatment	22,600	27,800	49,800		100,200
Regeneration without site preparation		2,000	1,600		3,600
Regeneration with site preparation	2,400	800	1,400		4,600
Conversion	2,200	14,400	10,800		27,400
Cleaning-thinning	4,600	74,400	92,800		171,800
Thinning		20,000	4,800		24,800
Clearcut,strip clearc,		1,400	400		1,800
Selection		17,000	4,600		21,600
Salvage		15,600	7,400		23,000
No data	400			81,600	82,000
Total	32,200	173,400	173,600	81,600	460,800

Table 7. Forest area by ownership and occurrence of uncontrolled harvesting (ha).

Ownership class	*Uncontrolled harvesting*	*No uncontrolled harvesting*	*No data*
Public	79,000	107,200	1,400
Private	45,200	109,800	400
Unknown	7,400	30,200	80,000
Total	131,600	247,200	81,800

Table 8. Growing stock by tree species, forest/other wooded land and surveyed/not surveyed area (1000 m^3).

Tree species	*Forest, surveyed*	*OWL, surveyed*	*Forest, not surveyed*	*OWL, not surveyed*	*Sum*
Quercus cerris	5,170	6			5,176
Quercus petraea	4,276	1			4,277
Other Quercus ssp.	129				129
Fagus ssp.	15,963				15,963
Other broadleaves	3,704	2			3,706
Undefined broadleaves			5,983		5,983
Abies alba	1,577				1,577
Picea abies	1,402				1,402
Pinus ssp.	2,018	1			2,019
Other conifers	223	1			224
Conifers < 7cm	126	185	10		321
Broadleaves <7cm	9,609	60	2,247	202	12,118
Total	44,197	256	8,240	202	52,895

Table 9. Volume of salvageable and not salvageable dead trees by forest/other wooded land and surveyed/not surveyed area (1000 m^3).

Tree species	*Forest, surveyed*	*OWL, surveyed*	*Forest, not surveyed*	*OWL, not surveyed*	*Sum*
Dead trees, salvageable	551	2	56		609
Dead trees, not salvageable	1,350	4	172		1,526
Total	1,901	6	228		2,135

Table 10. Annual increment by tree species, forest/other wooded land and surveyed/not surveyed area (1000 m^3).

Tree species	*Forest, surveyed*	*OWL, surveyed*	*Forest, not surveyed*	*OWL, not surveyed*	*Sum*
Quercus cerris	224				224
Quercus petraea	158				158
Other Quercus ssp.	4				4
Fagus ssp.	436				436
Other broadleaves	151				151
Abies alba	80				80
Picea abies	44				44
Pinus ssp.	61				61
Other conifers	7				7
Undefined		1	198		199
Total	1,165	1	198		1,364

Table 11. Forest area, mean volume per ha and mean annual increment per ha by stand origin. Surveyed area.

Stand origin	*Area (ha)*	*Volume (m^3/ha)*	*Increment (m^3/ha)*
No current stand	32,200	0.5	0
Natural seeding	171,200	156.7	4.9
Planting or artificial seeding	2,200	172.2	6.3
Mixed coppice/ seeding or planting	36,600	72.6	3.1
Coppice	115,800	27.2	1.3
Coppice with standards	21,200	67.9	2.3
Total	379,200	89.9	3.0

Table 12. Growing stock by tree species and timber quality (1000 m^3). Surveyed area.

Tree species	*High quality*	*Average quality*	*Low quality*	*Sum*
Quercus cerris	488	3,309	1,372	5,169
Quercus petraea	542	2,541	1,193	4,276
Other Quercus ssp.	4	27	99	130
Fagus ssp.	2,439	6,948	6,576	15,963
Other broadleaves	190	1,106	2,408	3,704
Abies alba	1,329	172	76	1,577
Picea abies	1,283	72	46	1,401
Pinus ssp.	1,015	720	283	2,018
Other conifers	96	125	2	223
Total	7,386	15,020	12,055	34,461

Table 13. Growing stock by tree species and damage (1000 m^3). Surveyed area.

Tree species	*N*	*I*	*D/F*	*F*	*A*	*W*	*H*	*S*	*M*
Quercus cerris	4,614	288	62	50	3	59	42	42	10
Quercus petraea	3,832	50	106	84	23	94	57	22	8
Other Quercus ssp.	129								
Fagus ssp.	13,531	268	1,010	41	2	334	430	143	203
Other broadleaves	3.011	24	352	23	1	79	94	7	111
Abies alba	1.164		69	12		82	246	4	
Picea abies	1,168		45			43	145		
Pinus ssp.	1,659	32	56	75		79	114	1	2
Other conifers	179					9	35		
Total	29,287	662	1,700	285	29	779	1,163	219	334

N=no damage
I=insect
D/F=disease/fungus
F=fire
A=animal
W=weather
H=human impact
S=suppression
M=miscellaneous