Scanagri	NFG NORWEGIAN FORESTRY GROUP	***Përkrahje arsimimit dhe trajnimit në lëminë e pylltarisë në Kosovë*** ***Podrška obrazovanju i nastavi o šumarstvu na Kosovu*** ***Support to Forestry Education and Training in Kosova***	Financed by Sida

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INTRODUCTION TO FORESTRY

A brief manual for the Vocational Education, Forestry, in Kosova

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Preface

The present text is intended to give a broad overview of the various activities in forestry.

This booklet gives the main headlines and only a very few details. The teachings in each subject will fill the many gaps in this text and then gradually the students will achieve a good and professional knowledge and practical skill in the very exciting and challenging profession called forestry.

At the same time, hopefully the students will be able to ask questions of why are things as they are.

Can things be done in a different and better way?

How can methods and equipment be modernized?

How can the illegal felling be minimized?

How can the administration and the forest management be improved?

How can the general understanding of the importance of forestry be improved?

How can the communication between people be improved?

What are the goals to aim at when working with forestry?

1 People and forest

Forestry is the science, skills and activities related to the human utilisation of the big plants called trees and the land on which they are growing. This implies that there are two main components in the art of Forestry, the human beings and the trees.

A professional forester must have basic knowledge about these two main topics, plus a great number of details in each topic. The professional forester could be a forest owner, a forest worker, the tractor and truck driver, the entrepreneurs, the administrators, the public forest service, the law makers, the researchers and the teachers. They are all professionals but have different fields of specialisation.

The interaction between people and forest is basic for survival for both parties. People have found that forests are basic for the life and elementary socio-economic demands are covered there. On the other hand the forests have also an advantage of the people as it may imply carefulness, protection, proliferation of new sorts. However, too often one has experienced that the carefulness and protection of the forest have been neglected by people. The result of careless utilization of the forests is destruction the human environment in smaller or bigger areas.

It is a generally accepted fact that the forests and the trees survive and live quite well without the human beings, but the humans are to a great extent dependent upon the forests and the trees. Each individual person cannot fully utilize the forest and the trees alone; we have to organize our activities.

Therefore the art of forestry to a great part is the art of human communication and cooperation between individuals and groups of people. If this does not function well, there will be misunderstandings, over utilisation, waste of resources, unskilled management of the forests and serious ecological problems to the organisms, to the soil and the land on which we live.

Not all people are dealing with forests; many don’t know anything about the forest. But the forests are resources that play a main role for our life and development, and therefore people should get more information about forest and forestry. The problems with illegal felling of trees in some parts of Kosova, is to a great extent due to lack of positive communication and understanding between people. The problem cannot be solved as if it is a technical problem alone; it is a human problem and has to be treated accordingly

As can be read below, Kosova has very rich and important renewable resources in the forests. The forests have a very good production and extremely good conditions for natural regeneration in most places. It is therefore a privilege and a great challenge to work as a professional forester in Kosova, working with both people and with the trees in nature.

In order to ease the communication and reduce the misunderstanding between people, we very often use the scientific names on trees and other plants. The name of a pine tree has a number of local names such as pisha (Albanian), furu (Norway), beli bor (Serbia), tall (Sweden), scots pine (Great Britain etc). The scientific name however is *Pinus sylvestris*. This name is given to this plant according to an internationally accepted botanical system. The name is not misunderstood or confused with any other plant or living organism.

2 Organic production and decomposition

The photosynthesis – production of organic material
The process which goes on in all green plants, the photosynthesis, is by many scientists regarded as the world's most important chemical process. The green colour of the plants i caused by the *chlorophyll*. The chlorophyll enables the plants to utilize the solar energy for building up the plant itself. The production of the bark and wood and fruits of a tree or the grass, carrots potatoes and rice etc, also called organic material, depends upon the photosynthesis where the solar energy is utilised for producing organic material. The plants need the chlorophyll in their leaves in order to utilize the solar energy in this process. In addition the plants need water and carbon dioxide for the production of organic material. Carbon dioxide is a gas which also is being used in soft drinks and beer to make it sparkle and taste refreshing.

The photosynthesis process can be written in a simple form like this

$$\text{Water + Carbon dioxide + solar energy} \longrightarrow \text{Organic material + oxygen}$$

The plants need water for their production of organic material (carbohydrates). If they do not get water, they will die sooner or later. The chemical formula for water is H_2O

The plants need carbon dioxide for their production. They get this from the air. If they do not get carbon dioxide, they will die sooner or later. The chemical formula for carbon dioxide is CO_2

The plants need light for their production of organic material. If not, they will die sooner or later. An abbreviation for this energy can be E

When the plant is producing, it will build up organic material, it will grow.
A simplified formula for organic material can be $C_6H_{12}O_6$ This is also called glucose and is one form of sugar.

The plant also produces oxygen which is emitted into the air. The chemical formula for oxygen is O_2

The process or the photosynthesis can be written in this shorter way, when we know the abbreviations or chemical formulas.

$$H_2O + CO_2 + E \longrightarrow C_6H_{12}O_6 + O_2$$

Respiration and decomposition
All animals and all people are unable to utilize the energy from the sun, like the plants do. The animals have to get their energy by eating organic material made by plants and decompose it in order to release the stored energy.

This process is in principle the reverse process of the photosynthesis and can be written like this:

$$C_6H_{12}O_6 + O_2 \longrightarrow E + H_2O + CO_2$$

The animals eat organic material and get oxygen from the air. The released energy is being used for the functioning of the animal, such as movement and keeping the body temperature correct etc. In the process, water H_2O and carbon dioxide CO_2 is produced.

The same basic process takes place when firewood is being burned. The organic material is the wood while the oxygen comes from the air. Energy is released as a fire with a quite high temperature. In this process water H_2O and carbon dioxide CO_2 is produced and released to the air.

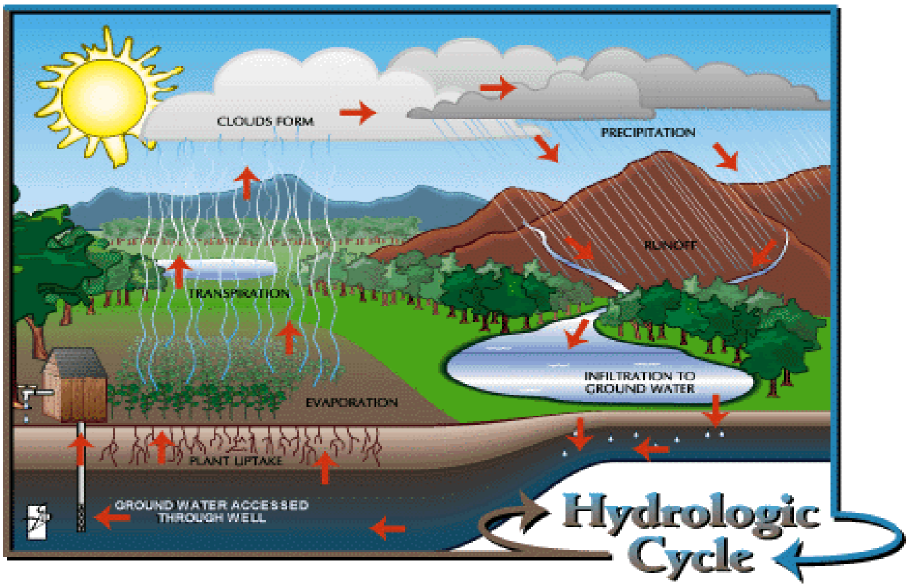
3 Factors for growth

The factors for growth imply all no-living environmental factors which have implications on the growth for plants and forests. These factors for growth are commonly subdivided in two groups, climatic factors and edafic factors:

3.1 Climatic factors

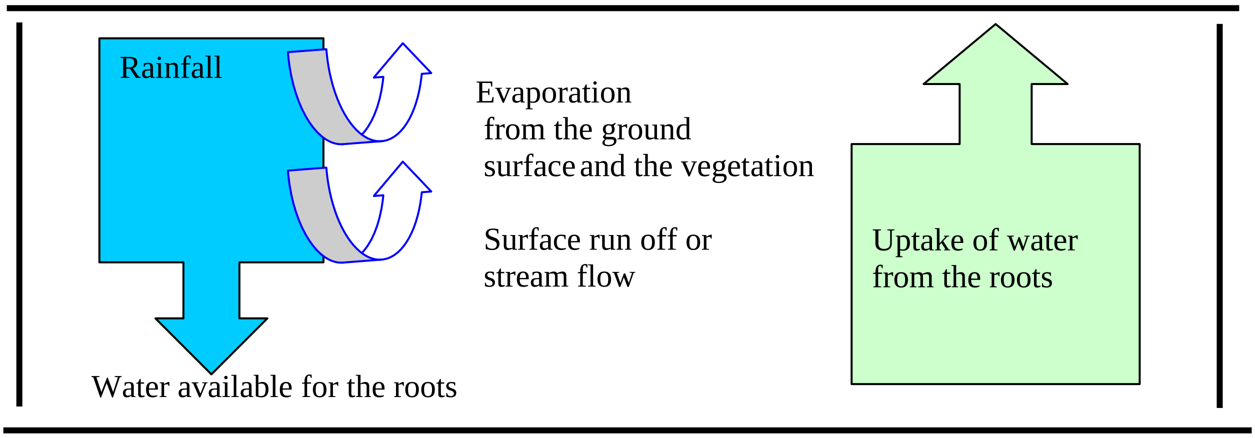
Water is moving in an eternal cycle, powered by the sun and the gravitation. The water evaporates from the soil, from the ocean and lakes and goes to the air where the clouds are created by tiny small drops of water. When the temperature changes to a lower level, the tiny drops of water in the clouds are becoming fewer and bigger and they fall down as rain. If the temperature is below 0^o C it will fall down as snow or hail. Rain and snowfall is very often also called precipitation.

The rain falls down on the ground and penetrates the soil and also runs off in streams and rivers until it eventually reaches the lakes and the ocean. The sun will in turn make it evaporate again and the hydrologic cycle continues.



The water which is utilized by the trees and plants, comes from the rain or snow and in the high mountains also from fog. To become available, the water must in most cases infiltrate the ground so it can be reached by the roots.

The water balance of the hydrologic cycle can be illustrated like this



In a simplified way we can state this equation:

Rainfall / precipitation
- (minus) evaporation from the ground and the vegetation
- (minus) surface run off and stream flow
=
water uptake available for the roots

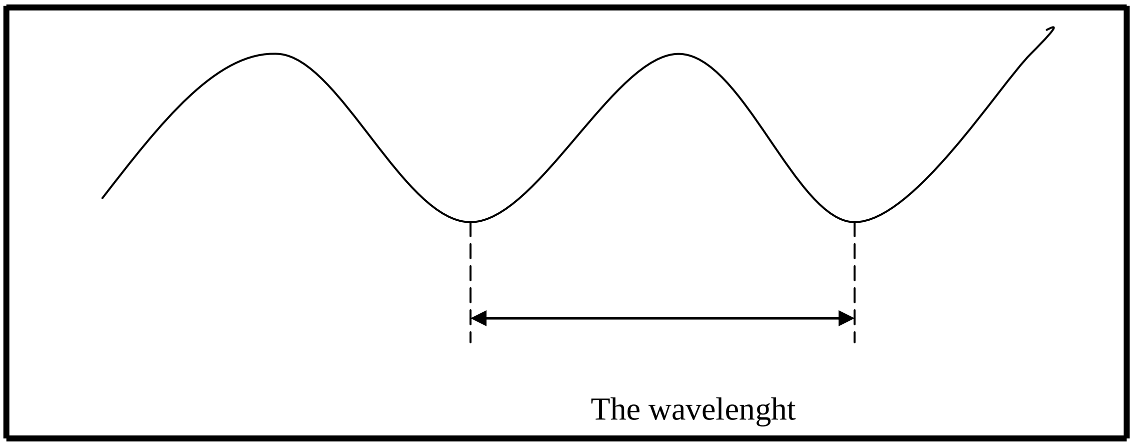
The different species of trees have different need for water. Some tropical trees like Acacia species can manage with extremely little water. Many *Pinus spp* , the *Juniperus communis* and some *Quercus spp* species are also very tolerant to dry conditions. Other trees like *Betula spp. Alnus spp.* and *Populus spp* need more water for their survival and production.

The air always contains sufficient amounts (0.038%) of carbon dioxide (CO_2) and this factor cannot be changed easily although the amount of carbon dioxide in the atmosphere has increased during the last decades.

Wind is however an important factor for growth. The winds will always affect the standing trees and sometimes limit their growth. Strong winds can in some cases cause the whole tree to turn over. Some species are very strong and resistant to storm, such as some *Pinus spp*. *Betula spp* and *Juniperus communis*. Other species are more vulnerable and are more easily windblown such as *picea abies*, and *Abies alba*. The various species have different abilities to resist strong wind and storms.

Light is the driving force for any green plant because the light is their only source of energy. The radiation of light comes directly from the sun or indirectly reflected from the sky, from clouds, from water surfaces and also neighbouring plants.

The sunlight is also called electromagnetic waves. These waves have different wavelengths. The wavelength is the distance from one top of a wave to the next one. This span of different wavelengths in the electromagnetic radiation is called the spectrum. When the wavelength is within the visible spectrum it is known as "visible light." The range of wavelengths human eye can perceive is approximately from 380 nanometers (nm) to 740 nm,



The colours of the visible light spectrum

Colour	wavelength interval
red	~ 625–740 nm
orange	~ 590–625 nm
yellow	~ 565–590 nm
green	~ 500–565 nm
cyan	~ 485–500 nm
blue	~ 440–485 nm
violet	~ 380–440 nm

The unit **nm** is called nanometre and is the distance of one thousandmillionth part of a millimetre or 1/1000 000 000 of a millimetre. This is a quite short distance. See the below table:

Multiple	Name	Symbol
10^{0}	Metre	m
10^{-1}	Decimetre	dm
10^{-2}	Centimetre	cm
10^{-3}	Millimetre	mm
10^{-6}	Micrometer	µm
10^{-9}	**Nanometer**	**nm**

The visible light of different wavelengths are detected by the human eye and then interpreted by the brain as colours, ranging from red at the longest wavelengths of about 740 nm to violet at the shortest wavelengths of about 380 nm. The intermediate vawelenghts are seen as orange, yellow, green, and blue. The colours are those we can see in the rainbow.

UV 380 nm 740 nm IR

The wavelengths of the electromagnetic spectrum immediately outside the range that the human eye is able to perceive, are called ultraviolet (UV) at the short wavelength (high frequency) end of the spectrum and infrared (IR) at the long wavelength (low frequency) end. Some animals, such as bees, can see UV radiation while others, such as pit viper snakes, can see infrared light. Some cameras can also "see" and record infrared light and ultraviolet.

The various wavelengths carry different energy. The shorter wavelength, blue and violet have the most energy, while the longer wavelength from green and onwards to red has less energy. The plants therefore utilize the blue and violet colours / wavelengths because that gives them the most energy. The green colour is therefore reflected from the chlorophyll in the leaves, the plant does not need this colour. That is the reason why we see the plants as green. The yellow and red wavelengths are also reflected but the green is dominating, and therefore we see the green leaves, even if it is a mixture of colours.

If the plants do not get enough light, they do not get enough energy for living and they will die. A plant can not survive on a place where there is no light. On the other hand, some plants have been adapted to a life in places with very little light and they may die if they are exposed to too much light.

Some forest trees are adapted to live on places with very much light and others are adapted to more shade and less light.

The temperature is measured in degrees Celsius often written as ^oC. 0^oC is the freezing point of water and 100 ^oC is the temperature when the water is boiling at sea level. Water is boiling at lower temperatures in high mountains because of the lower air pressure in the atmosphere.

The lowest possible temperature is – 274 ^oC, but there is no upper limit for temperature. For the plants and the forest trees, the temperature during the growing season in the summer is the most important. It seems that the optimum or the best temperature for the forest trees is in the range of 5 – 30^o C. When the temperature is low the growth slows down and the trees normally do not grow when the temperature reaches 0 ^oC. The trees in Europe have normally no problems in surviving frost, but they do not grow, they are just taking a rest, waiting for the next summer. If the temperature rises too high, it may cause damage to the cells and leaves and they will eventually die. The different trees species have different tolerance for high and low temperature and they therefore also have different optimum (best) temperature for growth.

3.2 Edafic factors.

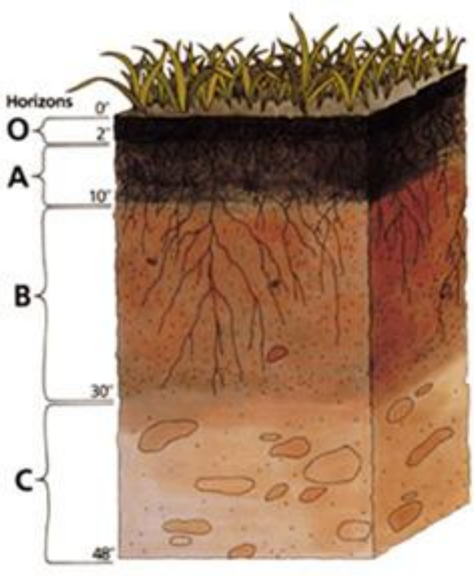
The bedrock contains several minerals which are nutrients to the plants. When the rocks and stones slowly are eroded into small particles, the minerals become available to the roots of the plants. The plant and trees need these nutrient minerals as building material in the plant itself and for making flowers and fruits.

Bedrock of granite and gneiss are hard and poor rocks and contain small amounts of minerals. The soil made from the erosion of this kind of rocks therefore is poor and the plants will grow very slowly.

Some sediments and also limestone contain large amounts of calcium and other minerals which are important for the plants. The soil from the erosion of this kind of rocks therefore is rich and the plants will grow fast.

Some are adapted well to the poor soils and some are adapted to the richer soils. *Fagus spp* normally needs rich soils while *Pinus spp.* and *Juniperus communis* normally can grow well on poor soils

The soil is made from the eroded bedrocks. Therefore the soil reflects the mineral content of the original bedrock. This sort of soil is called inorganic soil as it contains no organic components. The organic componets are developed gradually from rotting leaves, roots and other parts from plants An example of a soil profile is shown below:



O) Organic matter: Litter layer of plant residues in relatively undecomposed form.
A) Surface soil: Layer of mineral soil with most organic matter accumulation and soil life. This layer eluviates (is depleted of) iron, clay, aluminum, organic compounds and other soluble constituents. When eluviation is pronounced, a lighter colored "E" subsurface soil horizon is apparent at th base of the "A" horizon.
B) Subsoil: Layer of alteration below an "E" or "A" horizon. This layer accumulates iron, clay, aluminum and organic compounds, a process referred to as illuviation.
C) Substratum: Layer of unconsolidated soil parent material. This layer may accumulate the more soluble compounds that bypass the "B" horizon.

The plants need a mixture of different minerals for their growth, but some of them are needed in small quantities only. These are called microelements and are listed below. Some minerals are needed in larger quantities and are called macro elements

Macro elements	**Microelements**
Carbon C	Iron F
Nitrogen N	Copper Cu
Phosphorus P	Manganese Mn
Sulphur S	Boron B
Potassium K	Molybdenum Mo
Magnesium M	Chlorine Cl
Calcium Ca	

With the exception of nitrogen N and carbon C, the macro elements normally come from the bedrock. If the soil is poor, various macro- and micro elements can also be supplied by fertilizers. In agriculture this is quite common to apply fertilizer containing N, P and K.

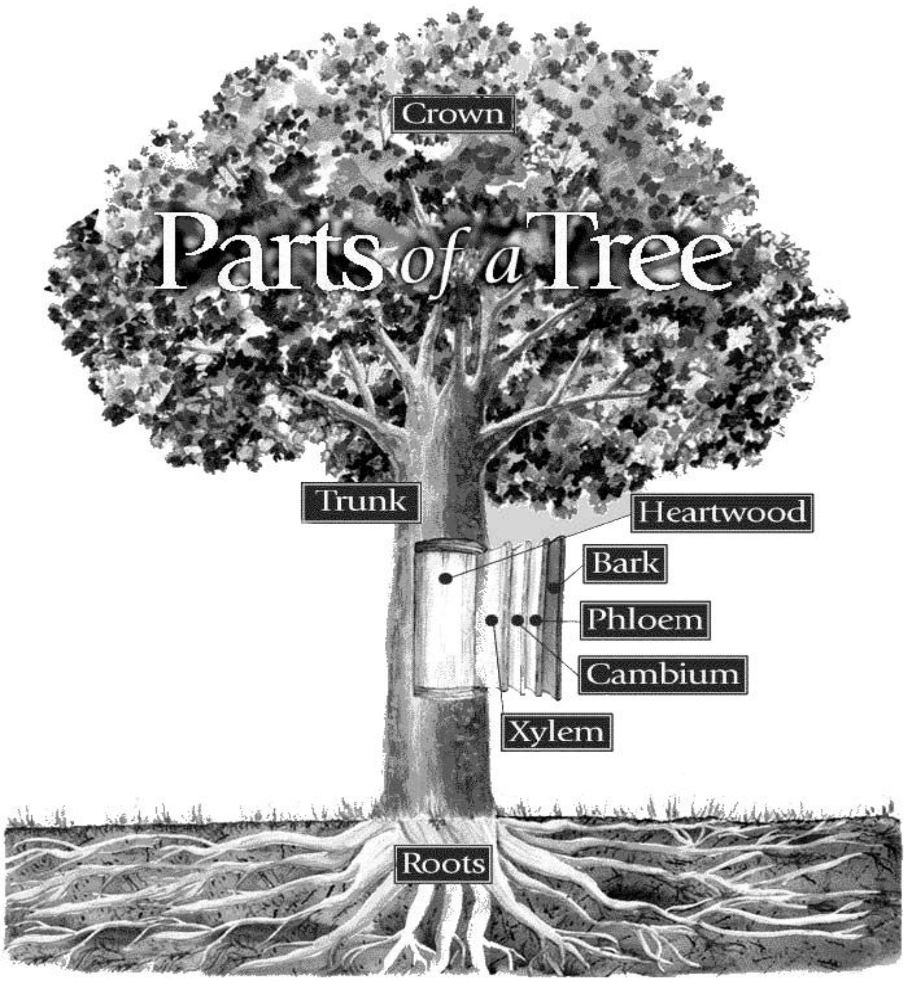
If the plants do not get the necessary nutrients, they will suffer and grow slower and they very often have visible symptoms of lack of one or more minerals.

Humus is organic soil, and originates from decomposed parts of plants and dead animals. The plants and animals are decomposed by fungi, by bacteria and by other micro organisms. A thick layer of humus mixed with rich inorganic soil is a good basis for plant production.
A thin or missing layer of humus on the top soil is, on the other hand, normally a poor site for plants to grow. Some plants have adapted to living on poor sites and other are adapted to the richer soil.

The wood production in a forest is much determined by the quality of the soil and humus. In most countries the foresters have made systems for classification of the different types of soil. This classification is directly linked to the potential production of wood.

4 The tree

A tree is a woody plant that usually is more than 3 meters tall and has one main stem. Although trees have different shapes and sizes, the all have the same basic parts. Each of these parts, from the highest leaves in the crown to the tiny rot hairs buried in the soil, play an important role in the trees function and survival.



4.1 The stem (trunk)

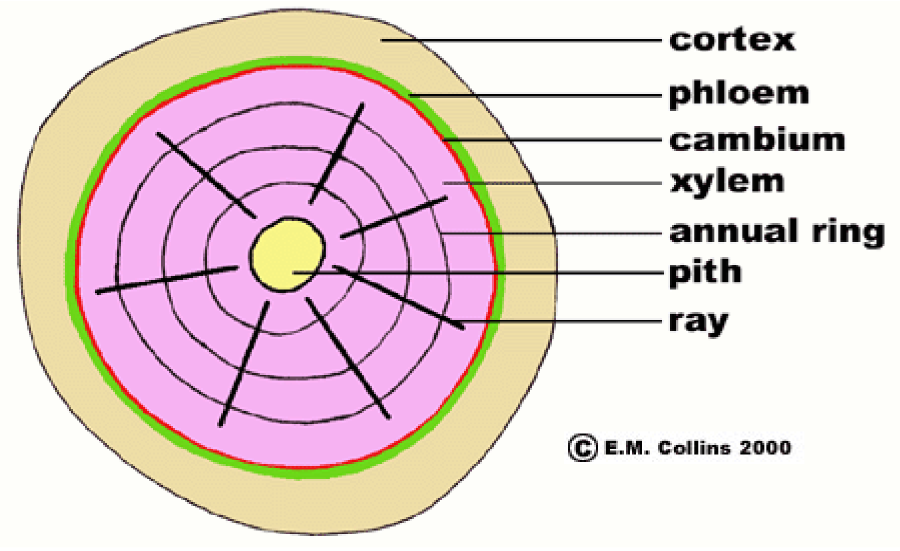
It consists of heartwood which is the dead wood of the stem, of sapwood which is the living wood (*xylem*), the *cambium* and the bark.

The heartwood is the older part of the wood and consists of dead cells. Its function is only to strengthen the stem. The cells in the heartwood are very often filled with resin and oil, which makes it very rot resistant. This resin has a darker brown and sometimes black colour and makes the wood very attractive for various purposes such as furniture and other carpentry. The heartwood of *Juniperus communis* is extremely rot resistant.

The sapwood (*xylem*) provides transport fort the tree sap (= water plus nitrogen and minerals) which is carried up from the root to the leaves / needles.

The cambium is a layer of cells inside the inner bark. It is found in between the sapwood and the bark. The cambium produces both the xylem (sapwood) cells and the *phloem* (= inner bark) cells. The cambium layer is responsible for increases in tree diameter, by creating annual rings, and responds to injury by producing callus tissue Each year a tree essentially grows a new "coat of wood" over the older wood. This is where the growth in diameter occurs and where the *annual rings* in the wood and the bark is formed. The annual rings found in tree stems are the result of variations in growth rate and in the type of wood produced early and late in the growing season. The annual rings are also reflecting the actual weather conditions every year; with a favourable summer, the rings will be wider. When counting the rings we can determine the age of a tree. Many trees are hundreds of years old, and a few live thousands of years. Thus the annual rings provide valuable information on climate and conditions for growth.

The bark layer is made up by *dead bark (cortex)* cells and protects the tree from insects and diseases, extreme heat and cold and from injuries.
In the inner bark *(phloem)* layer, the sugar which is produced in the leaves is carried down to the branches and stem and root, where it is converted to starch which in turn can be used by the tree for its growth in all parts.



4.2 The root

The root of the tree supports the stem and crown and it also anchors the tree to the soil where it grows. The root also serves as storage for the organic material produced by the leaves. The root also absorbs water and nutrients from the soil.

Trees' root systems are made up of large, permanent roots (which mainly provide anchorage and transport), and many small, temporary *feeder roots* and *root hairs.* It is these small parts of the root system that are the primary water and nutrient absorbers.

Roots of most species of trees are invaded by soil fungi to form root-fungus structures called **mycorrhizae**. The mycorrhizal association is beneficial to both the tree and the fungus. The tree supplies carbohydrates/organic material and other growth requirements to the fungus, and the fungus increases water and mineral uptake (particularly phosphorus P) of the host tree by increasing the total absorptive area of the root system.

4.3 Tree crown

The crown consists of all the leaves or needles, flowers and fruits and all smaller or bigger branches. One important function of the crown is to carry the leaves in such a way that they are efficient receivers of the energy from the sunlight. The flowers and fruits are almost always found in the crown. The final form of a mature tree is determined by the dominant growth in the crown of some buds and shoots at the expense of others, a phenomenon known as *apical dominance*.

Conifer trees are with few exceptions (*Larix spp.*) evergreen and they have needle shaped leaves. In most conifers the trunk or main stem grows more each year than the other branches, and the branches attached to the stem grow more than smaller branches. This results in a very orderly growth habit that forms a conical tree growth and is very typical on conifer trees as *Pinus spp* and *Abies spp.*

Deciduous trees have green flat leaves which are falling off in the autumn. Most deciduous trees do not show strong apical dominance and therefore typically exhibit less orderly growth. Instead, many shoots grow at the same rate, many branches are developed, and it sometimes becomes difficult to identify the main stem. These species usually have large spreading crowns.

4.4 Regeneration

As all plants, the trees are always producing male and female flowers. Very often the two sexes of flowers grow on the same tree. After being fertilized by the pollen the female flower produces a fruit with *seeds*, bigger or smaller. Very often the seed has wings, as on *Pinus spp* and *Picea abies, Betula spp, acer spp* and others. Sometimes the seed is bigger, like coconuts, walnuts, hazelnuts, oaknuts and others. The seeds are produced in great numbers to secure that at least some of them will survive and become a new tree. The regeneration of trees from seed in this way is called *natural regeneration* and is by far the most common in nature.

This small oak plant is germinating from a seed.

10 years old natural regeneration of Pinus peuce from seed after clearfelling of a small area of older trees. The high stumps protect against sliding snow

The trees can also have *vegetative regeneration.* The new shoots or new small trees are growing up from the roots of a big tree. In fact it is considered to be the same plant as the mother tree. Such regeneration is common for *Populus spp* and *Salix spp*.

In Kosova new shoots are commonly growing from the stump when the original tree is cut. These small shoots are called coppices and the regeneration is called coppice regeneration. Coppice regeneration is quite common for the oaks (*Quercus spp*) The oak however also produce a great number of big seeds which fall on the ground.

These small oak stems are coppices after the main tree has been cut.

Tree planting This practice is designed to establish trees where the existing vegetation is inadequate and on open lands where conversion to forest is desirable and feasible. When there is a general abundance of trees and a richness of native species and where the moisture and fertility of soils are good, the trees naturally regenerate well and tree planting is not necessary.

To produce the forest plants, the seed are collected from mature trees of good quality and sown in a forest nursery. After 2 – 4 years the plant is big enough to be planted in the forest and to survive in natural conditions. This method of securing the forest regeneration after felling of the big trees is relatively costly, but it gives very good quality forest when the production of plants, the planting work in the forest and the subsequent silviculture activities are done professionally.

5 Basic mensuration in forestry

When practicing in the professional forestry there is always a need for measurements for management and other purposes. The measurements give information on the size of a piece of forest land; the volume of a single tree; the total volume in the whole forest etc.

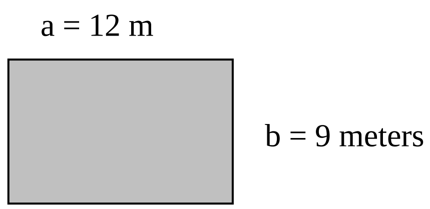
5.1 Units of measurement

To avoid misunderstandings, it is necessary to use the same units of measurement of distance, area, volume etc. The list below gives some basic units of measurement, commonly used in forestry

Distance		
1 m (meter)	=	100 cm
1 m	=	10 dm
1 dm	=	10 cm
1cm	=	10 mm
1 m	=	1000 mm
1 km	=	1000 m
Area		
1 dm^2	=	100 cm^2
1 m^2	=	100 dm^2
1 ar	=	100 m^2
1 decar	=	1000 m^2
1 hectare	=	10 decar
1 decar	=	0,1 hectare
1 km^2	=	100 hectare
1 km^2	=	1000 decar
Volume		
1 m^3	=	1000 dm^3
1 dm^3	=	1000cm^3
1dm^3	=	1 litre

5.2 Area calculation

<u>Area of a rectangle</u>



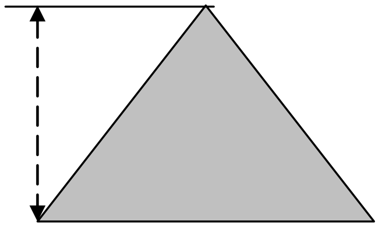
The area A of this is calculated like this:

A = a x b

A = 12 m x 9 m

A = **108 m^2** (square meters)

Area of a triangle



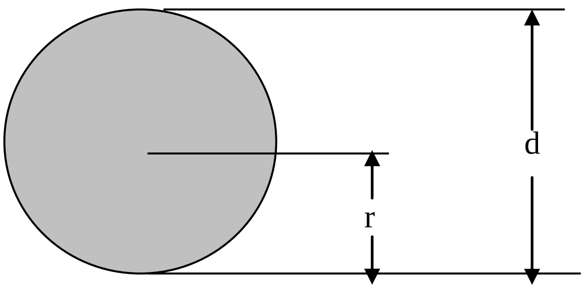
The area of this triangle A is calculated like this:

A = a x b x ½

A = 30 cm x 75 cm x ½

A = **1125 cm^2** = **11, 25 dm^2**

Area of a circle:



The area of this triangle **a** is calculated like this:

$$a = \frac{\pi}{4} d^2 \quad \text{or} \quad a = \pi r^2$$

Example 5.1

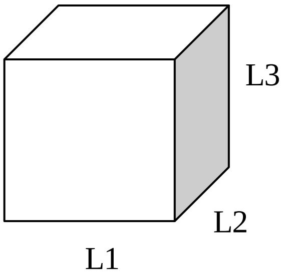
a = ? d = 34 cm i.e. r = 17 cm

$a = \frac{3{,}14}{4} 34^2$ = **907, 92 cm^2**

or

$a = 3{,}14 x 17^2$ **= 907, 92 cm^2**

5.3 Volume calculation



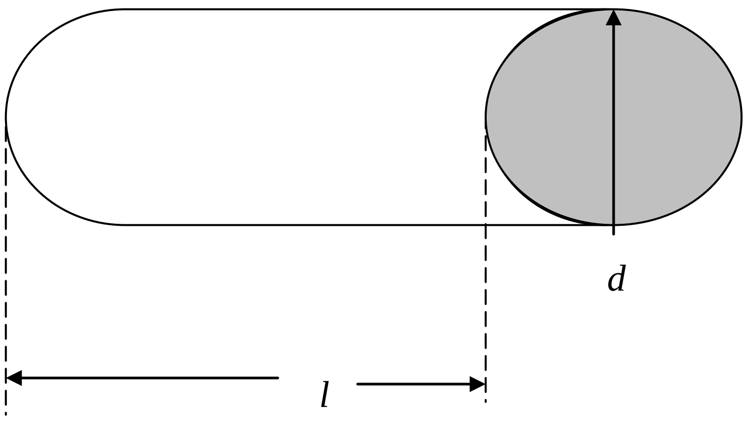
If each side of this cube is 2 meter then the volume V of this cube is

V = L1 x L2 x L3

V = 2 x 2 x 2

V = **8 m³ = 8000 dm³ = 8000 litres**

Volume of a cylinder



The formula for calculating the volume (**v**) of a cylinder is this:

$$v = \frac{\pi}{4} d^2 l$$

Example 5.2:

v= ? *d* = 21 cm, *l* = 2 meters
It is easier to calculate when all the measurements are converted to the same unit:
d = 21 cm = 2,1 dm *l* = 2 m = 20 dm

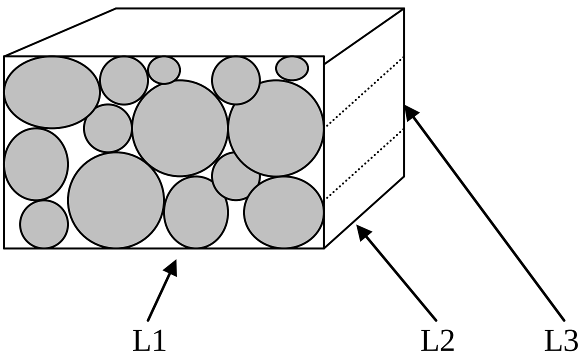
$$v = \frac{3{,}14}{4} 2{,}1^2 x 20$$

v = **69,24 dm^3 = 69,24 litres**

The volume of logs is calculated as the volume of cylinders. The diameter is measured at the middle of the log. In forestry there are volume tables for logs as well as for standing trees. This makes it easier to make quick calculations of e.g. the total volume of logs on a truck

Stacked and solid volume

When selling firewood is very common that the are cut 1 meter lengths. In the case below, these small logs are stacked together. It is very much work to measure every single log of firewood and therefore it is also common to measure the stacked volume.



Example 5.3:

The stacked volume V is calculated as

V = L1 x L2 x L3
L1 = 2 meters
L2 = 1 meters
L3 = 1,3 meter, the standard length of firewood logs in Kosova

V = 2 x 1 x 1,3
V = **2,6 m^3** This is the stacked volume.

We want to know the solid volume in this stack of wood. There is a lot of air in between the logs, and therefore the solid volume is less than the stacked volume. We therefore multiply the stacked volume with a factor **f**, which is less than 1 (one)

The solid volume can then be calculated:

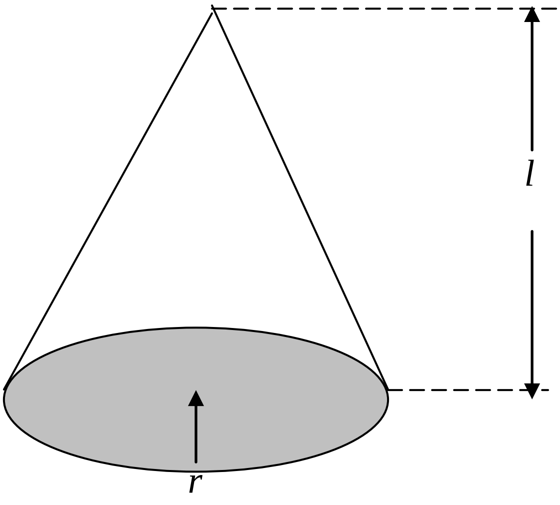
V = L1 x L2 x L3 x f

L1 = 2 meters
L2 = 1,3 meters
L3 = 1 meter
f = factor. Normally the value of **f** is around 0,65   This corresponds to 65% of solid volume in the stack and consequently there is 35% of air between the logs.

V = 2 x 1,3 x 1 x 0,65
V = **1,69 m^3**   This is the solid volume.

Stacked firewood of Quercus sp on a truck in Pristina

<u>Volume of a cone:</u>



The volume of a cone (**v**) is calculated with this formula:

$$v = \frac{\pi}{4} d^2 l \frac{1}{3}$$

Example 5.4:

v= ? r = 21 cm, l = 2 meters
We convert all the measurement to the same units r= 21 cm = 2,1 dm. then d = 4,2 cm l = 2 m = 20 dm

$$v = \frac{3{,}14}{4} 4{,}2^2 x 20 x \frac{1}{3}$$

v = **92,3 dm^3**

5.4 Calculation of %

The symbol % (*per cent*) means parts per hundred. The use of % is very common and practical in our daily life, and also in the life for professional foresters.

Example 5.5
You get € 200 for the sale of firewood but you have to pay 15 % of this money to a truck driver.
How many **€** do you have to pay?
You have to pay 15 parts of hundred (15/100)to the truck driver.
1/100 or 1% of € 200 is € 2.

15% is € 2 x 15 = **€ 30**. The truck driver must be paid € 30
The truck driver gets 15% and you get 100 – 15 = 85 %. (=85/100)

In money you get 85/100 x 200 = **€ 170**

Example 5.6
A forest worker will buy a new chainsaw; the old one does not work any longer because the piston in the engine is broken.
A new chainsaw will cost € 300. After some discussion and bargaining, the salesman offers the forest worker a discount of 12 % if he pays cash. How much is this discount in € ? How much does he have to pay in €?

This problem can be written in a mathematical way because mathematics is a very useful tool when discussing prices and payments. The value we want to answer is very often called X. In this case the discount in € is called X.

We use an equation which implies that these two fractions are equal to each other

$$\frac{x}{300} = \frac{12\%}{100\%}$$

$$x = \frac{12 * 300}{100}$$

$$x = 36$$

The forest worker gets a discount of **€36.** He has to pay cash 300 – 36 = **€ 264**

Example 5.7

The standing volume of a forest is 4500 m^3. The annual increment has been calculated to be 2,8 %. How much is the annual increment in m^3 ? Instead of the words “The annual increment” we use the symbol X.

$$\frac{x}{4500} = \frac{2{,}8\%}{100\%}$$

$$x = \frac{2{,}8 * 4500}{100}$$

$$x = 126$$

The annual increment is **126 m^3**

Example 5.8

A private truck owner has two trucks. He normally gets the diesel fuel for **€ 0,95** per litre. During a year the two trucks use 9 000 litres of diesel. But one day the price for diesel fuel increases with 6 %.
How much more does the truck owner have to pay for fuel per year after this increase?
This increased cost is called X in the calculation below.

First we calculate how much he has to pay per year with the present prices.
The sum he has to pay with the present price is called P in the calculation below.

P = 0,95 * 9000
P = € 8 550

That is a lot of money. but let us hope that he has more income from use of the trucks.

Now, how much more does he have to pay per year for the fuel?

$$\frac{x}{8550} = \frac{6,0\%}{100\%}$$

$$X = \frac{6,0 * 8550}{100}$$

***X* = 513**

The increase in total cost for diesel is **€ 513.**

Example 5.9

The number of trees is 5000 in one hectare of forest. This is very high density and some thinning has to be done. After the thinning has been finished and the wood have been sold, the foresters find that the number of stems have been reduced to 2 900 trees per hectare. What has been the removal % calculated as number of trees per hectare?

First we calculate the removal or how many trees have been removed. (R.)

R = 5 000 – 2 900
R = 2 100 trees

$$\frac{2100}{5000} = \frac{X\%}{100\%}$$

$$X\% = \frac{2100 * 100\%}{5000}$$

$X = 42$

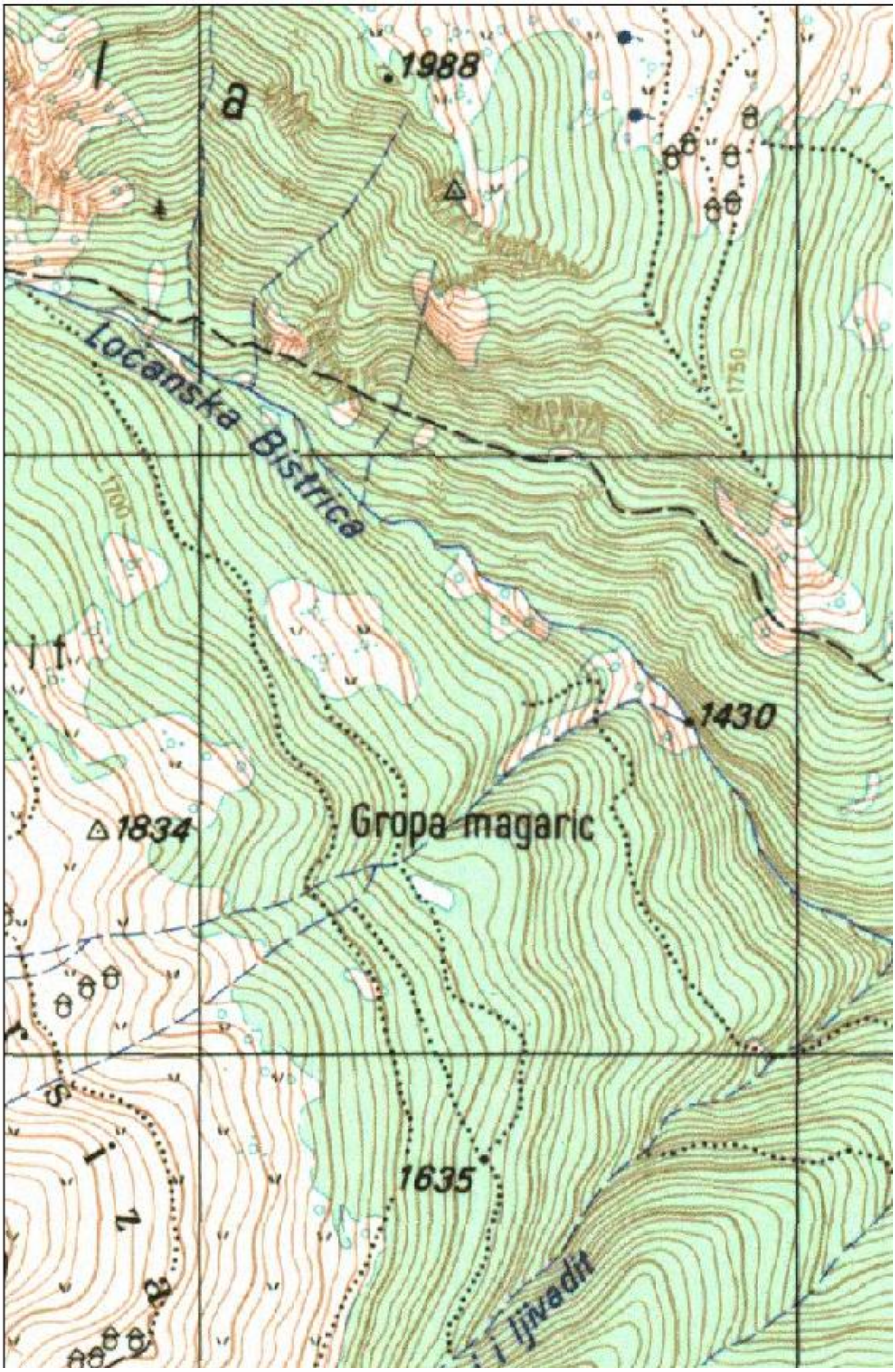
The thinning has been **42 %** of the total number of stems

6 Map

The forests often cover large areas and there is a need to have maps for management of the forest and for different activities. A map is a drawing on a paper or on a PC screen, where all the details of interest are drawn as if they were all seen vertically from above. The drawing is reduced in size compared to the real terrain. This reduction is called the scale. This implies that each detail is drawn on a dense coordinate grid where they also get unique coordinate numbers. There are an enormous number of details in the forest, most of which are uninteresting and they can not all be drawn on the map because.

Details of importance are represented on the map by using standard symbols and text. Maps are made for many specific purposes, such as geological maps, topographical maps, road maps, forest maps etc. Basically the same method of construction is applied for all, but the information included and the standard symbols used in the map will vary according to the needs.

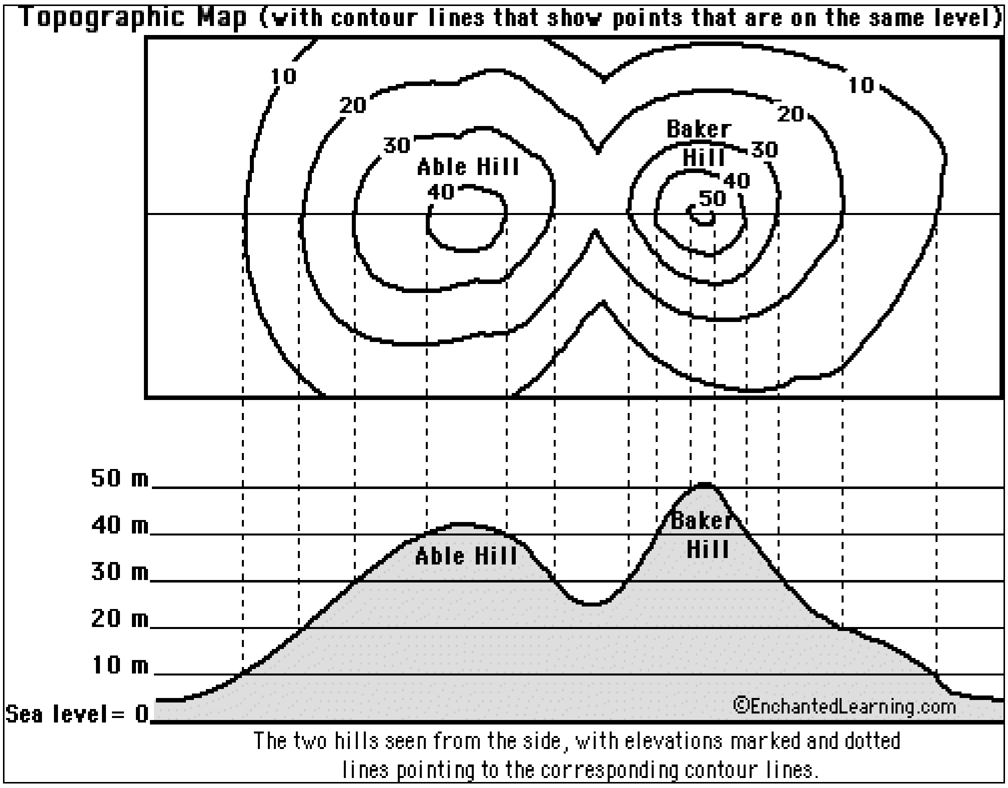
The construction of all modern maps is based on vertical stereo aerial photos and all details are given unique coordinate values according to the coordinate system used in each country. The use of numeric coordinate values, is the basis for satellite images, aerial photos, GPS (Global Positioning System) and the use of computers in mapping, so called GIS (Geographical Information Systems)



A topographic map

The above map is a cut of an ordinary topographic map in the Deçan area in Kosovo The green colour indicates forest and vegetation. The brown contour lines have an equidistance of 10 meters. The straight black lines are the coordinate grid. Each square is 1 km x 1 km = 1 km^2 . The vertical lines go south – north and the horizontal lines go west -east.

6.1 The contour lines on a map



The figure shows two hills, Able Hill and Baker Hill, in a profile and how these hills appear on a topographic map.

The contour lines are lines which connect all the details in the terrain having the same height above the sea level. The first line is the sea level itself. The second line is 10 meters above the sea level; the third line is 20 meters above the sea level etc. The vertical distance between these lines is 10 meters in this case. This distance is called the equidistance. Different maps may use different equidistance, depending upon the scale of the map and what the maps are used for. When the contour lines are seen very close to each other on the map, the terrain is steep. Similarly, when the distance between the contour lines on the map is bigger, the terrain is less steep. The contour lines can be used for measuring the actual slope in the terrain.

In forestry the topographic maps are very important tools because they can be used for basic road planning, planning of harvesting operations, planning of silviculture operations, management planning, forest inventory and a number of other detailed tasks.

6.2 Scale

Scale means the reduction in distance on the map compared to the same distance in the terrain. If a map is constructed to the scale of 1 : 1000 it means that a given distance on the map is 1000 times longer in the terrain. Therefore 1 cm on the map will correspond to 1000 cm. or 10 meters in the terrain.

Example 6.1:
What is the distance in the terrain when the distance between two houses is 8,4 cm. on the map. The scale of the map is 1 : 5000 The double arrow $\Rightarrow$ means "corresponds to" and not equal to.

Map **Terrain**

$$1cm \Rightarrow 5000\,cm$$
$$1cm \Rightarrow 50\,m$$
$$8{,}4cm \Rightarrow 8{,}4 * 50m$$
$$8{,}4cm \Rightarrow 420m$$

8,4 cm on this map corresponds to 420 meters in the terrain.

6.3 Area.

When calculating an area, the scale should be used in a different way compared to the example 6.1 above. An example will demonstrate this.

Example 6.2:
What is the area of a site when the area measured on the map is 27 cm^2? The map is constructed in the scale 1 : 25 000 The double arrow $\Rightarrow$ means "corresponds to" and not "equal to".

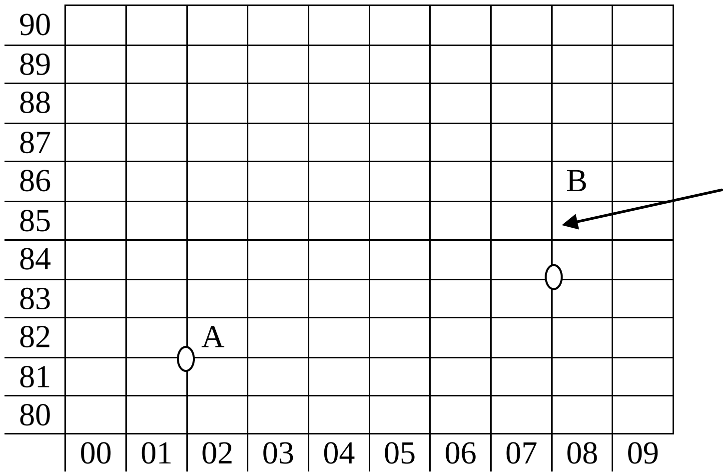
Map **Terrain**

$$1cm \Rightarrow 25000\,cm$$
$$1cm \Rightarrow 250\,m$$

$$1cm * 1cm \Rightarrow 250 * 250\,m$$
$$1cm^2 \Rightarrow 62500m^2$$
$$27cm^2 \Rightarrow 27 * 62500m^2$$
$$27cm^2 \Rightarrow 1687500m^2$$
$$27cm^2 \Rightarrow 1687{,}5ha$$
$$27cm^2 \Rightarrow 16{,}875\,km^2$$

6.4 Coordinates

Below is a very simple map with only two details, the ring at A, the ring at B and a grid with coordinates.



On the left side are the coordinate values for each of the intersection of the lines in the grid. In this example there is no unit of measurement, but normally the value of the coordinates indicates meters distance from a given point of origin.

The coordinates for the ring A and the ring B can be read from the map. Normally we read the horizontal coordinates (east-west) first, and then the vertical (south-north) ones. In this simplified example we read the coordinates of the O where the symbol A or B is written and indicated by the arrow.

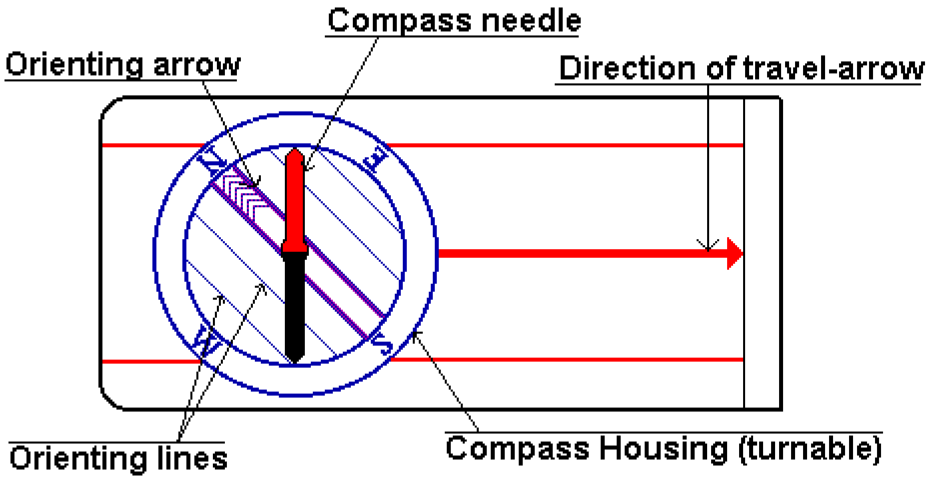
First we read the coordinates for ring A
The horizontal value is 02
The vertical value is 82
The coordinates for the ring A are **0282**

Then we read the coordinates for ring B
The horizontal value is 08
The vertical value is 87
The coordinates for the ring B are **0887**

With such a system, all the details in a map are given unique coordinate numbers. Numbers are easy for a computer to handle. With the above coordinates, a computer can calculate the distance between the A and B if we know that the coordinate values are meters. The computer can also easily calculate the bearing (azimuth) from A to B. All modern maps are based on coordinate systems.

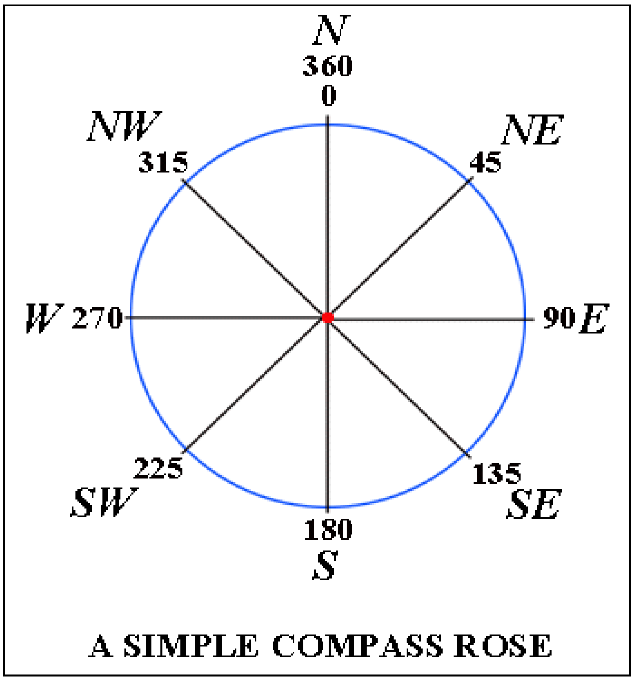
6.5 Bearing and compass

The principle directions on a compass are **N**orth, **S**outh, **E**ast and **W**est. In forestry the most commonly used compass is the one illustrated below.



The red and black arrow is the magnetic *compass needle*. **The red part of it is always pointing towards the earth's magnetic north pole.**

The *Compass housing* is turnable.. On the compass (bussola) the circle is subdivided in to (360^0) or sometimes it is subdivided in to 400 grades (400^g). The circle with 360 degrees is probably the most commonly used. On this one can read the *bearing* or *azimuth*. The bearing or azimuth is the direction of the straight line between two details in the terrain. There are also the letters N, S, W and E for North, South, West and East.



Some main bearings of the compass are tabulated below:

Compass with the circle 360 degrees = 360^0

North	NE	East	SE	South	SW	West	NW	**North**
0^0	45^0	90^0	135^0	180^0	225^0	270^0	315^0	**360^0**

Compass with the circle 400 grades = 400^g

North	NE	East	SE	South	SW	West	NW	**North**
0^g	50^g	100^g	150^g	200^g	250^g	300^g	350^g	**400^g**

When reading a map, the ordinary text goes from west to east. Then the north is always pointing away from the reader and the south is opposite of north. This is an international standard.

To identify and find a detail in the terrain we need to know the distance and the bearing. These two pieces of information we can find on the map.

7 Forests in Kosova

A national *forestry inventory* was finished in Kosova in 2003. A forest inventory is a method to find the area of forests, the total volume in m^3 of the different tree species, the annual increment of the different tree species in m^3/year, category of ownership, classification of the terrain and a number other details.

Because it is impossible and expensive to measure all trees in a big forest, the forest inventory always makes use of sampling. This implies a system of small sample plots, systematically distributed over the whole forest. This distribution of sample plots is very often made by means of a regular grid, covering the whole forest area in question. Each sample plot has a given area, which can be 100 m^2 or 200m^2 or 500m^2 or other size, depending upon the forest type and the total forest area. The measurements are made on these sample plots only, and we assume that the forest on these plots is similar to the rest of the forest outside these sample plots.

Planning and implementation of forest inventories for big areas requires special skills and experience, while reading and understanding the final results from an inventory should require basic forest knowledge only.

The main findings and conclusions in the forest inventory project in Kosova are:

Area distribution in Kosova

	hectares	**%**
Public forest land	278 880	
Private forest land	185 920	
Sum forest land	**464 800**	42,4
Other land	629 400	57,5
Total area	**1,094,200**	**100**

Broadleaved forests, cover about 93 % of the total forest area. The dominating broadleaved species are *Quercus spp* and *Fagus spp.* Coniferous forests, covering 7% of the total forest area are dominated by *Abies alba, Picea abies and Pinus spp.*

The forest inventory has calculated the total volume of the stems of the trees in the forest. A small tree may have a volume of 0,01 – 0,02 m^3 (= 10 – 20 dm^3) while a big *Fagus sylvatica* or *Abies alba* may be 1,5 m^3 or more.

Standing volume Kosova forests in million m^3

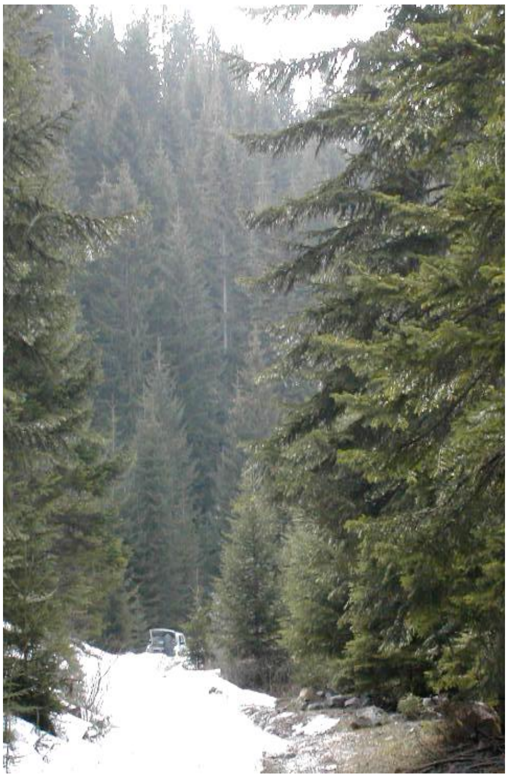
	million m^3	**%**
Public forest land	33.5	63
Private forest land	19.5	37
Sum volume	**53.0**	**100**

The forest inventory has measured the annual increment on a big number of different trees on the sample plot. These measurements have been used to calculate the total increment in the whole forest. Based on the information of the total standing volume and the increment, the total allowable harvesting has also been calculated. The allowable cut is the amount of wood which could be harvested every year, without cutting more than the forest can produce. In this forest inventory it is calculated that 77% of the total annual increment can be harvested every year. The allowable cut therefore is

100% – 77 %= 23% less than what the forest is producing.

Increment and allowable harvesting in thousand m^3

	Thousand m^3	**%**
Allowable harvest in high forest	700	60
Allowable harvest in low forest	200	17
Sum annual allowable harvesting	900	77
Total annual increment	**1 165**	**100**



Picea abies

Fagus sylvatica

From the forest inventory there has been calculated the standing volume for the various important tree species, because this is also of importance for the management of the forest resources in Kosova. The table below gives the results of one such calculation.

Standing volume by tree species, in 1000 m^3 and in %

Tree species	**Standing volume 1000 m^3**	**Standing volume in %**
Quercus cerris	5,176	9,8
Quercus petraea	4,277	8,1
Other Quercus spp.	129	0,2
Fagus spp.	15,963	30,2
Other broadleaves	3,706	7,0
Undefined broadleaves	5,983	11,3
Abies alba	1,577	3,0
Picea abies	1,402	2,7
Pinus ssp.	2,019	3,8
Other conifers	224	0,4
Conifers < 7cm	321	0,6
Broadleaves <7cm	12,118	22,9

Total	52,895	100,0

Harvesting licence

A licence is required from Kosova Forest Agency (KFA) before harvesting in the forest can take place. The licence for harvesting smaller quantities of wood is given by the regional office of KFA. Bigger commercial harvesting operations are subject to legal tender from the professional forest entrepreneurs. The winner of a tender gets a licence to harvest, transport and sell a given quantity (m^3) of wood after all the trees to be cut have been marked by the KFA foresters.

However a lot of illegal harvesting is taking place both of firewood from *Quercus spp.* and *Fagus spp.* as well as very valuable technical wood from conifers. The result is local over harvesting and partly serious damage to the trees and the forest. The illegal harvesting is also an indication of mismanagement and lack of control of the utilization of the natural forest resources.

8 Legislation

Kosovo legislation of the forestry field is quite progressive, based on international conventions and EU and includes the following principals:

- Precautionary principals;
- Conservation of biological diversity;
- Principal of the intergeneration equity;
- Sustainable ecological development.

The current legislation is made up of:

- Law No. 2003/3, on Kosovo Forests
- Law No. 2004/29, For the Amendments and Completion of Law No. 2003/3 for Kosovo Forests.
- Administrative Instruction No. 07/2003 for the establishment, responsibilities, functions and organization of Kosovo Forests Agency:
- Administrative Instruction MA – No. 02/2005 for responsibilities and obligations of forests guards.
- Administrative Instruction MA – No. 06/2005 for the Registration, License of Producers of the Forests Nurseries Material and Decorative Wood Plants Nurseries.

- Administrative Instruction MA – No. 12/2005 for the Determination of Tax – Prices for the Utilization of Forests Products, Non Forests Products and for the Professional Technical Services.
- Administrative Instruction MA – No. 23/2005 for the Given of Professional License;
- Administrative Instruction MA – No. 29/2005 Selection, Stumping, Marking of Woods Assortments, Wood freight Permit and Forests Order;
- Administrative Instruction MA – No. 23/2005 for the Selling of Forests Trunks and Wood Assortments.
- Administrative Instruction MA – NO. 03/2006 for the Authorization and Competences of Forests Inspection and Procedures of the Issuance of Decisions.
- Administrative Instruction MA – NO. 12/2006 For the Content and Way of Drawing up of the Forests Management Plans in Kosovo.

As well as part of proposals and strategies of the legislation for 2007, is planned to do the amendment of Kosovo Forests Law 2003/3 in some articles, and draw up of other instructions that come out form this law.

8.1 The forest law

The basis for all forestry activities in any country is the *forest law*, Law No. 2003/3,. The forest law gives general guidelines on how the forests should be managed. The forest law also specifies the public authorities who approve and control the law enforcement. Based on the forest law, there are a number of directives stating more technical details in forest operations and forest management.

The forest law states that the forests in Kosova are national resources to the benefit of present and future generations. The law is also guided by the principles of precautionary, conservation of biological diversity and ecologically sustainable development. The law strives to balance economical, social and environmental aspects. The law also addresses a number of other important issues:

* Definition of the Government tools for overseeing and developing forestry in Kosova. This includes, among other things, the creation of a *Forest Fund* to support restoration of Kosova's forest, creation of a Forestry Board to observe and investigate the management and administration of forestry and defining the responsibilities of Kosova Forest Agency.

* The Forest Fund is regulated by the Forest Law and approved in March 2003

* Allowing the public free access to and movement on the forestlands including allowing non-commercial gathering of mushrooms, berries, fruits, nuts and herbs.

* All public forestlands should be covered by a 10-year plan describing all activities during the duration of the plan. Planning requirements are also prescribed for private holdings larger than 3 hectares.

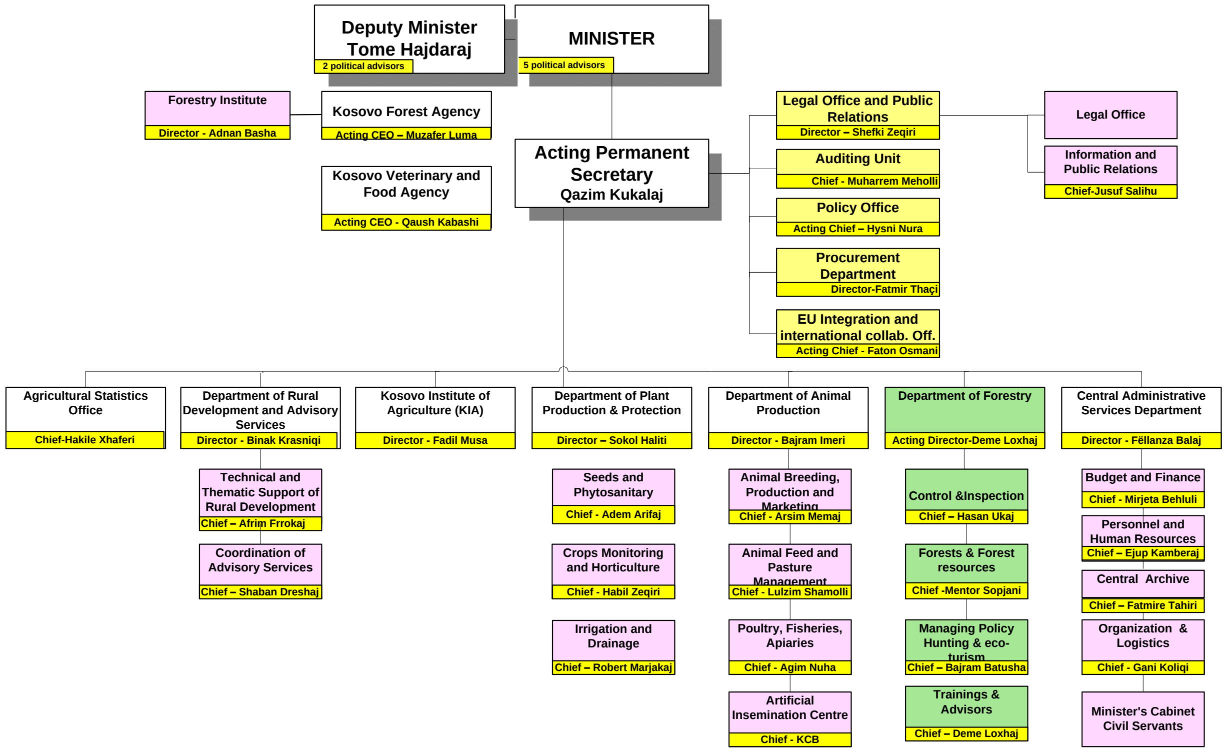
* Before any felling can commence on any forestlands, a felling permit is required and all trees have to be lawfully marked. The law also states that it is unlawful to transport wood without having a valid transport permit.

*	The law puts high attention to law enforcement. Implementation of clear procedures for handling offences, ordering of fines, responsibilities and rights of forest officials and setting of professional standards may improve the management and status of Kosovas forest. It will also be important to have close communication and cooperation with the community forestry.

*	Transparency, disclosure of government documents, and economic interests. This Plans and other information will be made available to the public and, thus, reducing risks of corruption and implementation of actions contradictory to the public interest.”

9 Administration

The current structure is being revised, and up the end of this year (2006) or possibly at the beginning of the next year there will be some changes, not only in the level of sectors but also to the individuals as a part of MAFRD Departments.



The diagram shows that there are various departments and other sections related to forestry within the Ministry of Agriculture, Forestry and Rural Development.

As a part of Kosovo Government, Ministry of Agriculture, Forestry and Rural Development is responsible for issues related to the forestry, wildlife and hunting, as well as fishing and eco tourism

MAFRD have two structures dealing specially with forestry issues:

1. Department of forestry (DoF);
2. Kosovo Forests Agency (KFA);

Main responsibilities

Department of Forestry (DoF), is a responsible for the drawing up and development of the forests policy, draft of the laws and activities regulating forest management as a sector for forests policy and development and also the sector for management policy with wild life and ecotourism, the development of education system, trainings and advisory service in forestry sector, the sector of inspection and field control etc.

Kosovo Forests Agency (KFA) is responsible for issues related to the regulation of forests, private forests lands, management and administration of forests and public forests lands, including the legal licences for commercial harvesting, as well as forest sin Kosovo National Parks.

The Main Challenges in Forestry Field are as following:

- Different interpretation of forestry and forestry land as a property and ownership;
- Not sufficiently professional staff at the country level
- Continued pressure in the damage of forests around at 40% of public forests lands and 29% of private forest lands, mainly because the forests may be the only resource of income for a number of families;
- Illegal hunting and illegal harvesting of wood etc.
- Limited possibilities for capital investments;
- Usurpations of forests and forest lands;

10 Commercial products and benefits from the forests

10.1 Products

There are a number of commercial (= which can be sold for money) products from the forest.
The most well known product is logs of the various trees. In Kosova the most valuable logs are from *Abies alba*, *Picea abies*, *Fagus sylvatica* and *Quercus spp*.
The logs can be processed in sawmills to sawn wood used in house building, carpentry and a number of other products.

Firewood is another very important commercial product in Kosova. Firewood is mainly produced from *Quercus spp* and *Fagus spp* and it is sold to private households, municipalities and local industry.

Firewood of Quercus spp. ready for sale

Other non wood commercial products from the Kosova forests are mushrooms, wild berries, honey, resin, edible nuts and flowers.

10.2 Benefits

Forest environment is not only supplying commercial products. There are numerous other benefits for humans. The benefits may vary from one place to another and from one country to another. A few of these benefits are mentioned below.

The forest affects the local climate and wind and it also gives shelter and shade.
The forest is important for protection against soil erosion on hillsides and along the rivers.
The vegetation in the forests helps to maintain and refill the ground water reservoirs.
Rivers and streams are coming from forested areas and is the basis for fishing.
The biodiversity in the different types of forests is important for the ecosystems.
The forests provide important recreational areas for people.

The growing and living trees need large amounts of carbon dioxide CO_2 and consequently they produce large amounts of oxygen O_2 The plants and trees are necessary for our survival. As we breathe in, our bodies take in oxygen O_2 and when we breathe out, we release carbon dioxide CO_2 Trees and other plants do the opposite, as they are absorbing CO_2 and release O_2 Both O_2 and CO_2 are gases vital for the life on earth. (See chapter 2)

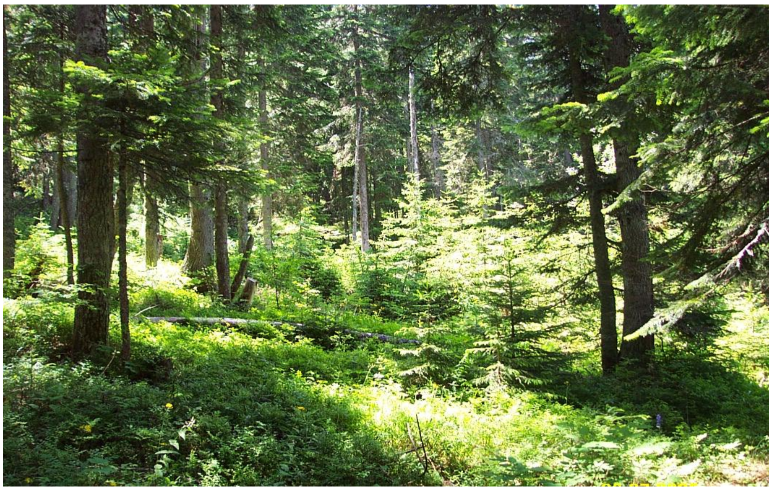
The plants cannot survive without the carbon dioxide CO_2 and the human beings, birds and animals cannot survive without the oxygen O_2

11 Silviculture

Silviculture is the subject dealing with all the biological aspects of growing trees and forests for a particular purpose. The purpose can be to produce logs and wood for the industry, producing firewood or any other commercial product or benefits. Very often the purpose of human intervention in the forests is complex and not aiming at one objective alone.

There should be a clear objective with any silviculture work or silviculture intervention in the forest. Such objectives are found in the **forest management plans.**

The regeneration is the first step of silviculture activity. To secure the regeneration is to make sure that the young forest plants have the necessary conditions for growth and become the next generation of forest.



Natural regeneration of Picea abies

As the young trees in a forest are growing, there are normally so many small trees that they all cannot survive. There are not enough nutrients, light and water for the survival of all. When the forest reaches this stage it will be appropriate to do spacing or thinning. The trees that are judged to become a part of the future forest are left, while the other trees are cut. This is done according to certain guidelines for each species. If the stems of the cut trees have a suitable size, they can be sold on a commercial marked and thereby cover some of the costs of the thinning operation..

A thinning operation takes place sometimes 2 – 4 times during the life of given forest area, before the final harvesting of the produced trees. The number of thinning operations depends on the life cycle of the trees, on the site quality and on what is the desired quality of the final product. Since most thinning operations are quite costly compared to the final harvesting, it is important to be aware of the economical costs and benefits. The forest management plans are normally made with these economical factors in mind.

When doing silviculture interventions, the forester must have good knowledge to th the forest management plan, about forest biology and forest ecology as well as forest harvesting and economy and not at least, about how to communicate with people.

The final harvesting can be made as a clear felling on a limited area. This is quite common and convenient for conifer forests. But the harvesting of the mature trees sometimes is in some occasions done as a felling of the bigger trees in two or three operations with some few years of interval. This may help the natural regeneration to establish itself. However, more technical operations causes damage to the remaining trees and to the forest ground and it is more costly.

Local conditions, economy and the method for regeneration to be employed, are important factors for the decision of how the final harvest is to be done. See the appendix 1 for explanation of some silviculture terminology.

The forester must think of economy as well as of the regeneration and sustainability when the forest area is to be harvested or thinned.

12 Economy

When utilizing the forest resources, the cost of the production should not higher than the price for the final product. Still we have to manage the forests in a sustainable way, which means that the forest shall not be destroyed or reduced by our activities. A sustainable forest management means to secure the forests and the production for the future generations. Therefore the cost of silviculture, such as necessary planting, thinning, pest control and other activities, is a part of the total production price.

Example 12.1

A private forest owner has a young oak forest. The forest is very dense and he is advised to carry out thinning. The forest owner decides to do the thinning but he also keeps record of all the expenditures and the incomes. The plan is to cut 40 m^3 of wood. Because the trees are young and small the wood can be sold only as firewood for €10 per m^3.

Costs in €			
Planning of the thinning operation 2 days		15	
Salary for the workers who do the thinning 4 man days		60	
Transport of the wood from the forest to the nearest market		60	
Repair of some necessary equipment		40	
Sum costs for the thinning	€	175	
Incomes in €			
Sale of wood €10 x 40 =			400
Surplus	€		225

The surplus per cubic meter 225 / 40 = **€ 6,60 per m^3.**

According to this calculation, the operation has been profitable.

If however the price for this wood in the market had been only € 5, then the operation would have given a surplus of only € 0,63 per m^3.

After the thinning operation the remaining forest is in a better condition and the quality of the future stems will be better.

Similar thinking is to be employed prior to all investments, such as buying a machine, a tractor, a house, make a forest road, planting or other things. Very often there are high immediate investment costs, while the benefits are coming later.

Example 12.2 Purchase of a chainsaw

The cost will be
Initial price, paid with a loan from a bank
Price for the money, interest rate
Maintenance, fuel and oil

The incomes will be
Increased production per day, possible higher salary
Less repair work on the new chainsaw
The possible future sale of the chainsaw when it becomes old

For doing this calculation it is of course necessary to have figures for all the costs and incomes When incomes and expenditures are compared, it is possible to know whether the investment is profitable or not.

Such calculations are made according to a certain method because of the difference in time for the expenditures and the incomes. If the calculation does not indicate a profitable investment, then it should not be implemented

Forestry is important in the **national economy** of Kosova. Conservative or low estimates of the products and benefits from the forestry sector are in the range of € 50 – 75 million. 1 million € = 1 000 000 €. This corresponds to €25 - 37 per person in Kosova every year. These figures are not only salaries but include the total value of the forest products, benefits and all other activities in the forestry sector. With a professional management based on sustainability of these renewable natural resources, this value can probably be increased considerably in the years to come.

13 Harvesting

Harvesting includes all the activities linked to the felling of trees, transport and the commercial sale of wood.

The harvesting of the commercial wood is important for the country as the industry and other customers are supplied with needed raw material and products. The harvesting is also important because it provides employment for a number of forest workers, for forest entrepreneurs and the companies who deliver the necessary supplies and service to the activities involved.

The harvesting is one element in the forestry supply chain. Such a supply chain is an important part of the logistics in forestry. When this supply chain is managed efficiently, the economical benefits will be the best for everyone involved, including the customers.

13.1 Supply chain management (SCM)

This is the process of planning, implementing, and controlling the operations of the *supply chain* with the purpose to satisfy customer requirements as efficiently as possible. SCM spans all movements and storage of raw materials, the industrial process, and finished goods from point-of-origin to point-of-consumption. The supply chain managemen also includes the equally important opposite flow of information.

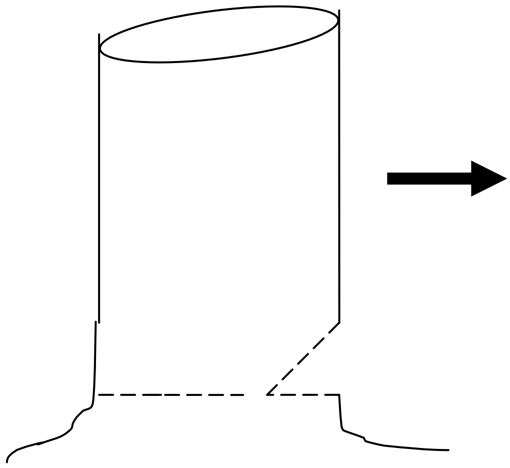
One detail of the SCM is the actual felling of trees. This is a risky and difficult part of the harvesting and it is important that the forest workers are well trained, that they have good equipment and that they use the necessary safety equipment as can be seen on the photo below.

Full safety equipment with helmet, ear protection, eye protection, jacket with signal colours, trousers with built-in protective fabric of synthetic fiber and protective boots with good grip soles

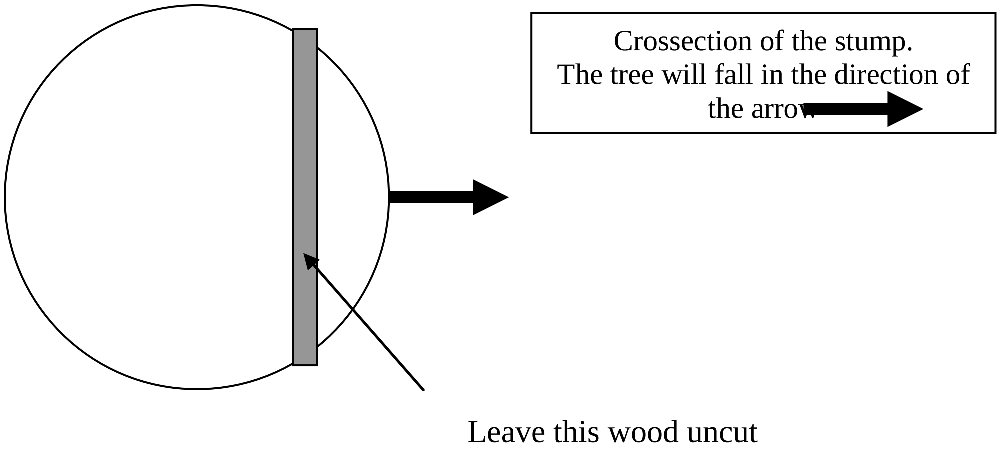
The felling work should follow a given procedure in order to avoid accidents and to reduce problems and to secure efficient progress in the work

The first cuts of have been completed. The worker know exactly where the tree will fall.

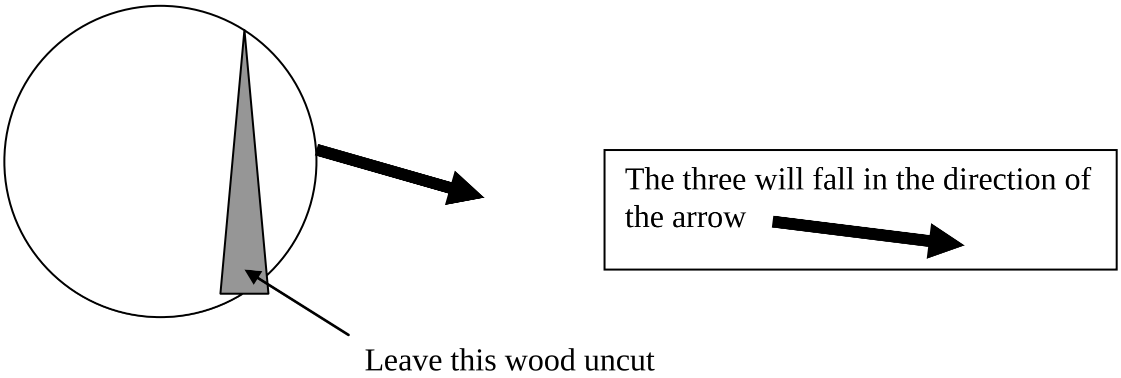
To control the direction in which the tree is falling when cut, is normally not a problem, not even for big trees of *Picea abies* or *Abies alba* The drawings below however are related to the felling of relatively small trees.



Principles of felling a tree



Principle of cutting when you want the tree to fall in the direction of the arrow



How to do the cutting if you want the tree to fall more to the right. Leaving more wood on the right side will force it to fall in that direction

The terrain transport of logs is sometimes difficult because of the terrain and it is also costly. The terrain transport requires good planning as do the whole harvesting operation. It is of importance that the skidding can be executed in such a way that the remaining trees are not damaged by the logs, by the tractor wheels or by wires. Because of the high risk of such damage, it advisable in steep terrain to do the final harvesting as limited clearfellings and not as thinnings. Thinning in mature forest with big trees will inevitably lead to damage to the remaining forest trees and to increased operation costs.

The equipment used for the terrain transport of logs in a harvesting operation can be *horses*, *farm tractors* with 2 or 4 wheel drive, *skidders*, *forwarders* or *cable systems*. Very much of the forests in the mountains in Kosova is very suitable for the use of cable systems. Some times also *manual hauling* downhill is being used, but this slow method, although it is relatively cheap, will open the ground for erosion.


A Timberjack skidder is used for the terrain transport of logs.

Logset forwarder with 8 wheel drive for terrain transport

A skyline system mounted on a 6 wheel drive truck
would be very suitable for terrain transport
when logging in steep terrain in Kosova

The poor quality of the forest roads is a serious problem for the commercial harvesting in Kosova. These poor roads is a reason for damage to the vehicles, reduced payloads and unnecessary high costs for transport. The bad quality of the forest roads is also an environmental problem as they very often are the reason for soil erosion.

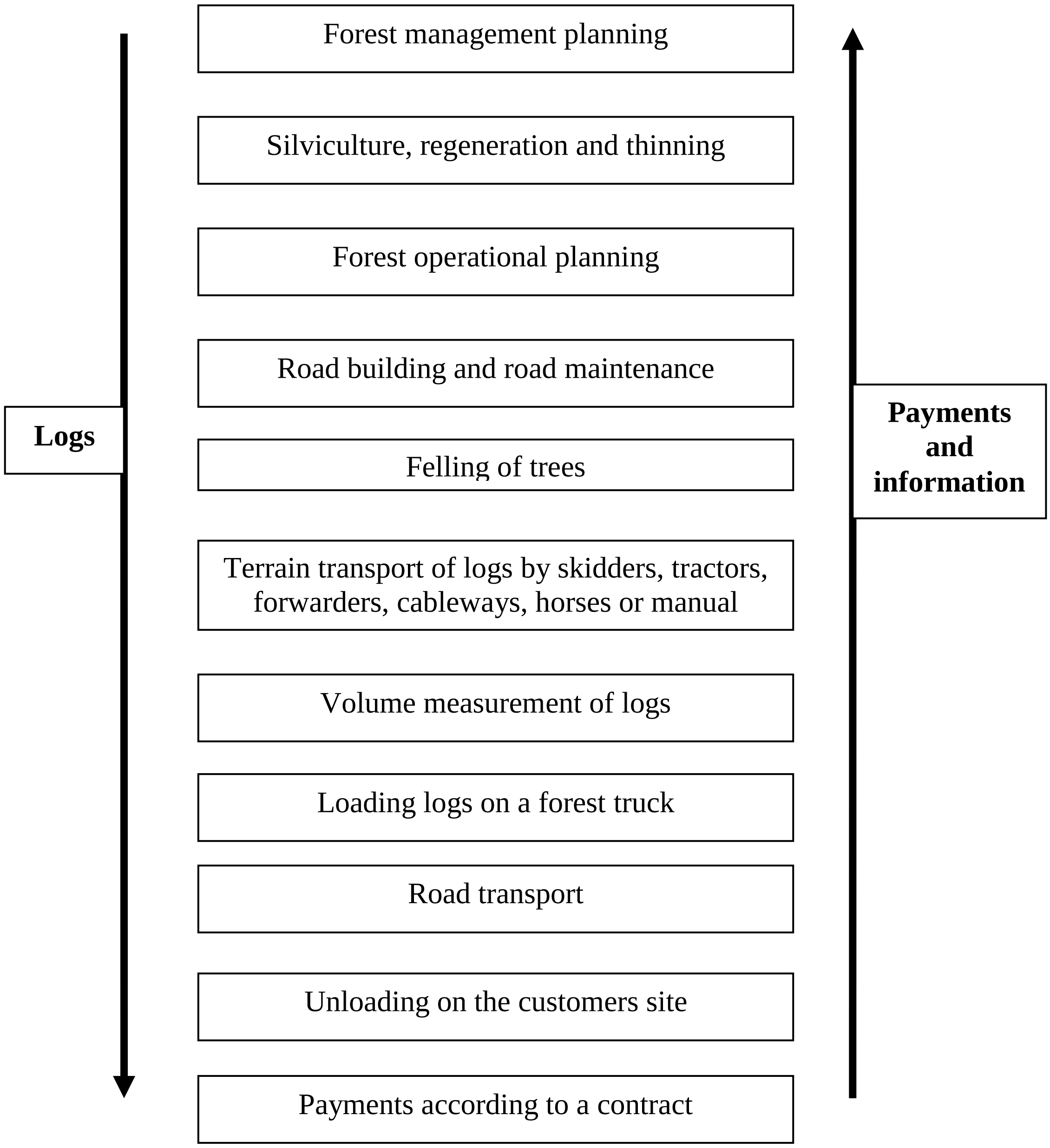
Forest road maintenance is an important part of the forest supply chain.
Here the rubber grader is being pulled by a skidder.

Loading the truck prior to the road transport.
The logs are measured before loading.

The most basic elements in the supply chain in forestry are illustrated below in a simplified way. The illustration shows that the various human activities for utilizing the forest resources are closely connected to each other. It is not sufficient to considering only one of the activities in this chain. Any chain, e.g. the supply chain in forestry, is not stronger than the weakest link.

Note that the visible part of the supply chain is the movement of logs and products. Less visible are the movement of payments and information. The information between the people working along this chain is crucial for an efficient production. One forgotten appointment, one forgotten piece of information, a misunderstanding, an unwillingness to cooperate, some delayed payments etc are always very costly. It causes delays and waste of time for people and machinery; it affects the agreed quality and quantity of the products and therefore reduces the value for the final customer.

The supply chain it Forestry



The professional forester must know the whole supply chain, although it is not for one person to have detailed knowledge on all details. The necessary knowledge includes both forestry and also knowledge about communication between people.

Successful forest management depends on the people, their ability to cooperate, to work in team and to communicate and organize the work within a sound and transparent economic system for the best for the whole society.

The harvesting of wood consists of a number of technical, logistic and economical details. It is the harvesting operation which provides the economical benefits from the long term investments in silviculture and protection of forests. The harvesting operations can be separated in these technical elements

14 Forest Management Planning

In a wide context the planning implies a systematic consideration of all possible actions within a certain field, with the purpose of coordinating all these actions in an efficient way in order to reach given objectives or goals.

Without defined objectives or purpose of these actions, it is useless to do planning. Similarly it will not be possible to win a football match if the goals on the football field are removed. A football match will also be quite uninteresting for everyone without the possibility to reach the goal.

There is no point in planting forest trees, to do pruning or thinning, harvesting or other silviculture activities if the forester or the forest owner does not know what she/he wants to achieve by these activities: the objectives for the forest work must be defined and be well known.

In forestry the management planning is based on several documents, of which the Forestry Law may be considered as being the most important. The Forestry Law outlines the general and nationals goals with the management of the forests as natural resource.

The forestry law in Kosova is among other details, based on these principles (see chapter 8)

- Precautionary principles;
- Conservation of biological diversity;
- Principal of the intergeneration equity;
- Sustainable ecological development.

The state and the municipality very often have different objectives for the forest management than what is the case for a private land owner. Within the framework of the overall national forest policy, the private or the public forest owner may have specific objectives such as

To secure a certain annual income in terms of money
To create an economic surplus sufficient to maintain and renew the necessary equipment
To minimize the costs and work safer and more efficiently
Employment of one or more forest workers
To produce a given quantity of firewood or bio energy every year
To produce a given quantity of technical wood for the wood based industry, either today or in the future.
To maintain and develop the forested area for sustainable production
To secure the biodiversity
To secure and develop the local income from non wood products

A basis for the forest management is the knowledge about the available resources. These resources are the forest area, the terrain conditions, the growing stock and the increment, the species, the distance from the market etc. etc. Such information comes from a forest inventory (see chapter 7). From the inventory it can be calculated the annual increment and the sustainable allowable harvesting of different qualities.

A general rule in forestry is that over a period of time, the harvesting of wood from a given forest should not exceed the increment or production from this forest during the same period of time. The harvesting of the forest will then be sustainable. There are various methods of calculating the *sustainable annual harvest* from a forest.

Other resources and information to be considered are; the available staff and their qualifications, the forest roads and transport capacity, the available machinery, the available capital, the costs for licences and other harvesting costs, as well as the market for the harvested products.

Some general principles in the process of Forest Management Planning are as follows.

1 Definitions of the general objectives
2 Date collection of the available resources, necessary to make a plan
3 Analysis of the resource assessment
4 Make a synthesis of this analysis and find the most likely and optimal set
5 of activities.
6 Writing and editing the forest management plan for the forest in question

7 Implementation of the plan
8 Control of the quality, quantities, qualities and economic results and make possible adjustments of the written plan and/or make adjustment on the activities, based on the experiences gained

Quite often there are developed certain routines and standards for forest management planning. These standards may be very useful, but one must be aware that such standards may not always be the best for all categories of forests or forest owners. Any professional forester including the professional forest worker should be able to read and understand the content of forest management plans, because such plans are the basis for most of the forest activities.

Appendix 1 Silviculture terminology

Modified from a work made by the Silviculture Instructors Subgroup Silviculture Working Group Society of American Foresters (1994)

Advance Regeneration (Reproduction)
Seedlings or saplings that develop or are present in the understorey of the vegetation.

Afforestation
Establishment of a forest or forest stand in an area not recently forested.

Age Class
A distinct aggregation of trees or a grouping of trees, e.g., 10-year age class, as used in inventory or management.

Artificial Regeneration (Reproduction)
An age class created by direct seeding or by planting seedlings or cuttings.

Basal Area
The area of the cross section of a tree stem, including the bark, generally at breast height (1,3 m above the ground).

Breast Height
A standard height 1,3 m above the average ground level for recording diameter, girth, or basal area of a tree.

Burning, Prescribed
The application of fire, usually under existing stands and under specified conditions of weather and moisture, in order to attain silviculture or other management objectives.

Canopy
The foliar /needle cover in a forest stand.

Canopy Closure
(see Crown Cover)

Cleaning
A release treatment made in an age class not past the sapling stage in order to free the favored trees from less desirable individuals of the same age class that overtop them or are likely to do so (see Improvement Cutting, Liberating, Weeding).

Clearcutting
(see Regeneration Methods)

Codominant
(see Crown Class)

Composition, Stand
The proportion of each tree species in a stand expressed as a percentage of either the total number, basal area, or volume of the important tree species in the stand.

Coppice
(see Regeneration Methods)

Crop Tree
Any tree that is selected to become a component of a future commercial harvest.

Crown
The part of a tree bearing live branches and foliage.

Crown Class
A class of trees based on crown position relative to the crowns of adjacent trees.

Emergent
Trees with crowns completely above the general level of the main canopy receiving full light from above and from the sides.

Dominant
Trees with crowns extending above the general level of the main canopy of even-aged stands or, in uneven-aged stands, above the crowns of the tree's immediate neighbors, and receiving full light from above and partly from the sides.

Codominant
Trees with crowns forming the general level of the main canopy in even-aged stands or, in uneven-aged stands, the main canopy of the tree's immediate neighbors, receiving full light from above and comparatively little from the sides

Intermediate
Trees with crowns extending into the lower portion of the main canopy of even-aged stands or, in uneven-aged stands, into the lower portion of the canopy formed by the tree's immediate neighbors, but shorter in height than the codominants. They receive little direct light from above and none from the sides.

Suppressed
Trees of varying levels of vigor that have their crowns completely covered by the crowns of one or more neighboring trees.

Crown Cover
The ground area covered by the crowns of trees or woody vegetation as delimited by the vertical projection of crown perimeters and commonly expressed as a percent of total ground area (syn. Canopy Cover).

Crown Density
The amount and compactness of foliage of the crowns of trees and/or shrubs as seen vertically from above.

Cutting Cycle
The planned interval between partial harvests in an uneven-aged stand (see Thinning Interval).

Even-aged Stand
A stand of trees containing a single age class in which the range of tree ages is usually less than 20 percent of the rotation age

Even-aged System
A planned sequence of treatments designed to maintain and regenerate a stand with one age class. The range of tree ages is usually less than 20 percent of the rotation. (see Clearcutting,

Seed Tree, Shelterwood, Coppice)

Forest Fertilization
The addition of nutrient elements for increased growth rate.

Genotype
The genetic constitution of an organism in terms of its hereditary characteristics as distinguished from its physical appearance or phenotype

Habitat
The place where an animal or plant naturally or normally lives and develops

Harvesting Method
A cutting by which a stand is logged. Emphasis is on meeting logging and economic requirements while concurrently attaining silvicultural objectives. (see Regeneration Methods)

Improvement Cutting
A cutting made in a stand pole-sized or larger primarily to improve composition and quality by removing less desirable trees of any species.

Ingrowth
Trees that during a specified period have grown past an arbitrary lower limit of (usually) diameter or height.

Intermediate Treatments (Tending)
A collective term for any treatment designed to enhance growth, quality, vigor, and composition of the stand after establishment or regeneration and prior to final harvest.

Liberating
A release treatment made in a stand not past the sapling stage in order to free the favored trees from competition of older, domination trees.

Monoculture
A stand of a single species, generally even-aged.

Mycorrhizae
The symbiotic association between certain fungi and plant roots which enhances the uptake of water and nutrients.

Natural Regeneration
An age class of trees created from natural seeding, sprouting, suckering, or layering.

Nurse Tree (Nurse Crop)
A tree, or group of trees, used to nurture, improve survival or improve the form of a more desirable tree or crop when young by protecting it from frost, insulation, or wind.

Overstory Removal
The cutting of trees comprising an upper canopy layer in order to release trees in an understory.

Phenotype
The observed, visible trait of an individual tree as the interaction of the individual's genotype and its environment.

Pole
A tree between the size of a sapling and a mature tree and which can be used for as poles in fences etc.

Precommercial Thinning
A thinning that does not yield trees of commercial value, usually designed to reduce stocking in order to concentrate growth on the more desirable trees.

Pruning. The removal of the live branches up to 4 -5 meters on a tree in order to improve high quality stems for a specific final use.

Reforestation
The natural or artificial restocking or reproduction of an area with trees.

Regeneration
Seedlings or saplings existing in a stand; or the act of establishing young trees naturally or artificially.

Regeneration Method
A cutting method by which a new generation of trees is created. The major methods are Clearcutting, Seed Tree, Shelterwood, Selection, and Coppice.

Coppice
A method of regenerating a stand in which all trees in the previous stand are cut and the majority of regeneration is from sprouts or root suckers.

Coppice with Reserves
A coppice method in which reserve trees are retained to attain goals other than regeneration. The method normally creates a two-aged stand.

Even-aged Methods
Methods to regenerate a stand with a single age class.

Clearcutting
A method of regenerating an even-aged stand in which a new age class develops in a fully exposed microclimate after removal, in a single cubing, of all commercial trees in the previous stand. Regeneration is from natural seeding, direct seeding, planted seedlings, and/or advance reproduction..

Seed Tree
The small number of trees left to provide seed. Seed trees are removed after regeneration is established.

Shelterwood
The residual trees left after the removal of most of an even-aged stand in which a new age class develops beneath these trees. This shelterwood is removed when the regeneration is well established.

Two-aged Methods
Methods designed to maintain and regenerate a stand with two age classes. In each case the resulting stand may be two-aged or tend toward an uneven-aged condition as a consequence of both an extended period of regeneration establishment and the retention of reserve trees that may represent one or more age classes.

Clearcutting with Reserves
A clearcutting method in which varying numbers of reserve trees are not harvested to attain goals other than regeneration.

Seed Tree with Reserves
A seed tree method in which some or all of the seed trees are retained after regeneration has become established to attain goals other than regeneration.

Uneven-aged (Selection) Methods
Methods of regenerating a forest stand, and maintaining an uneven-aged structure, by removing some trees in all size classes either singly, in small groups, or in steps.

Group Selection
A method of regenerating uneven-aged stands in which trees are removed, and new age classes are established, in small groups.

Group Selection with Reserves
A variant of the Group Selection Method in which some trees within the group are not cut to attain goals other than regeneration within the group.

Single Tree Selection
A method of creating new age classes in uneven-aged stands in which individual trees of all size classes are removed more-or-less uniformly throughout the stand to achieve desired stand structural characteristics.

Regeneration Period
The time between the initial regeneration cutting and the successful reestablishment of a new age class by natural means, planting, or direct seeding.

Regular Uneven-aged Stand
A stand in which different age classes occupy approximately equal areas and provide a balanced distribution of diameter classes.

Release (Release Operation)
A treatment designed to free young trees from undesirable, competing vegetation. Treatments include cleaning, liberating, and weeding.

Reserve Trees (Green Tree Retention)
Trees, pole-sized or larger, retained after the regeneration period under the Clearcutting, Seed Tree, Shelterwood, or Coppice Methods

Root Pruning
The root pruning of seedlings in a nursery bed to limit the extension of roots in depth or laterally. (see Undercutting)

Rotation age
In even-aged systems, the period between regeneration establishment and final cutting.

Salvage Cutting
The removal of dead trees or trees being damaged or dying due to injurious agents other than competition, to recover value that would otherwise be lost.

Sanitation Cutting
The removal of trees to improve stand health by stopping or reducing actual or anticipated spread of insects and disease.

Sapling
A young tree that is larger than a seedling but smaller than a pole

Scarification
Mechanical removal of competing vegetation and/or interfering debris, or disturbance of the soil surface, designed to enhance reforestation.

Silviculture
The science of controlling the establishment, growth, composition, health, and quality of forests and woodlands to meet the diverse needs and values of landowners and society on a sustainable basis.

Silvicultural System
A planned process whereby a stand is tended, harvested, and reestablished. The system name is based on the number of age classes (see Even-aged, Two-aged, Uneven-aged), and/or the regeneration method used (see Clearcutting, Seed Tree, Shelterwood, Selection, Coppice,).

Site Class
A classification of site quality, usually expressed in terms of ranges of dominant tree height at a given age or at culmination of mean annual increment.

Site Index
A measure of actual or potential forest productivity expressed in terms of the average height of a certain number of dominant trees in the stand at an index age.

Site Preparation
A hand or mechanized manipulation of a site designed to enhance the success of regeneration. Treatments may include bedding, burning, chemical spraying, chopping, disking, drainage, raking, and scarifying. All treatments are designed to modify the soil, litter, and vegetation and to create microclimate conditions conducive to the establishment and growth of desired species.

Site Quality (Productivity)
The productive capacity of a site, usually expressed as mean annual volume production per hectare.

Stand
A contiguous group of trees sufficiently uniform in age class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit (see Mixed, Pure, Even-aged, and Stratified Mixture.

Mixed Stand
A stand in which there is a mixture of species.

Pure Stand
A stand composed of essentially a single species.

Stratified Mixture
A stand in which different species occupy different strata of the total crown canopy.

Stand Density
A quantitative, absolute measure of tree occupancy per hectare in such terms as numbers of trees per hectare, basal area in m^2 per hectare or volume in m^3 per hectare.

Stand Improvement
All intermediate cuttings made to improve the composition, structure, condition, health, and growth of even- or uneven-aged stands.

Stocking
An indication of growing-space occupancy relative to a preestablished standard. Common indices of stocking are based on percent occupancy, basal area, relative density, and crown competition factor.

Stratum
A distinct layer of vegetation within a forest community.

Structure
The horizontal and vertical distribution of components of a forest stand including the height, diameter, crown layers and stems of trees, shrubs, herbaceous understory, snags, and woody debris.

Succession
A series of dynamic changes by which organisms succeed one another through a series of plant community stages leading to potential natural community or climax.

Sustainable maintain a steady level of use, without exhausting or causing ecological damage to the natural resources.

Thinning
A cultural treatment made to reduce stand density of trees primarily to improve growth and quality, enhance forest health, or to recover potential mortality.

Crown Thinning (High Thinning)
The removal of trees from the dominant and codominant crown classes in order to favor the best trees of those same crown classes.

Free Thinning. The removal of trees to control stand spacing and favor desired trees using a combination of thinning criteria without regard to crown position.

Low Thinning (Thinning from Below)
The removal of trees from the lower crown classes to favor those in the upper crown classes.

Mechanical Thinning (Geometric Thinning)
The thinning of trees in either even- or uneven-aged stands involving removal of trees in rows, strips, or by using fixed spacing intervals to favour simple and economical sound harvesting methods.

Selection Thinning (Dominant Thinning)
The removal of trees in the dominant crown class in order to favor the lower crown classes.

Thinning Interval
The period between successive thinning operations during the life span of the stand.

Tolerance, Shade
The relative capacity of a plant to become established and grow beneath overtopping vegetation where the light is limited

Two-aged Stand
A stand composed of two distinct age classes separated in age by more than 20 percent of rotation age.

Two-aged System
A planned sequence of treatments designed to maintain and regenerate a stand with two age classes.

Undercutting
The root pruning of seedlings in a nursery bed to limit root depth extension. (see Root Pruning)

Uneven-aged Stand
A stand of trees of three or more distinct age classes..

Uneven-aged System
A planned sequence of treatments designed to maintain and regenerate a stand with three or more age classes. (see Single Tree Selection, Group Selection)

Weeding
A release treatment in stands not past the sapling stage that eliminates or suppresses undesirable vegetation regardless of crown position.

Wrenching
The disturbance of seedling roots in a nursery bed (e.g., with a tractor-drawn blade) with the objective of stimulating the development of a fibrous root system.