FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

Forest Inventory 2002/2003

Introduction

Activities undertaken

Processing of data, accuracy of results

Inventory results

Assessment of harvesting practices

Recommended harvesting level, conclusions

ANNEX I: List of Project Personnel
ANNEX II: List of Inventory Equipment
ANNEX III: **Inventory methodology**

EXECUTIVE SUMMARY

Since existing forest information mainly stems from the period before and during the 1990s, and since all planning prior to the conflict was carried out only on state owned land, one of the urgent actions identified was to validate data and reinstall capacity to conduct forest resource assessments through a Kosovo-wide forest inventory. This kind of information is crucial for various strategic decisions, setting the sector policy, and for monitoring forest trends. Considering this urgent requirement the Government of Norway accepted to finance a forest resource assessment with the overall objective of establishing a Forest Information System on the status of the forest resources. Specific objectives of the project were to revise the existing classification system to secure compatibility with international definitions, calculate areas and standing volumes per defined class and owner category, and establish an organization capable of conducting national forest inventories.

The main findings and conclusions elaborated during the course of the project are:

- 379 200 ha was classified as forestlands through interpretation of aerial photos and field surveys. Another 85 600 ha was classified as forestlands through photo interpretation, but could not be surveyed in the field because of mines and other logistic constraints. Out of the total area made up of surveyed and not surveyed forestlands 278 880 ha is classified as public forestlands and 185 920 ha as private forestlands. This total area (464 800 ha) is slightly larger (6-8%) than previous estimates;
- Broadleaved forest, created through natural seeding, covers more than 90% of the forest area. Dominating broadleaved species are oak and beech. Coniferous forest, covering 7% of the total forest area, is dominated by Abies alba, Picea abies and Pinus species;
- The total standing volume on public forestlands is estimated at about 33.5 million m^3. Out of this volume 25.9 million $m^3$are trees with a diameter >7 cm. On private forestlands total standing volume is estimated at about 19.5 million m^3 out of which 14.5 million m^3 are trees with a diameter >7 cm;
- The annual increment of trees on the area surveyed, and with a diameter >7 cm, is calculated to 1.165 million m^3. As the non-field surveyed forest (85 600 ha) to a large extent are located near minefields and other areas not accessible, it seems reasonable not to include this increment in the basis for annual allowable cut;
- Based on the actual status of the forestry, the annual allowable cut has been estimated at 900 000 m^3 corresponding to 77% of the calculated increment on areas surveyed. About 700 000 m^3 will be harvested in High Forest (> 16 m) and about 200 000 m^3 in low forest. These estimates are gross and include tops, bark and larger branches. The realization of these harvesting volumes will require a change of current harvesting and management practices;
- 40% of public forestlands and 29% of private forestlands have been subject to uncontrolled or illegal harvesting activities. By all standards these figures are very high. The situation is most critical in coniferous forest where the entire existence of large forest areas is put at risk if no strong and immediate actions are taken. The inventory results also confirm expert opinions that coppice forest, especially on public forestlands, is exposed to heavy harvesting. The results also show that many young and middle-aged forests are in an urgent need of management interventions, ranging from cleaning/pre-commercial thinning to commercial thinning. Conclusions and recommendations are further presented in chapter 6.2.

TABLE OF CONTENT

TABLES

1. INTRODUCTION

1.1 Project objectives

In preparation for a phase II of FAO support to the Forestry Sector, a study conducted by the Norwegian Forestry Group (NFG) proposed to install capacity to assess and monitor forest resources on Kosovo-level and property level. These two elements included:

- An overview by interpretation and classification of systematic sample plots on orthophotos, followed by a forest monitoring system establishing a network of permanent sample plots along the lines of a National Forest Inventory (NFI);
- Detailed field measurements for collecting site-specific information useful for operational management planning;

In response to UN Consolidated Appeal (CAP) 2000, the Government of Norway approved the funding of US$ 1 275 000 for Forestry Emergency Support and Rehabilitation (OSRO/KOS/913/NOR) from January 2000 to April 2001. Funds left over from this project, US$ 314 620, has been used to finance the Forest Inventory Project (OSRO/KOS/105/NOR) from February 2002 to December 2003, parallel to and under the overall supervision of the Forest Sector Institutions Capacity Building Project (OSRO/KOS/101/NOR). The overall objective of the project was to establish a Forest Information System on the status of the forest resources of Kosovo. Specific objectives were to:

- Carry out on-the job training of relevant personnel;
- Establish an organization capable of conducting national forest inventories including monitoring and presentation of results;
- Revise the existing classification system to secure compliance with classification systems in other countries in the region and compatibility with international definitions (UN-ECE/FAO);
- Calculate areas per defined class and owner category;
- Calculate standing volume per ha and total per owner category and defined classes;
- Calculate the portion and main locations of bare- and degraded land that, after a further investigation, might be converted into plantations;
- Project future potential for harvesting of existing forest and the need for investment for rehabilitation work and plantation establishment.

Five forest engineers and 13 technical staff (fieldworkers) and their employer, the former KFA, now separated between the Department of Forestry and the KFA within the MAFRD, are the direct beneficiaries (Annex 1 lists the national staff involved). Indirectly, the forest sector, including forest owners, the government and the wood-processing industry will benefit through the availability of more accurate information for planning and policy-making. As such, the project targeted the population of Kosovo, through its contribution to a sustainable development of the forest resources and the overall economy.

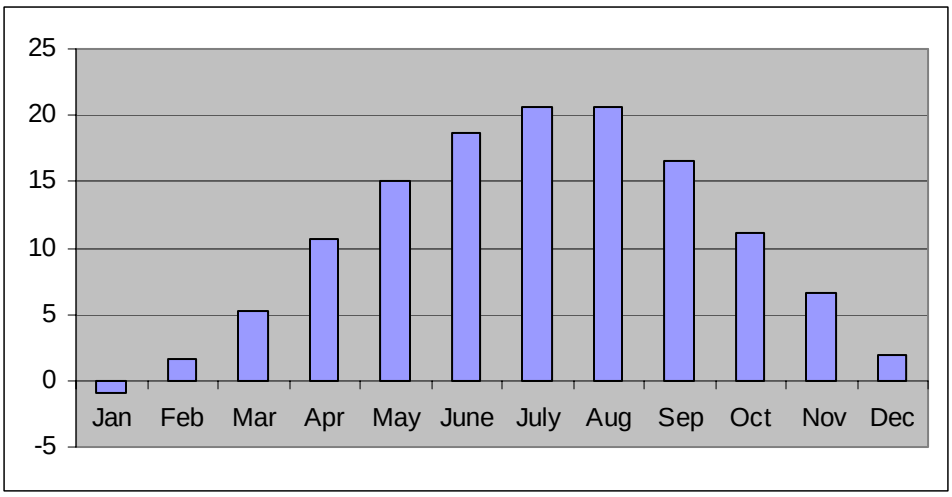
1.2 General conditions for forestry

The geographical basin of Kosovo is situated at an altitude between 500 - 600 m and is surrounded by mountains and divided by a central north-south ridge into two regions. The geological formation of Kosovo consists to a great extent of Potassium and Granite rock and this influences the soil formation and its pH value.

The soil seems to be rich in nutrients with a pH value of about 6.0 measured in water, as result of the parent rock. The mountains surrounding Kosovo and the central north-south mountain chain increase the conditions for forest production with the transportation of nutrients in a solution of water in the surface to the benefit of all trees standing in its way down slope.

During the months of January and February the temperature can go down below minus 15–20^{o} C, but mostly the temperature ranges around 0^{o} C. June-August are the hottest months when the temperature can reach 35-40^{o} C as an extreme. More normal temperatures are around 25^{o} C

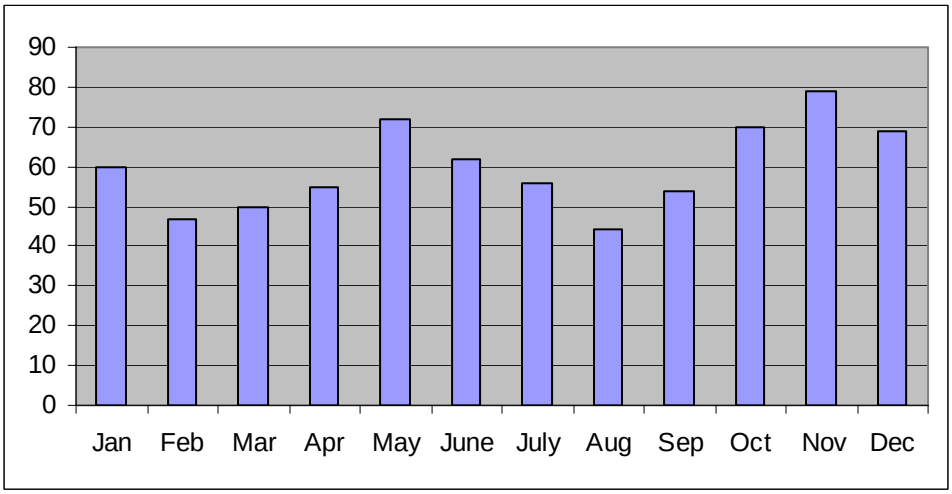
Figure 1. Average monthly temperature (Celsius) in the province of Kosovo (1923-1971)



Source: Meteorology Stations in Kosovo

The average annual average rainfall in Kosovo is about 720 mm but can reach more than 1000 mm on mountain slopes. In the western areas (Peje, Djacovica) average annual rainfall is in the order of 900–1 000 mm, while areas in the North (Mitrovica) and Central/East (Pristina, Lipjan) are considerably drier with annual average rainfall in the order of 600 mm. Most rain falls during the periods May-June and October-January. February/March and August are the driest months.

Figure 2. Monthly average rainfall in forest areas in Kosovo



Source: Meteorology Stations in Kosovo

Generally speaking, conditions for forestry are quite favorable, with no pronounced dry periods or other extreme conditions.

1.3 Existing forest data

In terms of forest area several species of indigenous oak dominates. European beech (Fagus Silvatica) is also widespread and of considerable economic importance. Fir (Abies Alba), Norway spruce (Picea Abies) and Scots Pine (Pinus Silvestris) are coniferous species growing naturally in higher elevations. Black Pine (Pinus Nigra) is important specie, which is the dominant plantation specie on lower elevations.

Following the 1999 conflict, returning foresters compiled available information on forest resources. These data stemmed from the period before and during the first half of 1990. The total forested area was estimated at about 430 000 ha, or approximately 40% of the land area. Of this area, low forest originating from stool-shoots (coppice) constituted the major part, covering more than 60% of the total forest area. High forest was estimated at about 25%. The growing stock in high forest was estimated at 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 forests.

By the Kosovo Forest Agency (KFA), the annual sustainable cut on public forestlands was initially estimated at 70 000 m^3 from high forests and 130 000 m^3 from low forests. Prior to the conflict, the state forest company Serbia Sume carried out resources assessments. 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.

Data on national level has been, and still is derived from aggregating data from forest management plans. Average figures for corresponding forest types are applied to include in the national statistics the areas in private ownership, where no management plans exist. Compiling information from management plans based on surveys over a period of 10 years would inevitably lead to a large number of people being involved in the inventory work. Then there will always be a risk of systematic errors or tendencies caused by different personal judgment. Since the forest situation is constantly changing, there will also be a problem in referring the total data to one single year and to quantify the development trends over time.

For many data due to uncertainty about definitions used, areas included/excluded, etc. comparisons between the old figures and new inventory are data difficult to make.

2. ACTIVITIES UNDERTAKEN

2.1 Procurement and installing of equipment, needs for additional equipment

The project procured seven complete inventory sets from the Swedish supplier Skogma AB (Annex 2). The project selected for GPS (Geographical Positioning System) handheld receivers for location of the sample plots the Garmin 12 XL. It is robust, waterproof and provides good reception of signals under dense foliage. The project bought a powerful computer Intel Pentium 1,7 GHz processor with hard drive 120 Gb and 512 Mb RAM to run the GIS (Geographical Information System), and ArcView 3.2 and 8.1 versions to facilitate the initial land cover classification and the production of project maps. In addition, an A4/A3 paper size color inkjet printer HP CP1700 was procured.

In the medium- and longer-term, and in order to facilitate data collection, personal hand-held computers with built-in programs for storing and transporting data could be acquired. This would make database operations more efficient and minimize errors. The price per computer ranges between 2 000-3 000 EUR.

To fully equip a GIS-lab for forest management planning, in addition to what has been provided through the project, one would need an A1 size plotter (must use ordinary paper), a Digit board and extension for image analysis. Satistical and other software should also be purchased.

2.2 Compilation of existing information, restrictions in use of information

Digital orthophotos (2D) and topographic maps was the primary data used for the initial land use classification and for producing maps. The project procured orthophotos from the Kosovo Cadastral Agency (KCA) covering about 80% of the total area. These were developed from aerial photos with ground resolution 40 cm taken during the year of 2000 and 2001. Each photo covers an area of 1 sq. km. The digital orthophotos were provided in the Gauss-Krüger position format used in Yugoslavia. Hardcopies of the topographic maps at scale 1:25,000 (two sets) consisted of 100 separate map sheets. The Yugoslavian Mapping Authorities produced these maps in the early 1970s.

The Western European Union Satellite Centre for Kosovo provided geo-coded Digital Geographic Information in three bands allowing for visualization and analysis of Kosovo at scales ranging from 1:1 000 000 to 1:5 000. The Directorate for Civil Protection manages the digital data provided by the UN Mine Action Co-ordination Centre. Some areas are defined as dangerous, i.e., mines or unidentified explosive objects may occur. The maps displayed confirmed mine fields as a point theme. The fields have been marked, but their exact location had to be verified by the field teams.

The KFA made available forest maps at scale 1:50 000 in the forest management plans. The maps provide information on forest class, site quality, and other attributes on public forestland. A large portion of the maps is outdated. In the flight restriction zone along the border with Serbia in the northeast and the northwest, for which orthophotos are lacking (20% of total area), satellite data originated from the Indian satellite IRS LISS was tested but proved less suitable because of the low resolution.

Information on protected areas exists with the Institute for Nature Protection under the Ministry of Environment. The project was unable to get digital data. Much information about the park is still with the previous park office in K-S-dominated Strpce municipality. There are several strict protection zones within the park, but the surveillance of activities inside the park is weak.

Eighty-seven plots interpreted as forest and other wooded land was reclassified into forest during the fieldwork. Still there seems to be reasonably good correspondence between the information about forest cover in the old topographic maps and the present situation.

This indicates that land use has been relatively constant throughout the period. The future need for up-dated land cover information will depend on the speed and scope, with which changes in land use will occur, e.g., natural succession from mountain meadows and pastures to forest.

The orthophotos will most likely be applicable for a period of 6-8 years. However, the right to use them was restricted to the project only. Use of the images for, e.g., forest management planning purposes must come according to an agreement with the KCA.

2.3 Revision of the forest classification system

The project compiled Field Instructions and Guidelines for Photo Interpretation. These instructions outlines the sampling statistical design, attributes assessed, measurement rules and valid values. The project applied the FAO Forest Resource Assessment Program and the UNECE Timber Committee Terms and Definitions. For the moment, for Kosovo there seems to be no forest definition based on direct physical characteristics, except from what was specified in the forest law (Official Gazete of Autonomous Socialist Province of Kosovo, 1987). According to this law, forest should be considered land that is covered by trees.

In the new Law on Forests in Kosovo, promulgated 20 March 2003, "Forest", unless other is stated, is land registered as such in the cadastral records. "Forestland" is land that is being managed for the production of wood or other forest products or whose best use, given its natural characteristics and economic condition, involves the growing of trees. Forestlands should be at least 0.1 ha in size, which differs from the international definition. Lands where trees have been planted in strips primarily to control erosion, create shelter from wind, give shade, or improve aesthetics are not forestland.

A description of the classification system and the guidelines for the former forest inventory was made available as three manuals in Serbo-Croatian language. However, the project has not translated the complete manual.

Inventory methods and classification systems were and still are similar for the countries of the former Yugoslavia, only with small variations. In Serbia, the first complete quick inventory of private forests took place in the late 1940s. As today, the forests belonged to agriculture estates and the forest patches were often less than 0.5 ha. The rapid assessment found poor stocking, and young stands dominated. The project has not been able to verify the results of an attempt in the early 1970s to carry out a National Forest Inventory in Serbia based on a method independent from forest management planning.

The study of the forest management system in Bosnia&Herzegovina in 2001 found that several classification systems are in use. Six basic categories of forests included in a forest management plan (Kategorije Sume) exist. The categories are high forest with natural regeneration, degraded high forest, forest plantations, coppice forests, bare land and non-productive areas. Each of these are then divided into broader ecological-production classification units (Management classes), based on species composition and soil productivity. Every stand is assigned to a management class based on their ecological composition and planned method of silvicultural treatment.

The present study emphasize that the system of dividing the forest area into different categories and management classes requires that the definitions of criteria for classification are clear and easy to use. The study concludes that this is not the case. In one economic region there may be over 1000 management classes. A similar system has been, and is still in use in Serbia.

2.4 Training

The training was organized in three phases: preparation, fieldwork and data processing. In addition to the International Training/Forest Management Expert training was also carried out with the support of national forest engineers, a national GIS consultant and an international Forest Inventory Expert from Slovenia. The training consisted of semi-structured indoor sessions and field exercises, in addition to daily follow-up of the national project staff.

A consultant with the Pristina-based company Illyrian Group provided a 24-hour introductory course in GIS and the use of ArcView software for spatial analysis. Participants were the Deputy Team Leader, the GIS/Database Consultant and the Forest Management Officer with the KFA, who was later on contracted as a Forest Management/Photo Interpretation Specialist.

The main topics covered were map projections and scales, types of data, creating own data, using the standard ArcView interface to manage attribute data for presenting information in layouts and making simple queries. The Illyrian Group also provided 20 days combined consultancy and training in map development and data management.

At the initiation of the project the following training was provided by the International Training/Forest Management Expert:

Topic	Number of sessions	Number of hand-outs
Forest Policy	2	2
Elementary Forest Sampling	4	3
Mapping	1	1
Land use/forest classification	2	2
Forest mensurations	3	2
Remote sensing	2	2
GPS use, navigation	4	1

National project staff and fieldworkers also received one-day Mine Awareness Training with the Directorate for Civil Protection.

As part of the agreement on procurement of the digital data the Kosovo Cadastral Agency provided on-going professional support to the project in 2002, most notably working with the GIS/Database Consultant in managing the data. International consultants with the Agency assisted in generating the 4 x 4 km grid with geo-referenced position of the clustered sample plots.

The Photo Interpretation Specialist conducted an initial land cover classification by interpreting the orthophoto coverage. Interpretation training consisted of separate field visits calibrating the interpretation, of which the Deputy Team Leader joined the majority. The group discussed interpretation cases illustrating the classification alternatives according to instruction drafted by the project manager. Attributes include municipality, land cover, forest type and /-development, crown cover, access, and risk of mines. Prior to fieldwork, twelve fieldworkers received training in assessing silviculture treatment options (9 days), assessing forest damage (4 days), Non-Wood Forest Products and biodiversity (2 days), and GPS-navigation (2 days). Selected forest engineers from Kosovo provided short-term training on assessing silvicultural options, forest damages, and wood quality and harvesting conditions. The Deputy Team leader compiled training material on tree species identification and conducted the training in the other topics. The figures below shows indoor- and field training for fieldworkers initiated and supervised by the International Forest Management/Training Expert:

Activity	Sessions in field	Sessions indoor
Forest mensuration	2	-
GPS-/map navigation	2	1
Photo interpretation	4	4

The international Forest Inventory Expert from Slovenia led the training from 16 September to 25 September 2002. The field exercises focused on drilling the fieldwork. This involved testing the draft field instruction and the field record forms. Further training was provided by the Regional Expert with the objective of securing the appropriate inclusion of the regional knowledge in forest inventories.

Activity	Location	Day in mission								
		2	3	4	5	6	7	8	9	10
NFI selected countries, presentation (K-A, K-S)	Pristina	*								
Project field instruction, presentation (K-A)	Pristina	*								
Field exercise (K-A)	Lipljan		*							
Field exercise (K-A)	Vitina			*						
Sampling Methods, Forest Information System - case Slovenia, presentation (K-A, K-S)	Pristina				*					
Field exercise (K-A)	Gnjilan				*					
Field exercise (K-S)	Leposavic					*				
Field trip (K-A)	Peja						*			
Field exercise (K-S)	Zubin Potok							*		
Field exercise (K-S)	Leposavic								*	
Field exercise (K-A)	Pristina									*

Together with the International Inventory Expert/Team Leader, the National Deputy Team Leader participated and presented the project in a seminar hosted by the Austrian Forest Research Institute in Vienna in June 2003, regarding cooperation of the National Forest Inventories in Europe.

Translation of training material, guidelines for photo interpretation, field instructions and field record forms into Albanian and Serbo-Croatian, and applying the documents, caused problems. Technical terms were discussed and clarified during the mission of the international Expert from Slovenia, which is the only country in the region self-sufficient in forest inventory capacity. In minority areas the Regional Expert and International Inventory Expert were capable of providing the training in the appropriate language. Material both for the species identification, training and assessing forest damage were developed in Albanian and translated into Serbo-Croatian.

During the mission by the international Expert from Slovenia, for the first time since the recent conflict, K-S and K-A foresters met in a professional setting. For two days in Pristina, all foresters involved in the project participated in training in selected topics in Basics of Data Capture, Forest Information Systems and Elementary Forest Sampling. In the joint sessions, also K-A forest engineers involved in the project and the KFA Regional Directors participated. Obviously, communication between the Regional Expert and the K-S and the senior K-A trainees was good. This may also be due to a close relationship between the way forestry is taught and practiced in former Yugoslavia and in the German tradition/-school.

Training and implementation of the project in the northern part of Mitrovica region and other minority areas was for security reasons to be organized separately. By 15 August 2002, project activities had not yet commenced in K-S-dominated areas. The project contracted the Director of KFA in Mitrovica Region to provide the training, and translated training material into Serbo-Croatian.

Communication between international experts and trainees went through interpreters. The vocabulary of forest inventory contains highly technical terms, which cannot be easily translated from English into the language of Kosovar foresters. Evidently, messages fail to reach its destination, and this goes both ways. One may be tempted to claim that questions and answers have been understood, even though the claimant is not sure.

A check of fieldworkers' knowledge and skills after completing the initial training could have preceded commencement of fieldwork. The practical part could include for each field team the measuring and assessing of a sequence of trial sample plots according to instruction, and covering different forest conditions. This would have provided a basis for comparing and identifying possible divergences.

There are indications that the parallel education system, which was put in place during the 1990s after limiting access by the Albanian population to some academic institutions, was unable to offer education of appropriate quality. The initial training of national staff in forest inventory detected gaps in basic knowledge in mathematics and statistics. To fill knowledge gaps future training could be organized along two tracks:

- Formal training through a trainee contract jointly with an educational institution and consultancy company leading to a graduate degree in forest management and planning;
- Semi-formal short courses in selected topics supported by regional/international experts and linked to a regional or local training institution;

Current locations are in Slovenia, Albania, Germany or one of the Scandinavian countries. English or German language skills would be required. To fill gaps it is recommended to initiate a discussion with the he Government of Sweden with the objective of including some training in the forthcoming Support to Forestry Education and Training Project.

Short duration (2-3 months) stays abroad could be combined with similar period in Kosovo, working on specific projects. Such training could be arranged as part of support to the second step of building GIS and forest inventory capacity for management planning. E.g., establishing GIS training facilities to carry out initial GIS training of foresters in Kosovo would provide an infrastructure for the future and give students of forestry a necessary introduction to GIS and applications of GIS in forest planning and management.

2.5 Establishment of a project organization

The project recruited the National Deputy Team Leader and the GIS/Database Consultant in April, 2003. A Forest Management/Photo Interpretation Specialist filled in for the national GIS consultant, who went on maternity leave from 23 August. During the last week of May twelve field workers distributed among six field teams were mobilized. One team operated in minority areas in North Kosovo. All teams were recruited on FAO casual labour contracts during the field period.

The National Inventory Expert planned for in the project document was not identified. A potential candidate, who was involved in inventories during the 1990s, was unavailable because of his position as Chief Inspector within the KFA.

Following concerns with motivation, ability and formal qualifications among some of the candidates for fieldwork, the project advised the counterpart to mobilize five additional forest technicians. After a two-and-a-half-week halt in training activities awaiting new candidates, the KFA management gave up the search arguing that no additional forest technicians were interested in fieldwork. Training only resumed with the existing group 12 September.

The Team Leader in North Mitrovica left his position in April 2003 and the work in this region suffered a standstill until end of September. Two additional fieldworkers were contracted to speed up the work. Because of the delay it was impossible to get a complete data set from this region. Only about 60% of the estimated total plots on forest and other wooded land were surveyed in the field, while the percentage for all of Kosovo was 80%.

3. ACCURACY OF RESULTS, PROCESSING OF DATA

3.1 Accuracy of data

General

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 these 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.

Generally speaking the quality of photo interpretation and fieldwork was found to be good, especially with respect to the attributes that are measured along a continuous scale. Some of the difference stems from the fact that the field teams and control teams have made their measurements at different time in growth season. This means that project estimates with respect to forest area, standing volume and annual increment by forest type will be confident.

All volumes (m^3) presented in this document are volumes of standing trees over bark and includes tops and larger (broadleaf) branches. To allow for calculating volumes under bark, the thickness of bark was also measured.

Volume estimates (m^3 per ha)

The mean volume has been estimated at 91 m^3/ha for all surveyed 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%/√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%. These estimates have also been applied for the non-surveyed forest plots (85 600 ha) will of course be an additional source of errors.

Mean errors on area measurement, sampling design

As a first stage, a regular grid of 4 x 4 km was established for all of Kosovo. In a specifically defined area, the density of the grid was increased to 2 x 4 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 4 x 4 (or 2 x 4) km grid indicates the centre of the south-western plot of each cluster, consisting of 4 circular sample plots. This means that each sample plots represents an area of 400 ha (in denser grids 200 ha).

The mean error of the area component has been calculated using the following formula:

$$sa = \sqrt{\frac{(100 -)xp}{n}}$$

p = percent of actual area in proportion to total area of Kosovo;

n = total number of sample plots (potential) in Kosovo;

The figures below present the mean sampling errors on selected areas. For the total area classified as forestlands (464 800 ha) the mean sampling error is calculated to 2.2% (+/- 10 200 ha). This area (selection) is represented by a large number of sample plots which gives a relatively small interval of 454 600 – 475 000 ha. For selections represented by a smaller number of sample plots the mean error is, consequently, considerably higher.

Total area (ha)	Selection (%)	Mean error (+/-)	Mean error (ha)	Mean error on selection
1 000 000	100			
464 800	46	0.99	10 200	2.2
350 000	35	0.95	9 500	2.7
300 000	30	0.90	9 000	3.0
250 000	25	0.86	8 600	3.4
200 000	20	0.80	8 000	4.0
150 000	15	0.71	7 100	4.7
100 000	10	0.60	6 000	6.0
50 000	5	0.43	4 300	8.6
20 000	2	0.28	2 800	14.0
10 000	1	0.20	1 980	19.8
5 000	0.5	0.14	1 400	28.0
1 000	0.1	0.06	630	63.0

Classification, tree measurements etc.

For parameters recorded in classes, consistency between the control team and the field team was presented in contingency tables. For parameters measured according to a continuous scale, correspondence is shown through mean values and the difference between these values.

The photo interpretation found a total of 1 252 plots in forest and 103 plots on OWL (other wooded land) and 495 in pastures/meadows. The fieldwork found 1 205 plots in forest and 49 plots on OWL. A total of 250 plots interpreted as forest and 54 plots interpreted as OWL were not visited in the field. Prior to commencement of fieldwork, the project experts expected to find quite an extensive area of OWL in Kosovo. The fieldwork control indicates that during the early stages, the field teams may have classed some OWL plots into pastures/meadows. The reason may be an incomplete understanding of the definition of OWL, uncertainty regarding which measurements to be taken on OWL, matter of convenience, or inaccurate photo interpretation. The latter is unlikely, since extensive calibration of interpretation was carried out during the training of the Photo Interpretation Specialist. Training could have emphasized the definition of OWL harder, how to calibrate/estimate the crown cover and which measurements to be taken.

The silviculture treatment options could not readily be translated into familiar Serbo-Croatian terms corresponding to familiar practices, especially the various partial regeneration felling (seed tree-, shelter wood, and selection methods). This can stem from translation problems, difference in forest educational system and silvicultural methods and practices. Determining an uneven-aged stand, and selecting future silviculture options for creation and maintenance of stands, require clarification of definitions and a full understanding of past and present traditions.

For those areas close to borders where no orthophoto exist, the land use was interpreted based on the thirty-year old topographic maps only. In some cases, plots having been interpreted as pasture or agricultural land may in reality be forest now. In some cases, the field teams did not visit these plots. The project should have stressed harder the importance of determining the present land cover on those plots.

Due to capacity and time constrains, it has not been possible to transfer detailed knowledge on data processing and analysis to local staff. For the future, capacity building on programming and statistics should be emphasized in follow-up work. The project visited 23 sample plots and conducted a reassessment and re-measurement of a total of 15 plots for analysis of consistency. The control functioned as a follow-up of the teams as the team members participated.

3.2 Calculations of volumes and increment

Volume functions

The field data was continuously entered into a database developed 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 former state forest company (Serbia Sume) carried out all data processing for the management plans, and 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 the tables developed by Drinić, Matić, Pavlič, Prolić, Stojanović, Vukmirović and Koprivica (Tablice taksacionih elemenata visokih i izdanačkih šuma u Bosni I Hercegovini) have been used. In several cases functions to be included in a computer program 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.

High forest (>16 m)

Volume estimation for high forest has been carried out in a number of steps. 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

Coppice forest (forest developed through stol-shoots)

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 there 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 registered. The calculations of tree volumes are then based on the publication from Bosnia defining the volume for small dimensions by species and by 1 cm diameter classes. For these assessments the average volume for oak of diameter class 3 and 4 has been used. This tree volume has then been used as an approximation for all trees with a diameter from 1-7 cm.

Increment

Basal area increment percentage for individual trees was estimated from the measurements of annual rings (10 last) on selected sample trees. To adjust 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 total volume increment. Increment percentages were assigned to the trees with no increment boring, using regression methods.

Calculation of volumes, corrections

A grouping was made 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 volumes, increments etc. was 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.

4. INVENTORY RESULTS

4.1 Distribution of forest areas on stand origins, species classes, age classes and treatment opportunities.

The project found a total of 464 800 hectares (ha) of forest, which would be about 35 000 ha more than previous estimates. The reason for this deviation might be due to factors as differences in classification of land, and transformation of marginal agriculture land to forestlands.

The inventory also classified 28 200 ha as other wooded land. This, or any similar category, has not been used in the previous inventories of Kosovo. Barren land, out of which some would be suitable for plantation establishment, amounted to 23 400 ha. Another land use class is meadows and pasture lands accounting for as much as 153 200 ha. This land is used for grassing. Some areas are eroded, have thin top layer soil. Despite of less fertility, some of these areas might, however, be suitable for plantation establishment or other kinds of landuse.

Table 1. Total area of Kosovo by land classes

Land use	**Area (ha)**
Forest	464 800
Other wooded land	28 200
Barren land	23 400
Agricultural land	342 400
Meadows and pasture	153 200
Urban areas, built up land	40 000
Water	4 600
Not classified	41 600
Total	**1 098 200**

The total land area corresponds rather well to the existing official figures. This is a justification of that the grid system is properly allocated.

According to table 2 out of a total area of 464 800 ha 278 880 ha, or about 60%, is classified as state forestlands. Remaining 40% (185 920 ha) is owned by private persons. These figures differ from both old statistical data and data from the cadastral records.

Source of information		Public forest	Private forest	Total
Old statistical data		266 000	162 000	428 000
Cadastral records 2004		196 000	198 000	394 000
Inventory data:	Surveyed areas	202 800	176 400	379 200
	Not surveyed areas	76 080	9 520	85 600
	Total inventory data	278 880	185 920	464 800

The figure from cadastral records (198 000) is far above the old figure (162 000 ha), and should be checked up. Taking into account the results of the allocation of sample plots suggesting a total area of 176 400 ha of private forestlands, the total forest area of 464 800 ha and an anticipated distribution of 40/60 between private and public forestlands the total area of private forestlands is calculated to 185 920 ha and public forestlands to 278 880 ha. As a consequence of these assumptions 88% of the non surveyed areas are allocated to public forestlands.

The main part of the non surveyed forestlands is on areas not de-mined, in North Mitrovice, on areas close to border lines, on high altitudes and other areas difficult to access. This fact may support the assumption that the overwhelming part of not surveyed forestlands is public.

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

Stand origin	**Public**	**Private**	**Total**
No current stand	22 200	10 000	32 200
Natural seeding	89 200	82 000	171 200
Planting or artificial seeding	1 800	400	2 200
Coppice/seeding or planting (mixed)	17 600	19 000	36 600
Coppice	62 000	53 800	115 800
Coppice with standards	10 000	11 200	21 200
Total forestlands surveyed	202 800	176 400	379 200
Forestlands not surveyed (no data)	76 080	9 520	85 600
Total areas of surveyed and not surveyed forestlands	**278 880**	**185 920**	**464 800**
Percent out of total area	60	40	(100)

Table 2 presents forest area by stand origin and ownership classes. The following comments can be made:

- 32 200 ha is classified as land with "no current stand". This stand origin might include high productive forest land suitable for artificial regeneration;
- 171 200 ha is forest created through natural seeding and classified as high forest (>16 m)
- 115 800 ha is classified as coppice forest (low forest, forest developed through stol-shoots). Main areas can be found in central parts of Kosovo;
- Coppice with standards are low forest but with scattered larger trees (21 200 ha);
- Only 2 200 ha is registered as planted forest. This figure does not corresponds well to the plantation records showing a total planted area in the order of 15 000 – 20 000 ha. Some planted forest might have been registered in the class "mixed coppice/seeding or planting, but it is obvious that many plantations have failed.

The main part of the public forest is located on altitudes between 600-800 m above see level. Table 3 presents areas of public forest by stand origin and altitude.

Table 3. Public forest areas by stand origin and elevation (ha)

Stand origin	Elevation								No data	Total
	200-400	400-600	600-800	800-1000	1000-1200	1200-1400	1400-1600	>1600		
No current stand	400	6 000	9 800	4 400	800	600	200			22 200
Natural seeding	1 400	4 400	16 800	22 600	10 200	13 000	9 400	11 400		89 200
Planting or artificial seeding		1 600				200				1 800
Coppice/seeding or planting (mixed)	200	4 000	3 000	2 000	4 800	2 000	1 000	600		17 600
Coppice	800	7 600	21400	25000	2 800	2 600	1 400	400		62 000
Coppice with standards			3 000	5 000	2 000					10 000
No data									76 080	76 080
Total	**2 800**	**23 600**	**54 000**	**59 000**	**20 600**	**18 400**	**12 000**	**12 400**	**76 080**	**278 880**
Percent of total area	1	8	19	22	8	7	4	4	27	100

Comments:

- Areas classified as no current stands are on lower elevations. It might be assumed that these areas are most accessible, and have for this reason been subject for heavy cutting activities;
- More than 60% of the stands created through natural seeding are located on altitudes between 600 – 1 000 meters. These forests are often growing well, are of good quality and is used for cutting technical wood;
- 50% of the total area is located on elevations lower than 1 000 m;
- Areas not surveyed are classified through photo interpretation. Tree species have been classified as undefined broadleaved species (see also table 4).

Generally speaking public forests are located on higher elevations than private forest.
The next table (4) presents the distribution by stand origin and altitude of private forests.

Table 4. Private forest areas by stand origin and elevation (ha)

Stand origin	Elevation								No data	Total
	200-400	400-600	600-800	800-1000	1000-1200	1200-1400	1400-1600	>1600		
No current stand	1 000	3 000	5 000	800		200				9 000
Natural seeding	800	5 200	41 400	23 400	6 000	2 400	2 200	600		82 000
Planting or artificial seeding				400						400
Coppice/seeding or planting (mixed)	1 000	10 400	2 800	3 400	800	200	400			19 000
Coppice	5 000	10 200	22 000	13 600	1 800	1 000	200			53 800
Coppice with standards		600	3 000	5 600	1 200	800				11 200
No data									9 520	9 520
Total	**7 800**	**29 400**	**74 200**	**47 200**	**9 800**	**4 600**	**2 800**	**600**	**9 520**	**185 920**
Percent of total area	4	16	40	26	5	3	1	-	5	100

Comments:

- As for public forests, stands created through natural seeding and coppice forests dominates;
- Only minor areas of plantation forests exist. This is justified through the plantation programs which have been concentrated to public forestlands;
- The portion of coppice forests with standards is higher than in public forests. This might indicate that management of private forests is better than management of public forests (or not subject to the same cuttings circles as public forests);
- 86% of private forests is located on elevations below 1 000 m.

Table 5. Public forest area by species class and stand structure (ha)

Species class	Stand structure				No data	Total
	Under regeneration	Even-aged	Two-storeyed	Uneven-aged		
Without trees	1 600	400				2 000 (1%)
Coniferous		5 000	1 400	8 400		14 800 (5%)
Broadleaved	2 600	117 400	11 200	52 800		184 000 (66%)
Mixed		200		1 800		2 000 (1%)
No data					76 080	76 080 (27%)
Total	**4 200**	**123 000**	**12 600**	**63 000**	**76 080**	**278 880**

Table 5 (above) presents the public forests by species class and stand structure. Coniferous forests include a number of pine and abies species while broadleaved forest is dominated by oak and beech species. Comments:

- Broadleaved forests covers (defined and undefined) cover more than 90% of the forest area;
- 5% is defined as coniferous forest. These forests are mainly located in the western parts of Kosovo;
- Considerable forest areas are classified as uneven-aged or two-storeyed. Also not surveyed areas (76 080 ha) most probably fall into these two categories;
- More than 50% of coniferous forest is uneven-aged. This is because of the applied management practices (selection management system).

Table 6 presents the private forests by species class and stand structure. Coniferous forests include a number of pine and abies species, while broadleaved forest is dominated by oak and beech species.

Table 6. Private forest area by species class and stand structure (ha)

Species class	**Stand structure**				No data	Total
	Under regeneration	Even-aged	Two-storeyed	Uneven-aged		
Without trees	1 800					1 800 (1%)
Coniferous		2 200	200	1 800		4 200 (2%)
Broadleaved	4 600	108 400	10 800	45 800		169 600 (92%)
Mixed				800		800 (0%)
No data					9 520	9 520 (5%)
Total	**6 400**	**110 600**	**11 000**	**48 400**	**9 520**	**185 920**

The distribution of species classes over stand structure is similar to public forests with some minor exceptions. The portion of even-aged forests, and areas under regeneration, is slightly higher than in public forests. It is difficult to judge whether these differences are the result of management interventions, different site conditions or other factors.

Table 7 and 8 presents the distribution by age and tree species structure for public and private forests respectively. As for many other parameters the large portion of non surveyed areas in public forests makes comparisons with private forests difficult. It is, however, obvious that in private forests the portion of young forest is higher than in public forests.

Age class	Public forests (%)	Private forests (%)
0-20	29	23
20-40	18	32
40-60	11	23
60-80	9	8

Table 7. Public forest area by age and tree species structure (ha).

Age class	Tree species structure					Total
	Without tree	Coniferous	Broadleaved	Mixed	No data	
0-20	4 400	400	75 400			80 200 (29%)
20-40		3 200	45 400	400		49 000 (18%)
40-60		3 800	26 400	1 000		31 200 (11%)
60-80		3 400	23 200	400		27 000 (9%)
80-100		1 600	5 400	200		7 200 (3%)
100-120		1 000	3 800			4 800 (2%)
120-140		1 400	2 000			3 400 (1%)
No data					76 080	76 080 (27%)
Total	**4 400**	**14 800**	**181 600**	**2 000**	**76 080**	**278 880**

Table 8. Private forest area by age and tree species structure (ha).

Age class	Tree species structure					Total
	Without tree	Coniferous	Broadleaved	Mixed	No data	
0-20	2 200	600	45 600			48 400 (26%)
20-40		1 000	59 400			60 400 (32%)
40-60		1 400	40 200	400		42 000 (23%)
60-80		800	13 600	400		14 800 (8%)
80-100		400	6 400			6 800 (4%)
100-120			2 000			2 000 (1%)
120-140			2 000			2 000 (1%)
No data					9 520	9 520 (5%)
Total	**2 200**	**4 200**	**169 200**	**800**	**9 520**	**185 920**

For both public and private forests the following comments are made:

- Age distribution of coniferous forest is relatively even, but with an overweight of middle-aged forest (40 – 80 years);
- Two third of the broadleaved forest (225 800 ha) is younger than 40 years. Out of this area 137 000 ha (table 3 and 4) is probably coppice forest and coppice forest with standards;

The tables 9 and 10 summarize areas by treatment opportunities and stand structure. To facilitate a comparison between public and private forests the distribution on treatment opportunities is summarized below.

	Public forests (%)	Private forests (%)
No treatment	20	24
Regeneration without site preparation	1	1
Regeneration with site preparation	1	1
Conversion	5	7
Cleaning-thinning	32	44
Thinning	4	6
Clear cut, strip clear cut	1	-
Selection	5	4
Salvage	4	8
No data	27	5

Table 9. Public forest area by treatment opportunity and stand structure (ha).

Treatment opportunity	**Stand structure**				Total
	No stand	High forest	Coppice or mixed	No data	
No treatment	16 400	10 400	28 800		55 600 (20%)
Regeneration without site preparation		800	400		1 200 (1%)
Regeneration with site preparation	1 400	800	800		3 000 (1%)
Conversion	1 000	8 200	6 000		15 200 (5%)
Cleaning-thinning	3 400	40 200	47 000		90 600 (32%)
Thinning		11 800	1 000		12 800 (4%)
Clear cut, strip clear cut		1 200	200		1 400 (1%)
Selection		11 000	2 200		13 200 (5%)
Salvage		6 600	3 200		9 800 (4%)
No data				76 080	76 080 (27%)
Total	**22 200**	**91 000**	**89 600**	**76 080**	**278 880**

Table 10. Private forest area by treatment opportunity and stand structure (ha).

Treatment opportunity	Stand structure				Total
	No stand	High forest	Coppice or mixed	No data	
No treatment	6 200	17 400	21 000		44 600 (24%)
Regeneration without site preparation		1 200	1 200		2 400 (1%)
Regeneration with site preparation	1 000		600		1 600 (1%)
Conversion	1 400	6 200	4 800		12 400 (7%)
Cleaning-thinning	1 400	34 200	45 800		81 400 (44%)
Thinning		8 200	3 800		12 000 (6%)
Clear cut, strip clear cut		200	200		400
Selection		6 000	2400		8 400 (4%)
Salvage		9 000	4 200		13 200 (8%)
No data				9 520	9 520 (5%)
Total	**10 000**	**82 400**	**84 000**	**9 520**	**185 920**

From the data in the tables 9 and 10 it is obvious that future management interventions will have to focus on cleaning/thinning of young forest. As for all other parameters the large portion of not surveyed areas, especially on public forest, makes detailed comparisons and evaluations difficult. This uncertainty will, however, not alter the overall picture and conclusions.

4.2 This chapter presents the growing stock per tree species group and stand origin for public and private forests, annual increment and mean volumes per ha. Comments to the figures are presented after each table.

Table 11. Growing stock by tree species and ownership (1000 m^3).

Tree species		Public forest			Private forest			Public + Private		
		Areas		Total	Areas		Total	Areas		Total
		Surveyed	Not surveyed		Surveyed	Not surveyed		Surveyed	Not surveyed	
Quercus ssp		2 872		2 872	6 803		6 803	9 675		9 675
Fagus ssp		11 834		11 834	4 129		4 129	15 963		15 963
Other broadleaves		1 584	5 385	6 969	2 121	600	2 721	3 705	5 985	9 690
Abies alba		1 413		1 413	164		164	1 577		1 577
Picea abies		834		834	568		568	1 402		1 402
Pinus ssp.		1 994		1 994	25		25	2 019		2 019
Other conifers		184		184	39		39	223		223
Conifers < 7cm		117	9	126	9	1	10	126	10	136
Broadleaves <7cm		4 861	2 022	7 066	4 756	245	5 001	9 617	2 267	11 884
Other wooded land	Conifers	166		166	20		20	186		186
	Br. leaves	54	180	234	10	20	30	64	200	264
Total		**25 913**	**7 596**	**33 509**	**18 644**	**866**	**19 510**	**44 557**	**8 462**	**53 019**

Comments:

- The total standing volume is calculated to 53.0 million m^3. Old calculations, which are based on aggregated management plans, suggested a total standing volume in the order of 30 million m^3. Because of factors as different definitions and inventory systems, the inclusions of trees <7 cm in this inventory, a larger forest area (8%) and uncertainty to what extent private forests was included in the old figures comparisons between the inventories are difficult to make;
- The total standing volume on public forestlands is estimated at about 33.5 million m^3. Out of this volume 25.9 million $m^3$are trees with a diameter >7 cm. An estimate of an additional 7.6 million m^3 was calculated for trees on other wooded land and for trees <7 cm;
- The total standing volume on private forestlands is estimated at about 19.5 million m^3. Out of this volume 14.5 million m^3 are trees with a diameter >7 cm. An estimate of an additional 4.5 million m^3 was calculated for trees <7 cm;

- Volumes on non surveyed areas are calculated to 8.5 million m^3 of broadleaved forest (16% of the total volume of 53.0 million m^3). Calculations are based on interpretation of aerial photos and average figure from surveyed stands of similar characters;
- 90% of total standing volume is broadleaves, and with fagus and oak as dominating species;
- Coniferous forest is dominated by naturally regenerated Picea Abies and Abies Alba (about 3.0 million m^3) and pine species (about 2.0 million m^3) out of which parts are classified as forests created by artificial means;
- The total volume of broadleaves <7 cm are 11.9 million m^3 out of which 2.3 million m^3 is on forestlands not surveyed. Most of these volumes are oak dominated low forest in central parts of Kosovo;
- The total volume of conifers is some 5.4 million m^3 (10% of total standing volume). Out of this volume 2.5% is trees <7 cm. This figure confirm expert opinions that conditions for natural regeneration in coniferous forests are favorable;
- Out of the Quercus species 54% is recorded as Q Serris and 46% as Q Patraea. This distribution does not consider broadleaves on areas not surveyed, which all are classified as "other broadleaves";
- Volumes on other wooded land (28 200 ha, see table 1) amounts to 0.5 million m^3.

Table 12. Annual increment by tree species >7 cm in 1000 m^3 and in percent of standing volumes

Specie	Public forest	Private forest	Total volume	% of total standing volumes
Quercus ssp	99	290	389	4.0
Fagus ssp	320	116	436	2.7
Other broadleaves	75	76	151	4.1
Abies alba	73	7	80	5.1
Picea abies	27	16	43	3.1
Pinus ssp.	60	1	61	3.0
Other conifers	6	1	7	3.0
Broadleaves on areas not surveyed	180	20	200	3.3
Total	**840**	**527**	**1 367**	**3.4**

- Total annual increment is calculated to 1 367 000 m^3. Out of this total volume about 1 167 000 m^3 is on surveyed forestlands;
- The annual increment of conifers is about 0.2 million m^3 (191 000 m^3). This figure does not include increment on not surveyed areas, since all forest on not surveyed forestlands is classified as broadleaved. This might indicate a slight underestimate of the total increment of coniferous forests.

Table 13 presents the volumes and annual increment per ha per category of owner on the surveyed areas (379 000 ha)

Table 13. Forest area, mean volume per ha and mean annual increment per ha by stand origin (surveyed areas, >7 cm).

Stand origin	Public forest			Private forest			Average		
	Total area	Vol m^3/ha	Incr. m3/ha	Total area	Vol m^3/ha	Incr. m3/ha	Total area	Vol m^3/ha	Incr. m^3/ha
No current stand	22 200	0.4	0	10 000	0.9	0	32 200	0.5 (-)	0
Natural seeding	89 200	190	5.5	82 000	120.4	4.2	171 200	156.7 (5.4)	4.9
Planting/artificial/ seeding	1 800	103.4	4.2	(400)	(481.6)	(15.5)	2 200	172.2 (34.4)	4.2
Coppice/seeding/ planting (mixed)	17 600	96.1	3.9	19 000	50.9	2.3	36 600	72.6 (11.6)	3.1
Coppice	62 000	19.9	1.0	53 800	35.6	1.7	115 800	27.2 (9.2)	1.3
Coppice with standards	10 000	57.5	2.4	11 200	77.1	2.2	21 200	67.9 (17.6)	2.3
Total	**202 800**	**100.5**	**3.2**	**176 400**	**77.7**	**2.9**	**379 200**	**91.1 (6.1)**	**3.0**

- The mean annual increment on areas surveyed is 3.0 m^3 per ha per year. Considering the soil- and climate conditions this is a low figure, and there are certainly great potentials for improvements through better management of existing forests and establishment of plantations with faster growth than the existing ones;
- Average standing volume for all stand origins on the surveyed area (379 200 ha) is 91.1 m^3 per ha;
- On areas covered by forest (347 000 ha) average volume per ha for trees >7 cm is 99.6 m^3. Volume per ha of trees <7 cm is about 28.8 m^3 which makes up a total average volume of 128.4 m^3 per ha;

	>7 cm	<7 cm	Total
Areas with stands (347 000 ha)	99.6 m^3/ha	28.8 m^3/ha	128.4 m^3/ha
Total area surveyed (379 200)	91.1 m^3/ha	26.3 m^3/ha	117.4 m^3/ha

- The combined standard error (volumes and areas) on the average volume per ha is 6.1%. For stand origins, which are less homogenous and/or represented by a few number of sample plots (small areas) the standard errors are larger;
- Stands established by natural seeding (171 200 ha) are relatively well stocked and is dominated by high productive coniferous and beech forest;

- Stands established by artificial means have a moderate growth, and includes many Pinus Negra stands established on pasture lands and other relatively low productive soils. According to expert opinions and old records during the last 30-40 years a total area of 15 000 – 20 000 ha has been planted. The field teams have only recorded 2 200 ha of existing plantations.

  The reasons for this big discrepancy are, most probably, a low rate of survival and that some stands have been classified into the stand origin of coppice/seeding or planting (mixed stands);

- Coppice/seeding or planting are mixed stands that most probably also include plantations that partly have failed, and there other broadleaved species have developed. Stocking and growth is low, and parts of this group should be subject for management interventions with the objective of re-establishing the growth potential;

- Coppice forest 115 800 ha) is forest that during a long period of time have been subject to harvesting of firewood using very short cutting cycle, often as short as 5-7 years. This intensive harvesting, giving little possibilities for the stands to recover, has resulted in many degraded forests with low stocking and slow growth rates (average 27.2 m^3/ha, growth 1.3 m^3 per ha and year. The situation in private forests are slightly better than in public forests;

- Coppice with standards are forest that have been subject to more careful management practices and, with good future management, have a future potential of producing not only firewood but also industrial wood. As for coppice forest, private forests are higher stocked and growths better than public forests.

5. ASSESSMENTS OF HARVESTING PRACTICES

On the area surveyed the (379 200 ha) a control was made whether the harvesting operations were conducted properly or not. The results of these assessments are summarized in the following three tables. The first table (14) presents the areas on which harvesting is considered to be out of control, i.e. trees are not stamped, harvesting operations have resulted in damages on remaining trees, etc.

Table 14. Uncontrolled harvesting on surveyed areas per category of owner (ha).

Ownership	Total surveyed forest area (ha)	Uncontrolled harvesting out of total area	
		Ha	%
Public	202 800	81 000	40
Private	176 400	50 600	29
Total	**379 200**	**131 600**	**35**

On public forestlands 81 000 ha, or 40% of the area surveyed, has been subject to uncontrolled harvesting. On private forestlands the situation is slightly better (29%), but is far from satisfactory. If the situation is similar on areas not surveyed, a total area in the order of 170 000 is subject to uncontrolled harvesting activities.

Because of comprehensive illegal logging and in many cases improper harvesting technology, in large volumes of commercial wood is left on ground resulting not only in loss of fiber but also creating risks of comprehensive damages from insect attacks. Table 15 summarize the volumes of salvageable and not salvageable volumes left on ground on the area surveyed (379 200 ha) for trees >7 cm (34. 6 million m^3, see table 11)

Table 15. Volumes of salvageable and not salvageable dead trees >7 cm in percent of surveyed volumes (1000 m^3).

Condition of trees	**Public forest**		**Private forest**		Average (%)
	Volume	% of total surveyed volume (20 715 m^3)	Volume	% of total surveyed volume (13 849 m^3)	
Salvageable	460	2.2	89	0.6	1.6
Not salvageable	701	3.4	644	4.7	3.9
Total	**1 161**	**5.6**	**733**	**5.2**	**5.5**

In average 5.5% of the total volume on surveyed areas (379 200 ha) corresponding to one tree out every 18 trees are dead trees. This is a very high figure and to a great extent the result of uncontrolled harvesting activities (table 14).

The next table (16) summarizes various damages on the standing volumes

Table 16. Damages on standing volumes >7 cm (1 000m^3). Surveyed area

Tree species	Type of damage									Total	% damages of total
	No damage	Insects	Fungus	Fire	Animal	Weather	Human impact	Supression	Misc.		
Quercus ssp	8 675	338	168	134	26	153	99	64	18	9 675	10
Fagus ssp	13 532	268	1 010	41	2	334	430	143	203	15 963	15
Other broadleaves	3 014	24	352	23	1	79	94	7	111	3 705	19
Abies alba	1 164		69	12		82	246	4		1 577	26
Picea abies	1 169		45			43	145			1 402	17
Pinus ssp.	1 660	32	56	75		79	114	1	2	2 019	18
Other conifers	179					9	35			223	20
Total	29 393	662	1 700	285	29	779	1 163	219	334	34 564	15

As average 15% of the total standing volume of trees on the surveyed area (379 200 ha is damaged. With all international standards, this is a very high figure. The following comments to the figures can be made:

- 10% of quercus species are damaged by insects (most frequent), fungus and through forest fires;
- 15% of the beech forest is damaged. Human impacts and weather conditions has also resulted in secondary damages (fungus);
- Also other broadleaved species are damaged (19%) by fungus, weather and by humans;
- Most serious damages are on stands of Abies Alba (26%) and Picea Abies (17%) and other conifers (20%). The main cause of these damages is related to the impact of humans (impropriate/uncontrolled harvesting). So far, only damages by from fungus are notified. This is in some contradictions to what can be seen in forests in Western parts of Kosovo dominated by these species;
- 18% of pine forests are also damaged. As for other conifer species the main cause seem to be human interventions;
- Damages by animals seem to be less frequent

The information in the tables 14, 15 and 16 clearly shows the needs of a better control of forest management, and the introduction of appropriate methods and technology for forest operations. According to expert opinions most serious damages are in coniferous forest. Secondary damages in form of comprehensive attacks from insects are now visible.

The current situation is alarming, and confirms expert opinions that management and supervision of forestry in Kosovo to a great extent is out of control of the government authorities. If no strong and immediate actions are taken the survival of the entire forest resource base is put at risk, at least in western parts of Kosovo, which areas are dominated by coniferous forest. In addition to training, awareness rising, etc. an immediate action must be to, by using all legal means, enforce the implementation of the Law on Forest (2003) which define the standards and systems for sustainable forest management.

6. RECOMMENDED HARVESTING LEVELS, CONCLUSIONS

6.1 Recommended annual allowable harvesting

Harvesting levels are often discussed in terms of potential and allowable harvesting. Calculations of potential harvesting bases on factors as increment and age structure and is calculated with the objective of maintaining a sustainable forest, while in setting the allowable harvesting target also the long-term development objectives are taken into consideration. The difference between the potential and allowable harvesting will, thus, constitute a safety margin but also showing the decision of a government to invest in increasing the forest resource base.

In table 12 the annual increment of trees with a diameter of more than 7 cm on areas surveyed (379 200 ha) has been calculated to 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 calculating the 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 all trees above 25 cm on high forest, and all trees above 15 cm on low forest are considered as mature or near mature, and the trees will be harvested over a 40 year period (harvesting cycle), the following estimates of annual allowable cut can be made:

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

It is important to be aware that these figures refer to the gross total volumes including bark, large branches, tops and other losses. The merchantable volumes will thus be substantially lower. Another obstacle is the fact that harvesting has concentrated to most accessible areas, which means that for using the potential future harvesting has to concentrate on the less accessible areas.

In order to provide more specific figures per category of owner and per species group table 17 presents a break down of the above overall harvesting targets on ownership and species. The estimates are based on the following assumptions:

- The total annual allowable harvesting is rounded to 900 000 m^3, corresponding to 77% of the increment on areas surveyed (see table 12);
- The overall allowable harvesting has been distributed on species and ownership by using deduction factors varying between 0.50 and 1.00;
- Extent of damages (see table 16);
- Needs for cutting dead/dying trees are not included. All other forms of sanitary cuttings are included;

Table 17. Distribution of annual allowable harvesting by specie and ownership, >7 cm (1 000 m^3). Surveyed area.

	Public forest			Private forest			Total net volume
Specie	**Gross**	**Factor**	**Net**	**Gross**	**Factor**	**Net**	
Quercus ssp	99	0.50	50	290	0.55	162	212
Fagus ssp	320	1.00	320	116	1.00	116	436
Other broadleaves	75	0.85	64	76	0.85	65	129
Abies alba	73	0.50	36	7	0.80	6	42
Picea abies	27	0.50	13	16	0.80	13	26
Pinus ssp.	60	0.80	48	1	1.00	1	49
Other conifers	6	0.75	5	1	1.00	1	6
Total	**660**	**0.81**	**536**	**507**	**0.72**	**364**	**900**

Comments:

- In low forest Quercus is the dominating specie. These forests, both public and private, seem to have been subject to heavy cuttings (short cutting cycles and with concentration to the largest trees). For this reason the harvesting should be well below anticipated growth. Concentration should be on pre-commercial thinning in over-dense stands;
- Many young and middle-aged beech forest is over-dense, and in needs of thinning. For this reason during a coming 5-10 years period it is recommend that the harvesting target should be close to the projected growth;
- Other broadleaves include a mix of both valuable and less valuable species. To promote quality development harvesting shall always concentrate on the less valuable species;
- Abies alba and Picea abies forests have been subject to heavy damages. Harvesting must concentrate on thinning young over-dense stands, and harvesting operations aiming at preserving heavily damaged forest;
- Pine ssp and other coniferous are concentrated to public forestlands, either as mixed stands or as pure stands (plantations). Harvesting shall concentrate on thinning of over-dense plantations (mainly Pinus Negra). The total area of plantations is not fully visible in the inventory results. For this reason it is not possible to make detailed harvesting projections.

In the above calculations the anticipated annual allowable harvesting is set to 900 000 m^3. By adjusting the individual deduction factors in table 17, or by applying a common reduction factor on all individual deduction factors, the overall harvesting volume can be adjusted upwards or downwards.

6.2 Conclusions, recommendations

The following sections summarize the main findings and conclusions elaborated through the project activities.

Fieldwork

- The actual data collection could have been preceded by a concentrated period for all the field teams of more consorted drilling the definitions and testing the field instruction covering the different forest conditions e.g., the suspiciously low area of other wooded land indicates that this could have been appropriate;
- Contacts with professionals in other countries would be essential to bridge the gap created in professional experience and knowledge during the two last decades. A follow-up project in management planning including training, possibilities for graduate-level studies abroad for selected forest engineers, and participation in shorter courses and seminars, would be necessary;
- The field workers were allocated from KFA regional offices, and have to split their work between some regularly tasks and the inventory work. Availability of suitable vehicles was also a problem. These personnel and logistic problems created some delays of the entire project. For further planning activities it is recommend to establish to a team of experts under the supervision of KFA's central unit for planning

Establishment of permanent capacity for planning and inventory

In the future, forest inventory capacity is needed both for management planning and for national resource monitoring (forest inventories). Prior to the project, only two professional foresters active in Kosovo had experience with inventory work. Also the material resources are scarce. This supports the combination of the two activities into one organization.

A Forest Planning/Inventory Specialist within the KFA could have responsibility for organizing, supervising, and training in forest management planning, and to compile plans and calculate sustainable harvesting levels and needs for silviculture. A database manager/programming specialist could develop a forest information system, including information on forest growth and yield. Financing of future national resource assessments must be covered by the budget of the MAFRD. This would install capacity to produce site-specific information for operational management at the property level. Such information is valuable for the forest manager to manage the forestland in an economic and environmentally sound manner. Key recommendations are:

- Build and maintain capacity in selected aspects of forest inventory by identifying a few candidates to receive formal post-graduate education and further training;
- Support the second leg of building capacity for forest inventory in two stages: 1) Introducing GIS in forest management and planning and 2) a pilot project on developing cost-efficient forest management planning. This would entail financial and/or technical support from a donor and countries in the region;
- Secure sufficient budget funds for maintaining and building capacity for forest continuous inventories. To keep the data bas updated and to control the real harvesting level, it is recommended that about 20% of the sample plots should be re-inventoried every year;
- In the short-term, identify support resources in Kosovo for data management and analysis, especially in programming and statistics;

- Complete the forest inventory by include/exclude sample plots on steep terrain and decide about how to handle the situation with uncollected sample plots in N Mitrovica and organize re-inventory of sample plots with the main objectives of following up actual annual harvesting on a Kosovo level, damage control and increment;
- A coming project on Forest Management Planning shall among other tasks (i) establish appropriate links to the inventory work, (ii) establish a computerized map data base using ARC View (or similar software) and new aerial photos covering all of Kosovo, and (iii) transfer inventory sample plots to this new map material;

Inventory results

In addition to the comments presented under the tables 1-17 the following key issues would require specific attention:

- The area of private forestlands is much larger than previous estimates. For this reason it is recommended, in cooperation with the Cadastral Agency, to analyze the reason for the deviation and establish firm figures;
- Compared to plantation records areas of plantations are small. The reasons might be under-representation in the inventory data (too few plots allocated) and that some plantations are in bad condition and for this reason are classified into other stand origins. To elaborate more precise data it is recommended to conduct a specific survey of all plantations in Kosovo;
- Inventory data shows a lot of natural regeneration. For this reason plantation should be concentrated to barren land of reasonable good quality and where the survival of the plantation is not put at risk due to external factors, and in case of change of species or destination;
- The results confirm expert opinions that coppice forests are exposed to heavy cuttings. This is especially true for public forests. To change ongoing practises, and to commence a rehabilitation of these forests, the government through KFA must take a special responsibility. Key actions must include stronger control, awareness rising/campaigns, involvement of local communities and private persons in managing these forests. The main areas of this stand origin are located in central parts of Kosovo, and in the selection of stands priority shall always be given to stands growing on fertile soil and with possibilities of developing into high forest;
- Many young and middle-aged forests are in an urgent need for interventions ranging from pre-commercial thinning/cleaning to commercial thinning. The work is labour intensive and KFA seem not to have the capacity for managing these operations, nor the full knowledge about most suitable management regimes to be applied. KFA staff involved would need training and financial support must be made available from the ministry budget;
- The annual allowable harvesting has been calculated to 900 000 m^3, which corresponds to 77% of the predicted growth on the area surveyed (379 200 ha). However, this volume cannot be achieved without a change of the current harvesting practices. Compartments must be completely treated i.e. the intervention shall include all dimensions, and all wood (tops, larger branches) must be taken care of;

Assessment of forest damages

The extent of forest damages is alarming. The damage survey shows that harvesting activities are out of control on 30-40% of the area surveyed. Too much wood is left on ground and the risks for large scale insect attacks are obvious. The situation seems to be

very critical in conifer forests in the Western parts of Kosovo. During many years this area has been subject to comprehensive illegal and unsustainable logging, and if no strong actions are taken the entire existence of thousands of hectares of high productive forest is put at risk in this region. The actions must include immediate implementation of sustainable harvesting practices and the set up of a health control/monitoring program.

ANNEX I: List of Project Personnel

International consultants

Team Leader/	1st mission:	13 February – 14 April 2002
Inventory Expert:	2nd mission:	4 June – 23 July 2002
	3rd mission:	22 September – 05 October 2002
	4th mission:	11 October – 18 October 2003
	5th mission:	8 December – 17 December 2003
Forest Management-/	1st mission:	1 April – 9 June 2002
Training Expert:	2nd mission:	15 August – 25 September
	3rd mission:	25 June – 11 July 2003
	4th mission:	29 September – 10 October 2003
	5th mission:	7 December – 18 December 2003

National staff

Ergin Hajredini, Deputy Team Leader, (forest engineer) April 2002 – December 2003
Ibrahim Muja, Forest Management/Photo Interpretation Specialist, (forest engineer). September 2002 – June 2003
Ardiana Zhuri, National Consultant, GIS, (Agriculture Specialist, on maternity leave) May 2002 – August 2002
Kemajl Kadriu, Database operator (forest engineer) May 2003 – October 2003
Albert Llunji, Driver
Bekim Latifi, IT System Manager, FAO Office
Bekim Kajtazi, GIS Specialist, Illyrian Group (20 man-days consultancy)

Professional personnel on short-term training services contract

Hysen Shabanaj, Forest engineer, KFA, Assessment of Forest damage (4 days)
Adnan Basha, Forest Engineer, KFA/Forest Institute, Peja. Assessment of Silviculture (9 days)
Fatos Mulla, Forest engineer, KFA/Forest Institute, Peja. Non-wood Forest Products (2 days)
Muharrem Bahor, Forest engineer, KFA Mitrovica (trainer up to 14 days in K-S dominated areas)

Fieldworkers

K-S-dominated areas:

Maximilian Sekulic	Forest Engineer	Mitrovica region
Slobodan Jelenic	Forest Technician	Mitrovica region
Murat Bahor	Forest Engineer	Mitrovica region
Vladica Colic	Forest Technician	Mitrovica region
Ivan Radovic	Forest Technician	Mitrovica region

K-A-dominated areas:

Faik Kadriu	Forest Technician	Pristina, Pristina region
Mehdi Berisha		Pristina, Pristina region
Hajriz Hajrizi	Forest Technician	Vuhsstri, Mitrovica Region
Ramadan Salihu	Forest Technician	Vuhsstri, Mitrovica Region
Rrustem Dautaj	Forest Technician	Decan, Peja region
Beqe Mehmetaj	Forest Technician	Peja Forest Institute
Mustafe Veseli	Forest Technician	Gjilan, Gnjilan region
Zair Maaloku	Forest Technician	Ferizaj, Ferizaj region
Jeton Krasniqi		Prizren, Prizren region
Fitim Hoxhaj	Forest Technician	Prizren, Prizren region

ANNEX II: List of Inventory Equipment

Equipment	**Pcs.**
Calliper, Mantax aluminium 65 cm	8
Diameter measuring tape (3 m)	8
Skogma relascope with interchangeable gauge, factor 1, 2 and 4	8
Increment borer, 200 mm (Mattson)	8
Replacement extractor, 200 mm	
Increment borer, 400 mm (Mattson)	8
Replacement extractor, 400 mm	
Increment borer, 500 mm (Mattson)	8
Replacement extractor, 500 mm	
Measurement line (30 m)	8
Suunto hypsometer with prism	8
Suunto tandem clinometer, compass w/ protective cover	8
Loggers tape (Sandvik, 20 m)	8
Bark Gauge (Hagloef)	8
Magnifying glass	
Silva Ranger 15 T Compass 360°	8
Cruiser vests	15
Binoculars WE-KA 8x21, 131/1000m	6
Camera Canon Prima BF-800	5
GPS hand-held receiver (Garmin 12 XL)	8

ANNEX III: Inventory methodology

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. 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 assessments. 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 centers 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 sub-sample 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.

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 program, 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 functions exists 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 these assessment it 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.